GLOBAL BUSINESS REPORTS

GBR SERIES

ARIZONA & NEVADA MINING 2023

Production - Exploration - Precious Metals - Green Metals
Mine Reclamation - Innovation - Technology - Services

Dear Reader,

Two great mining stories are currently unfolding in the southwestern US. GBR is delighted to present “Arizona and Nevada Mining 2023”, a special report covering the main mining trends and actors in the southwest. The importance of both states at times of economic uncertainty and climate change challenges should not be overlooked. Arizona’s role as the leading copper producer in the US is further reinforced by energy transition goals and policies. Gold heavyweights in Nevada, meanwhile, surf on high commodity prices to strengthen their operations and invest in forward-looking technologies, while forward-looking companies look to extract lithium.

Regulars among the top 10 mining jurisdictions in Fraser Institute's Investment Attractiveness Index, Arizona and Nevada ranked 5th and 3rd respectively in 2021. With Nevada likely to retain its throne as the premier mining jurisdiction in the US in the coming months, high rankings should however not dissipate a shadow that looms over both states: a lengthy and hardly streamlined permitting process. In both states, several current development projects highlight the dilemma between the increased stringency of environmental restrictions and increased public scrutiny on companies’ social licenses to operate against the need to produce the minerals needed for decarbonization goals.

The challenge posed by climate change is immense, but the mining industries in Arizona and Nevada are ready to play their part in tackling it. Net-zero targets have been fixed, roadmaps towards sustainability drawn, and low-carbon technologies increasingly adopted. Beyond its abundant red metal, the “Copper State” can rely on players keen on developing rare earth and uranium potential. In Nevada, gold, silver, copper, lithium (and other) developers are actively working towards securing the US’ mineral supply chain and laying the foundation for tomorrow’s societal practices.

To make mines more efficient, sustainable and safe, miners can rely on a widespread network of service providers, environmental consultants, and technology firms. Historically lagging in terms of automation adoption rates and technological penetration within mine operations, mining firms in the southwestern US now appear intent on accelerating their use of innovative solutions. Both states benefit from a unique regulatory and secure operating environment, allowing associations, miners and service providers to operate with little external constraints.

From on-the-ground research at mining sites to in-person meetings with key industry players, GBR’s research team conducted 120 interviews from the depths of the Grand Canyon to the shores of Lake Tahoe to draw a picture of these states’ resourceful mining industries. The following pages are the culmination of those meetings and provide exclusive executive insights and analysis of the key trends likely to shape the future of Nevada, Arizona, and the US.

We would like to warmly thank these executives for their inputs and our partners at the Nevada Mining Association (NVMA), Arizona Mining Association (AMA), AMIGOS and AEMA for their kind support.

Alfonso Tejerina
Director and General Manager
Global Business Reports (GBR)

Use QR code to read
this report on any device.

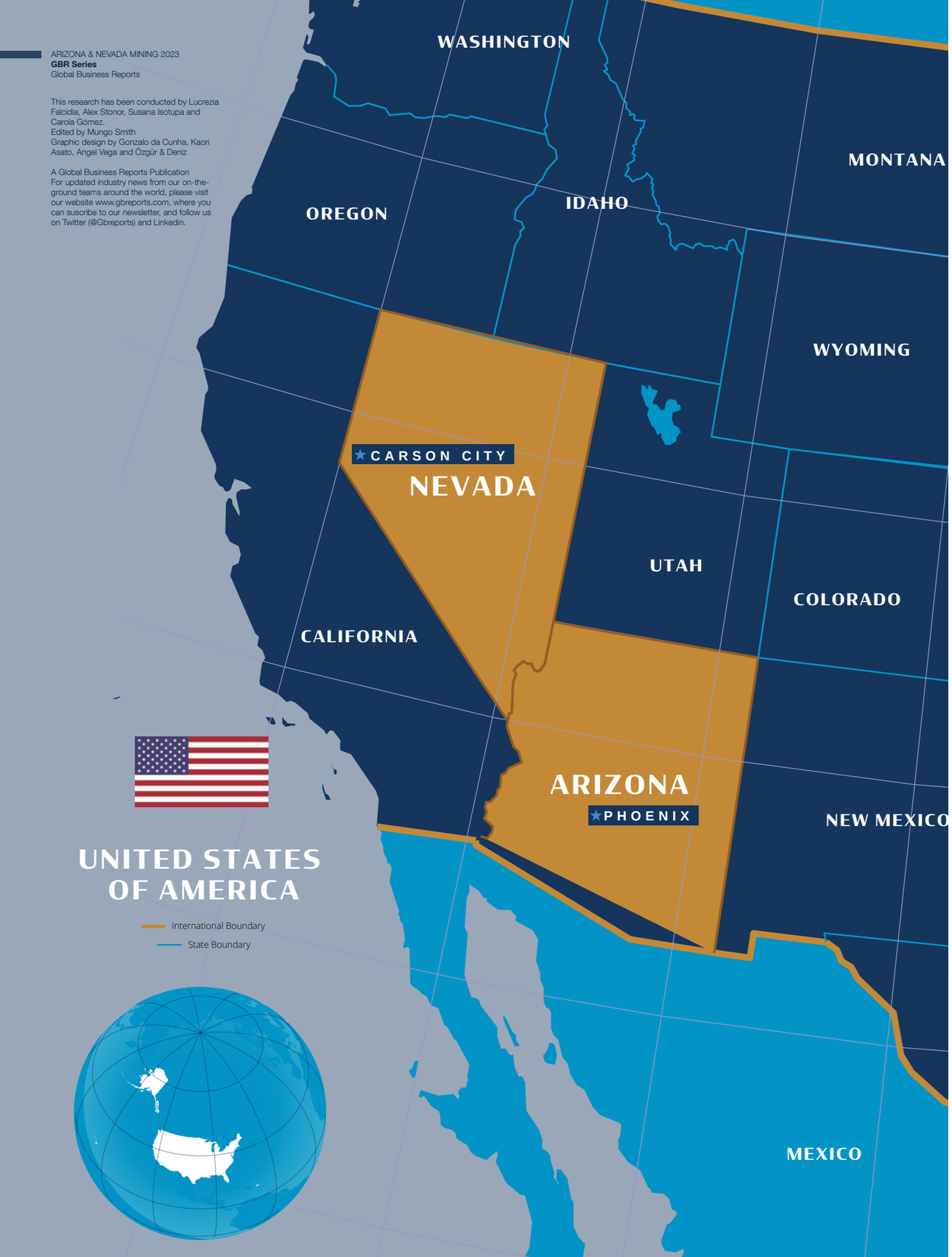
Arizona digital

Nevada digital

ARIZONA & NEVADA MINING 2023
GBR Series
Global Business Reports

This research has been conducted by Lucrezia Falcidia, Alex Stonor, Susana Isotupa and Carola Gómez.
Edited by Mungo Smith
Graphic design by Gonzalo da Cunha, Kaori Asato, Angel Vega and Özgür & Deniz

A Global Business Reports Publication
For updated industry news from our on-the-ground teams around the world, please visit our website www.gbreports.com, where you can suscribe to our newsletter, and follow us on Twitter (@Gbreports) and Linkedin.



6 Introduction

8 Introduction to Mining in the Southwestern US
11 Interview with the Bureau of Land Management
12 Interview with the Nevada Mining Association (NVMA)
13 Interview with Arizona Mining Association
14 At the Heart of the Green Transition
18 Interviews with the Nevada's Government Office for Economic Development (GOED) and Arizona Natural Resources, Energy & Water Committee
19 Expert Opinion Article: Resource nationalism: US dependency on foreign REEs
20 Interviews with American Exploration and Mining Association (AEMA) and with AMIGOS
21 Mining Investment Environment
23 Interview with OTC Markets Group

24 Nevada

27 Precious Metals Production
29 Interview with Nevada Gold Mines (NGM)
30 Interview with Barrick Gold
31 Interview with Kinross Gold
32 Interviews with i-80 and with Coeur Mining
33 Interview with Hycroft Mining
35 Precious Metals Exploration
37 Interview with NV Gold Corp
38 Insights from the Explorers
42 Interview with Ioneer
43 Interview with Lithium Americas
44 Interview with Century Lithium
45 Interview with Pan American Energy
46 Insights on the Financing Outlook for Lithium Projects
47 Copper and Molybdenum in Nevada and the Western US
49 Interview with Robinson Nevada Mining Company (KGHM)
50 Interview with Northern Dynasty Minerals
51 Interview with New Moly

52 Arizona

55 Copper Production
57 Interview with Freeport-McMoran
58 Interview with Resolution Copper
59 Interview with Florence Copper
60 Interviews with Hudbay Minerals and with Arizona Sonoran Copper Company
61 Copper Exploration
63 Interview with Copper Fox Metals
64 Critical and Energy Minerals
66 Precious Metals: Production and Exploration
67 Interview with Elevation Gold Mining
68 Interviews with Energy Fuels and with American Rare Earths
69 Insights from Explorers: Leveraging Existing Assets to Make New Discoveries

70 Consultancies and Engineering

72 Water Management and Environmental Legislation
75 Insights from Consultants
76 Interview with WSP
77 Interview with Civil & Environmental Consultants (CEC)
78 Expert Opinion Article: Mine Water Stewardship in Arizona
79 Interviews with Piteau Associates and with Forsgren Associates
80 Engineering and Mining Contractors
82 Expert Opinion Article: Heap Leach Improvements
85 Interview with Stantec
86 Interview with Ausenco
87 Interview with Practical Mining
88 Interview with MMR Constructors
89 Underground Contractors
90 Interview with Small Mine Development
91 Interview with Turner Mining Group

92 Equipment, Technology and Services

94 Equipment and Technology
96 Interview with Cashman Equipment
97 Interview with Liebherr Mining
98 Interview with Epiroc
99 Interview with Sandvik
100 Interviews with Strayos and with 3D-P
101 Interview with Hexagon
104 Interviews with Caltrol and with Dyno Nobel
105 Interviews with Western Cast Parts
106 Drilling, Energy and Mining Services
108 Interview with Boart Longyear
109 Interview with Cyanco
110 Innovation in Geology

Company Directory

Introduction

An analysis of the key trends ahead for Arizona and Nevada's mining industries

6-23

Consultancies & Engineering

Arizona and Nevada are leading mining jurisdictions in water management and continue to remain leaders in engineering and innovation

70-91

Equipment, Technology & Services

The backbone of both states' mining industries continue to strive towards more sustainable, efficient and safe mining

92-111

INTRODUCTION

"More mines are needed by 2030 to meet global net carbon emission goals".

Chris King
Senior Vice President
OTC Markets Group

Image courtesy of Freeport-McMoRan

Introduction to Mining in the Southwestern US

Two great mining stories, one regional hub

Image courtesy of Freeport-McMoRan

More than any other region, the legacy of mining is engraved into the landscapes of both Arizona and Nevada, making the industry a vital part of the culture, economy and environment. The southwestern states remain mining heavyweights in the US, and are responsible for most of the production of copper and gold in the country.

In lands rich in copper, gold, lithium, silver, and molybdenum, mining players are key actors in the urgent transition towards a greener economy.

Nevada, the top mining jurisdiction in the US

Nevada is the top mining jurisdiction in the US and is unlikely to give up its throne in the coming years. Despite a two-rank fall in the Fraser Institute's Annual Survey of Mining Companies from 1st in 2020 to 3rd in 2021, Nevada remained the top mining jurisdiction in the US – and again, a world leader – this year. Indeed, mining is critical to the economic transformation of Nevada. The industry surpassed the US$9 billion mark for the first time in 2022, reaching US$9.3 billion, an increase of almost a billion since the beginning of 2021, according to the Bureau of Economic Analysis.

First and foremost, Nevada is a state where precious metals production rules. Boosted by heavyweight producers such as Nevada Gold Mines (the joint venture between Barrick and Newmont), and home to the largest gold-producing US mine at the Carlin Complex, Nevada alone represented 77% of US gold production in 2021, and close to 5% of world production.

Besides its abundance of precious metals, Nevada is endowed with several of the "future-facing commodities" necessary to achieve a green energy transition. The state is home to the only lithium-producing mine in the US, Albemarle's Silver Peak, and is also a producer of copper. And from a mineral – but also national security – standpoint, Nevada's importance is second to none. Geopolitical tensions prompted in 2022 by the Ukraine War and the Taiwan strait crisis have further highlighted the importance of minerals for national security, and according to the Nevada Division of Minerals, Nevada contains known occurrences of 21 of the 35 critical minerals in the USGS list, with these occurring in 60% of the state's historic mine districts.

Nevada is also home to pioneers in terms of technological innovation, talented contractors, and expert consultancies, all contributing to improving modern mining practices. This is key at a time when demand for supply chain transparency and ethically sourced minerals is growing. As put by Tyre Gray, president and CEO of the NVMA: "Nevada is known for innovation. We are at the forefront of conversations on the best ways to extract lithium, and our mining techniques using microscopic mining or heap leach technology represent a huge uptick in how mining operates in the world."

Unique initiatives prompted by a superior policy and regulatory environment

Nevada figured among the top 10 world jurisdictions based on policy attractiveness due to low uncertainty regarding the fluctuation of regulations, allowing for a de-risking of projects entering permitting stages. Political, economic, and social concerns continuously worry shareholders and investors in Latin American, African and Asian jurisdictions, but the Nevadan and Arizona landscapes are ones of stability in terms of attracting capital.

Mining was a catalyst for Nevada to become a state, and in that regard, authorities and regulatory bodies perpetually understand the socio-economic importance of mining for the development of Nevada. As put by Comstock Inc.'s CEO Corrado DeGasperis: "Nevada has the most robust environmental protection agency that is pro-business. They want you to be clean, but they want you there."

Giving back and fostering the future

Nevada's mining industry knows no match across jurisdictions when it comes to local community involvement. After having supported small businesses during the pandemic through the i-80 fund, NGM transitioned this fund towards being a start-up supporting fund. In the Elko and Spring Creek area, the firm committed US$3 million to the Boys & Girls club daycare facilities, now named Nevada Gold Mines Early Learning Centers. In Ely County, Robinson mine made a US$500,000 donation to a new early learning center to provide childcare to young children. Tyre Gray expanded: "The industry has invested in childcare facilities, which is a woman's rights issue. Unlocking the power of gender equity comes through having parity in childcare."

Looking ahead, industry players at the state and federal levels are actively tackling challenges to create the next generation of miners. In November 2022, the GOED received state approval to contract with the University of Nevada, Las Vegas, and the University of Nevada, Reno, to create a program aimed at retaining top science and engineering talent in the state. NGM also has partnerships with these universities. In 2021, the mining tax bill, Assembly Bill 495, prompted a US$169 million contribution to the state education fund by the mining industry, further reinforcing its commitment towards access to education and fostering the next generation of miners. Understanding that talent is a natural resource, the industry can also count on its Associations. The NVMA launched the "360 Internship Program", while Mark Compton, president of the AEMA, said: "AEMA advocates at the federal level for more funding for agencies to be able to hire skilled personnel. We have helped develop and support legislation at the federal level."

Arizona, the copper state

Copper mining has been center stage in Arizona for many years. Arizona produces approximately 71% of the nation's red metal, with 825,000 tons (t) mined in 2021. The state is not only home to important copper producers including, Freeport-McMoRan, KGHM, ASARCO, Capstone Copper, and Hudbay Minerals, but it also hosts some exciting, world-class development projects. Among these, Resolution Copper, a joint venture owned by mining giants Rio Tinto (55%) and BHP (45%), could play a significant role in addressing the nation's growing copper needs. "Our proposed underground mine is expected to become the largest copper mine in North America, capable of producing up to 25% of US copper demand each year," revealed Andrew Lye, vice president of Resolution Copper.

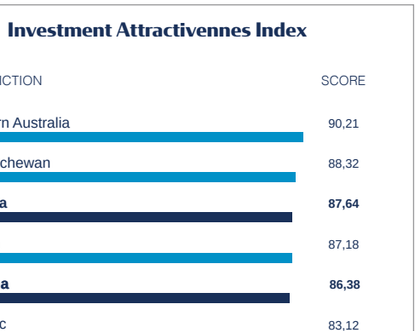
But Arizona's mining output is not limited to copper. The state is a major producer of other non-fuel minerals, including zinc, lead, manganese, gold, silver, lithium, and uranium. In addition, Arizona is rich in rare-earth elements (REEs), which are an essential part of many high-tech devices. And according to data from the Arizona Mining Association (AMA), in 2021 the mining industry produced a direct output valued at US$8 billion and created 13,645 direct jobs. As mining firms purchased intermediate goods and services and workers spent their incomes, an additional US$6.2 billion of indirect Arizona output was created, along with another 33,617 jobs.

Minimizing environmental impact

A core focus of Arizona's mining industry is water. The state regularly suffers periods of severe droughts or extreme precipitations. "The industry had to change the way it thinks about water, especially regarding stormwater. Mines had to stop thinking of stormwater as something to get rid of, and instead as something to capture store, and integrate into their processes, instead of focusing exclusively on fresh water," explained Eric J. Mears, vice president of consulting company Haley & Aldrich.

Steve Trussell, president of the AMA, talked of the advances in water stewardship in the state: "In 2022, the legislature took on a huge investment in water augmentation, and authority was created to help address these issues in the state. The mining industry has been proactive and is at the forefront of water management, but it remains important for us to continue those efforts and support the state to address this challenge."

> Unique to the state, Nevada has developed a standardized reclamation cost estimator, an Excel-driven template where the operator documents the amount of disturbance such as drill holes, the length of the roads, the pits, tailings ponds, and water treatment.
>
> **Michael Visher, Administrator, Nevada Division of Minerals**



Strategic opportunities, generational challenges

When asked to answer an NVMA survey about the most significant business challenges and threats to the mining industry, almost one in two respondents named 'hiring/retaining quality employees' first, with inflation arriving second with less than 25% of the votes. The message is clear; the labor shortage is the biggest threat to the industry today. Direct mining jobs in Nevada have this year fallen below the 15,000 bar, resulting in 383 fewer employments than in 2021, according to the US Bureau of Labor Statistics.

Besides challenges such as a negative perception of the sector, labor shortages, and a lengthy permitting process, the future for Arizona and Nevada's mining industries is bright. Global economies are currently experiencing a confluence of demand drivers that threaten to outstrip supplies, potentially depriving the US of the minerals it requires to drive the economy toward its decarbonization goals. Beyond electrification, critical minerals are also needed to replace traditional infrastructure including roads, bridges, and public buildings. The stability of the jurisdictions and their remarkable mineral endowment put both states in a unique position to address the US' increasing mineral needs.

The following pages will analyze how the mining industries in Nevada and Arizona are trying to overcome to organic, geopolitical, and financial challenges, and how actors throughout the supply chain strive to reinforce the states' position as world leaders in modern and sustainable mining.

Looking out West, this report will analyze another great unfolding story: that of copper and molybdenum potential in states such as Nevada, Utah, Idaho, and Alaska. As demand for copper shows no sign of declining in an energy transition context, the above states are keen on carving themselves a slice of the "red metal" market.

Historically, southwestern miners were individual explorers, who set foot in the harsh and unforgiven landscapes of the silver state, creating whole communities by themselves. Today, faced with net-zero targets and energy security requirements, the industry will more than ever need to work in conjunction with federal decision-makers to follow a "visible-hand" concept of government interventionism in market affairs. ■

Justin Abernathy

Deputy State Director for Energy and Minerals
BUREAU OF LAND MANAGEMENT (NEVADA)

Can you provide an overview of the Bureau of Land Management's (BLM) role in the Nevada mining industry?
The BLM is responsible for managing approximately 48 million acres of public lands in Nevada, and several hundred thousand acres of split estate lands (private surface and Federal minerals). We thus manage over two thirds of the land in Nevada for a variety of uses, including mining. As a result, most of the mining projects permitted in Nevada involve BLM managed land and minerals.

Our solid minerals program is generally divided into three categories – leasable, saleable, and locatable minerals. Locatable minerals include metallic and non-metallic minerals like gold, silver, cooper, lithium and vanadium. Project proponents submit proposed mining plans of operation and our staff will first review the proposals for completeness and then we complete an environmental review of the proposed projects. We will then identify what we believe is the necessary amount of financial assurance to ensure reclamation. After an approved plan of operations is issued and the required bonding is in place, we will allow the proponent to proceed with development. Once operations commence, we will inspect, at least once annually and more often for certain types of operations or if needed, and monitor the projects to ensure they are complying with the terms of their permit.

We have seen a significant upswing in the number of mining claims in recent years. As of September 2022, there were approximately 262,000 active mining claims on BLM managed land in Nevada, which is a 40% increase from five years ago

Can you expand on the environmental review stage of a mining project?
Nevada has consistently been recognized as a model for other jurisdictions. We focus on early planning with mining operators and have a close and effecting working relationship with our state agency partners, particularly the Nevada Division of Environmental Protection. ■

> We have a unique understanding of how to mine in a more innovative, sustainable, and safe way.

Tyre Gray

President and CEO
NEVADA MINING ASSOCIATION

What is the NVMA's role within the mining industry?
Our target is to serve as a public voice for mining in Nevada. We educate, unite and advocate for mining within the state. Mining is important for the US as the country looks at transitioning away from a fossil fuel-based economy. Mining techniques have changed with new technologies, and we have a unique understanding of how to mine in a more innovative, sustainable, and safe way. We pride ourselves on being one of the safest mining jurisdictions in the world. We are proud of our safety and environmental records which attract investments to our operations here.

Can you expand on the trends that shaped the industry in 2022?
Going into 2021, the industry was at a tipping point in terms of taxation in the state. Calls to increase taxes in Nevada came as we are tourism-dependent and our state budgets can get tight. The State of Nevada asked the mining industry to help. Our schools have always been underfunded, so the industry made sure this would not happen in the future. We helped increase school funding by US$300 million, which represents about US$700 per student on average, to ensure that we are ahead when the next economic downturn comes..

How are new technologies changing the industry?
Automation has been discussed for a long time, but what we have seen throughout the pandemic has sped processes up. There are currently many sites where someone above ground is operating machinery below ground, and this will grow. We are excited about the diversity technology brings to our workforce.

Could you expand on the NVMA's "2D Demystify and Diversify" plan?
We recognized that we must demystify what mining looks like today to ensure workforce development. We have drone technology, sophisticated mapping, SONAR and LINAR to help mining be environmentally conscious and safe. Demystifying is the first step. The diversification part is about bringing gender, culture, thought, and geographical diversity. All business reports highlight that diversity is a huge component in increasing profitability for firms. In the gender area, the industry has invested in childcare facilities, which is a woman's rights issue. Unlocking the power of gender equity comes through having parity in childcare.

What can Nevada's role be within the processing and refining stages of the domestic supply chain of critical and precious minerals?
Nevada has limitless opportunities when it comes to being a one-stop shop for precious and critical minerals. As we expand out towards critical minerals, we also have an abundance of lithium. Nevada is home to the only active lithium mine in the US. Hopefully, we will see three more come on in the next two years. The issue is we are mining here and sending lithium to China to be processed. Thinking about the economic and environmental costs, this makes little to no sense. Looking at state leadership, the opportunity to process here seems to be on top of the agenda. Now we need to work on building processing facilities here to secure the nation's supply chain and the US' ability to process domestically. This is a critical issue.

What is mining's role in a net-zero transition away from a fossil fuel-based economy?
We provide the raw materials that are key to the transition. We must ensure that we extract in a way that the downstream impacts are not lost. If extracting is done in a polluting way, it won't matter if the material is integrated into green technology. The industrial revolution took about 70-80 years, so the concept of being a net-zero tomorrow cannot happen yet. We have a smart-from-the-start program, where before a shovel hits the ground, firms must plan for closure. We are looking to incorporate solar panels into those closure plans because we have the infrastructure and grid running to the site to provide power. Barrick and NGM are working on a solar project that will mitigate their power usage for instance.

Where is the Nevada mining industry going next?
Nevada is known for innovation. We are at the forefront of conversations on the best ways to extract lithium, and our mining techniques using microscopic mining or heap leach technology, have been a huge uptick in how mining operates in the world. ■

Steve Trussell

President
ARIZONA MINING ASSOCIATION

> We work very well with the Arizona agencies, the administration, and our state legislature, as they absolutely understand the importance of mining in the state of Arizona.

Can you give an overview of Arizona's geological potential and the state's mining industry?
Arizona has earned the title as the 'Copper State' for its abundant copper reserves and for producing 74% of the nation's copper. Mining is very important in Arizona and we have a copper dome on our state capitol, a copper star in our state flag, and a miner on our state seal. We are the number one producer of nonfuel minerals in the US, and the second most attractive state for mining investment due to our political and regulatory environment. We have a tremendous mineral endowment in the state and are starting to see more interest in other elements beyond copper, such as manganese, zinc, lithium, and rare earths.

Can you speak about the permitting issues around Resolution Copper and Rosemont Copper in Arizona?
Both projects just received favourable decisions from the courts that further define a path forward. Hudbay Minerals, who owns the Rosemont project, has actually pivoted towards the Copper World project, which is on private land, rather than trying to mine on federal land and dealing with the permitting issues there. The Copper World project is moving forward very quickly and has incredible reserves. With regards to Resolution Copper, a world-class deposit over a mile deep, there are cultural concerns over the land they are using, but I believe that they will find a path forward as many of the issues are being addressed.

What are the main challenges and opportunities in Arizona's mining sector?
Arizona has a constructive tax structure, favorable to mining and business. With regards to the regulatory landscape, we work very well with the Arizona agencies, the administration,
and our state legislature, as they absolutely understand the importance of mining in the state of Arizona. There are, however, many NGO groups that have a different opinion about mining and this certainly poses challenges. There are companies that can hire upwards of 1,000 people for their operations in Arizona, but unfortunately it is difficult to find people who want to work in an industry they do not understand.

How are mines in Arizona recycling water?
All mining companies have initiatives to address ESG-related issues. Water is a very big topiin Arizona as we are in a desert and some water supplies are being depleted. In 2022, the legislature took on a huge investment in water augmentation and an authority was created to help address these issues in the state. The mining industry has been very proactive and is on the forefront of water management, but it remains important for us to support the state efforts to address this challenge.

Can you elaborate on the safety standards in the mining industry in Arizona?
According to the Bureau of Labor Statistics, incident rates in mining are lower than that of retail and are on par with education. Arizona's incident rate used to be lower than the national average, but it has increased a little bit above that, which is unacceptable to mines in Arizona. We are very competitive, and our goal is to reach zero incidents.

How do you see the Arizona mining industry evolving?
Looking at global competitiveness for reserves, it is important for the US and Arizona to be able to mine domestically. Currently, even though we are a high ranking jurisdiction in terms of friendliness to investment and mining, it still takes 10 or 12 years to permit mining operations. We are looking at new ways to quickly get mines online, and a lot of that has to do with going to older mining sites and looking at mining waste, which can hold significant opportunity. For example, the property of Arizona Sonoran had already been mined in the past and a very impressive ore body was found under the waste facility. Arizona Mining Association's goal is to keep the US very competitive. Arizona will be in the lead as the number one producer of nonfuel minerals and we want to be able to continue to provide the quality of life that people enjoy with their phones, computers, and electric vehicles, but do it in a very responsible way in terms of environmental health and safety. ■

Arizona and Nevada

At the heart of the green transition

Image courtesy of Robert Murray (Unsplash)

Ambitious decarbonization targets set both at governmental and private levels will unlikely be met without overcoming considerable challenges. Recent environmental pushes by the Biden Administration – through the Inflation Reduction Act particularly – are the result of clear objectives in terms of decarbonizing the US economy by 2035.

Challenges in leading the "green revolution"

The consumption of critical minerals, which are essential in many of today's clean energy technologies from wind turbines to electric vehicles, is expected to increase sixfold by 2050, according to a scenario published by the International Energy Agency.

As producing states of key energy metals, such as copper, lithium, and silver, Arizona and Nevada have a major role to play in the drive towards electrification: both states face the enormous opportunity – and challenge – of increasing mineral production to meet the country's burgeoning needs. A July 2022 Study by S&P Global projected that the demand for copper will double by 2035 from 25 million metric tons (t) today to about 50 million t. "Demand for copper is slated to increase 300% by 2050", stated Andrew Lye, project director of Resolution Copper, which could potentially supply almost 25% of total US copper demand.

The 2035 decade-long deadline reflects contradictory understandings between the government and key players of the mining industry regarding the time – and capability – to produce the amount of raw materials needed to electrify the economy at scale. "The current administration favors electrification and green energy, but politicians do not appear to appreciate where that copper is going to come from," stated Jim Norine, director for minerals and metals at Ausenco.

Indeed, state and federal approval for a mine in Arizona can take more than a decade, compared to an average of a few years in mining countries like Canada and Australia. In Arizona, mines that could make a significant contribution, such as Hudbay's Rosemont copper project and Rio Tinto-BHP's Resolution Copper, have been under development for over a decade. "Developing a project in the US is a long process. It not only involves discovering a deposit but also showing it can be mined in an environmentally friendly way. This usually means a 10-year period before construction or operations can begin," summarized Brent Berg, general manager at Florence Copper.

Faced with the urgent need to increase the production of battery minerals, producers and explorers have resorted to exploiting past-producing properties in Arizona. "This will include bringing older mining sites back into production and looking at mining waste, which can hold significant opportunity," Trussell explained.

One of the most prominent examples of this is the Arizona Sonoran Copper Company, which is trying to put the Cactus mine, a former producing open pit mine that operated in the 1970s and 1980s, back into production. The mine, previously owned by ASARCO, closed in 1984 due to the copper price at the time being only US$0.65/lb. "There was still a significant amount of mineralization in the ground, and our PEA issued in 2021 demonstrated a resource of approximately 3.5 billion pounds (lb) of copper," explained George Ogilvie, president, and CEO of the company.

But reopening such mines also comes with challenges in terms of updating environmental and water management standards, with companies also having to comply with the Global Industry Standard on Tailings Management since 2020.

The lithium capital of the US

This subtitle is certainly bold, but the argument for it goes beyond Nevada being home to the only lithium-producing mine in the US. It rests on a forward-looking two-part combination that could drastically change the face of American energy security in the coming decade. First is an unmatched development pipeline, followed by the unique ability to sustain the supply chain from lithium production to finished batteries within the Nevadan borders. "Nevada can be to lithium what Wall Street is to finance, or what Silicon Valley is to technology", famously stated Governor Steve Sisolak, and the next months might prove him right.

The US produces less than 4% of lithium globally, but its aggressive development pipeline could see this figure increase to 14% by 2030. Added to Albemarle's Silver Peak mine in Nevada's Clayton Valley, two major projects could

affirm Nevada's place as the lithium leader in the country: Lithium Americas' Thacker Pass, and ioneer's Rhyolite Ridge. Looking at supply and demand fundamentals for lithium, there arguably should not be any dilemma regarding putting these projects into production promptly; before 2030, the IEA forecasts that 50 new lithium mines need to come into play to meet the projected demand of 4 million t/y of lithium by 2035. The Tesla/Panasonic battery factory alone needs five times the amount of lithium mined annually in Nevada.

The state's valleys have witnessed a new wave of financiers, geologists, and engineers since 2015, all keen to carve themselves a slice of the market for – perhaps – the most important metal in the context of the green transition. The crystalline-blue evaporation ponds in Nevada's Esmeralda County, home to 743 souls, contain water, but not just any water: lithium-rich H20. Those ponds belong to Albemarle's Silver Peak operation, which has been producing white oil since 1956, and which can these days produce about 5,000 t/y Li. The firm plans to double production by 2025 to meet EV makers' demand.

Thumping potential beyond raw materials

Nevada is undoubtedly strategically positioned to lead in lithium. Northern Nevada is only a one-day truck drive away from 11 states, giving the state potential to be the distribution hub of the Western US. Beyond Tesla, the state is also home to firms like Lilac, Redwood Materials, and Schlumberger. The latter is currently evaluating its DLE technology at the Clayton Valley Pilot Plant in collaboration with Panasonic Energy to optimize the process for battery-grade feed. As advancements in DLE are critical to the future of lithium brine production, Nevadan minds are likely to export their expertise worldwide in the coming years.

> In the most recent USGS survey, there are 17 critical minerals we do not produce at all or produce very little of, with many being imported from countries that are not friendly towards the US. By allowing this, we are putting our country's security at the mercy of others.
>
> 
>
> **Jeff Parshley, Corporate Consultant, SRK Consulting**

Michael Brown, executive director of the Governor's Office for Economic Development (GOED) up until January 2023, is well aware of the state's responsibility in leading the lithium space beyond the production of the "white oil": "We can implement the entire lithium value chain in our state; from extraction to processing of the anodes and cathodes that go into the batteries. Of the 50 states, we will be the only one that can complete the entire circle."

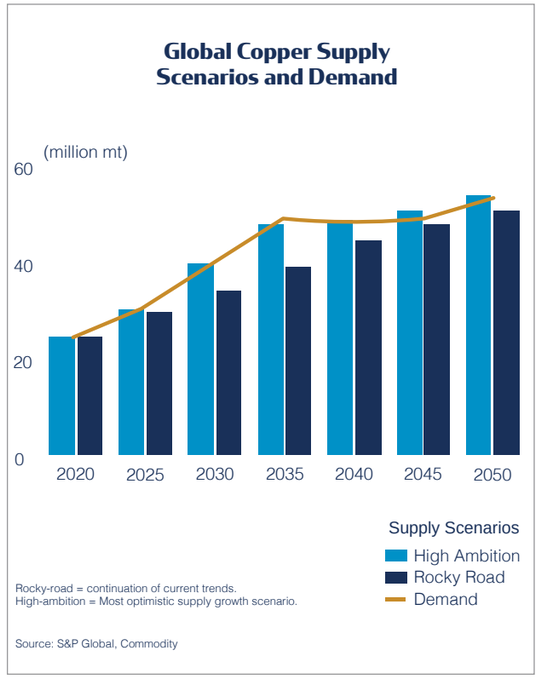
The downstream part of the value chain is where Nevada truly makes a difference. The IRA requires 50% of battery components (like anodes and cathodes) to be eligible for tax credits in 2024, yet the US does not have enough cathode production. Reno-based Redwood Materials said this year it would spend US$3.5 billion at its Fernley plant – which could supply materials needed for 1 million EV batteries per year - and plans to expand cathode production to 100 GWh by 2025, using local and recycled material. In the Tonopah area, ABTC received a US$58 million grant from the DOE to operate a first-of-its-kind facility to manufacture battery-grade lithium hydroxide from Nevada's claystone deposits. Still downstream, ABTC will open a lithium-ion battery recycling plant in 2023, while Comstock Inc. is actively focusing on producing lithium carbonate from recycled lithium batteries.

Overcoming hurdles before unlocking the state's potential

In June 2021, the White House introduced a report on material security that stated "More secure and resilient supply chains are essential for our national security, our economic security, and our technological leadership." Indeed, GlobalData suggests that the US is the most vulnerable country in the EV battery materials supply chain. Yet, lithium players notice a cognitive dissonance between Washington's ambitions and on-the-ground realities. Certain barriers currently impede this shift from reserve to production, and put net-zero goals, along with several critical industries' futures, at risk.

Debates over a contested water pollution control permit for Lithium Americas' Thacker Pass have taken on national proportions. In May, a coalition of conservation groups warned stakeholders that the mine could unleash toxic slurries in the state's watershed, despite Thacker Pass having been issued a state permit by the NDEP in February 2022. Contesting the appeal, the firm upholds its sustainable approach. Almost a decade in the making, this controversy over Thacker Pass highlights the burning dichotomy between a country hungry for lithium to feed its growing EV market and a reticence to streamline permitting due to environmental concerns, which Washington appears unable to solve. Bernard Rowe, managing director of ioneer, expanded: "The US needs the process to be more efficient to increase its lithium domestic production. It is crucial to meet the environmental targets being set that rely heavily on domestic supply."

Miners in Arizona and Nevada have a crucial role to play in the success of the transition away from a fossil-fuel-based economy. Yet, some cases in the Grand Canyon and Silver State demonstrate different wavelengths from policymakers and actors on the ground. Cooperation and common discourse will be key for the US to maximize its resource potential. ■



Michael Brown

Executive Director*
NEVADA GOVERNOR'S OFFICE FOR ECONOMIC DEVELOPMENT
*up until 2 January 2023

Can you introduce the Governor's Office for Economic Development (GOED) and its main missions?

The GOED is the governor's agency that is charged with forward-facing economic development for the state of Nevada.

With the Biden administration's focus on infrastructure, we are a coordinating agency for federal money coming through the state. Today, the main activity we are seeing in the mining space is related to lithium, as we try to deal with climate change through electrification.

There are 24-25 firms trying to bring lithium deposits into commercial production in Nevada. We have the opportunity to implement the entire lithium value chain in our state: from extraction to processing of the anodes and cathodes that go into the batteries. Of the 50 states, we will be the only one who can complete the entire circle.

What is your outlook on Nevada's role in the lithium supply in the US?

Projects in Nevada will require multi-billion-dollar investments, with workforce forces exceeding the thousands.

Our staff likes to say that Nevada will become the lithium capital of the US, and I am seeing that coming together, particularly after the series of grants allocated by the DOE to several lithium projects in Nevada.

What will be the GOED main's priorities in the coming months?

If we want to fix workforce issues, we need to ensure there is broadband in rural areas to ensure generations X and Y will live there. We will focus on permitting efficiency, helping people through the process, and helping the industry get itself organized. We believe in public intervention and the "visible hand", where government and industry come together to help the industry get the standing it needs to address the issues it faces. ■

Gail Griffin

Chairman of the Natural Resources, Energy & Water Committee
ARIZONA STATE HOUSE OF REPRESENTATIVES

What is the Arizona Natural Resources, Energy & Water Committee's role in supporting the mining industry?

Our Committee hears bills and presents information on all of our natural resource industries. That includes mining, agriculture, forestry, and of course energy and water. Our goal is to pass good legislation and stop bad legislation. We have presentations to educate the members and the public on the importance of our natural resource industries. Our economy needs the mining industry to be successful to help keep Arizona's future bright. The figures speak for themselves: Arizona is ranked first among all states for non-fuel mineral resources, our copper accounts for 74% of all US production and the industry creates approximately 75,000 jobs.

How is the Committee tackling the current challenges in Arizona?

In the 2022 legislative session, we passed a US$1.4 billion funding package for water projects. We will be looking at how to bring new waters to Arizona. This could be desalinization, bringing flood waters into Arizona, and other ways to bring new waters into the state. We have funds for recharge projects and water conservation projects to use less water.

What will the Committee prioritize in the next 12 months?

We will be working closely with the University of Arizona and its mining school on several issues. The Mining, Mineral, Natural Resources, Education Museum is one project I look forward to getting open. The committee will continue to advocate for the support of the mining industry. Indeed, during my last trip to Washington, DC, we touched on the need for critical minerals- which Arizona is endowed with- for national security. Finally, we will continue to strive towards educating the public. There is a good future for mining. ■

Resource nationalism: US dependency on foreign REEs

Expert Opinion Article by
Eric Mears, Vicepresident, Haley & Aldrich

Mineral production in the US is not keeping pace with world markets or our own domestic demands for minerals.

The US is blessed with abundant mineral resources. We enjoy a well-educated workforce, reliable transportation, robust infrastructure, and reasonably predictable political and legal systems. We also have a diverse economy, a fair tax structure, and strong manufacturing and business sectors. When compared to other mineral producing regions across the globe, the US is easily one the most attractive locations for mineral exploration and the development of mining projects.

Yet, mineral production in the US is not keeping pace with world markets or our own domestic demands for minerals. Consequently, our exponential growth in technology, defense, housing, green energy, and infrastructure has become alarmingly dependent on critical minerals produced overseas, even when the resources we need are in our backyard.

Why is this a problem?

Many of the critical minerals used in manufacturing today are sourced from non-democratic countries; extracted from poorly regulated mines that exploit children or slave labor; enrich despots, terrorists, or other criminals; or decimate natural resources, native people's lands, and wildlife habitats. And although US mining, defense, and manufacturing leaders have been waving red flags for several decades, consumers are largely unaware of the geopolitical implications of sourcing critical minerals outside of the US. Most consumers know more about where their broccoli is sourced than virtually every critical mineral used in electronics and clean energy, defense, and manufacturing products – so there is no demand for change.

Why haven't we addressed the problem?

Aside from consumer indifference, we don't produce more of our own resources because well-meaning political, legal, and regulatory systems have been misused to the point where it becomes easier for mining projects to be offshored to less regulated, more politically pragmatic, and less litigious mining jurisdictions. In 2010, the federal government acknowledged that the rapid expansion of materials-intensive industries like clean energy and defense put critical materials at "risk of unpredictable moments of short supply," and more recently, the government has placed emphasis on understanding and addressing vulnerabilities in our critical minerals supply chain. However, despite this acknowledgement and emphasis, actions have been taken by all levels of government to systematically dismantle policies, agency actions, and programs that held promise for fairly regulating and streamlining critical mineral permitting and entitlement efforts such as the transparency and predictability of the National Environmental Policy Act review and authorization processes. Unsurprisingly, even when projects have government support, economic and political issues get in the way of their coming to fruition. The current administration recently highlighted its support and funding for a multibillion-dollar research and development effort to determine if lithium can be extracted from geothermal brines in Imperial County, California. Before a single pound of lithium has been extracted, a newly authorized Lithium Valley Commission is already developing a royalty structure to collect profits from its future operations, and the California legislature hurriedly imposed an industry crushing tax on lithium production.

What can we do?

The reality is that the US can only reduce its dependence on foreign critical minerals when domestic mines capable of producing critical minerals are routinely permitted and operational. This means that consumers need to care about the ethics of mineral sourcing, that permitting agencies must be appropriately staffed and directed to efficiently permit mines, that non-governmental organizations have to collaborate more and litigate less, and that the government needs to dedicate more resources to cultivating a critical industry rather than creating additional obstacles to shut it down.

In other words, we have to dig our own way out of this problem. ■

Mark Compton

Executive Director
AMERICAN EXPLORATION & MINING ASSOCIATION

Can you give an overview of AEMA's mission?
AEMA is a national trade association representing the hard rock mining industry, both metal, and non-metal. Based in Spokane, Washington, our diverse membership is in 46 states, seven Canadian provinces, and 10 other countries. We are the recognized national representative for the exploration sector, the junior mining sector, as well as mineral developers interested in maintaining access to public lands. We represent the entire mining life cycle, from exploration to development, operations, reclamation, and closure.

How does AEMA engage at the permitting process level?
Part of our mission is to advocate for the industry and create a business and operating environment in which the mineral industry can succeed. This leads to two areas of focus: Maintaining access to mineral deposits and the ability to permit projects promptly. A serious impediment to attracting mineral investment in the US is the lengthy federal permitting process, which takes on average seven to 10 years, but often much longer. AEMA is committed to working with the administration and members of Congress on both sides of the aisle to find efficiencies in the permitting process. Put simply, without permitting reform it will be impossible to meet our nation's mineral needs.

What is AEMA's role in helping the industry in getting workers back in the field?
Our members have a difficult time finding skilled workers. Just as important, a lack of workers knowledgeable about mining within our federal government contributes to the inefficient permitting process. AEMA advocates at the federal level for more funding for agencies to be able to hire skilled personnel. AEMA also has launched a mentorship program called the AEMA Society to help advance the mining workforce and develop the next generation of industry leaders. ■

Sydney Hay

President
AMIGOS

What is the role of AMIGOS in the mining industry?
AMIGOS stands for Arizona Mining and Industry Get Our Support. Our 300-plus AMIGOS member companies collectively employ thousands and are the best of the best mining suppliers.

What are the main global trends influencing AMIGOS members?
Prior to the pandemic, our members mostly built relationships with customers in person, and this became challenging, but new opportunities have been created. Now, we have all become Zoom experts, and this allows us to assist our members in reaching new clients worldwide, especially throughout North America. That is not only good for our members, but also for the mining industry as a whole because of supply chain issues. Today, mines need a deeper bench of suppliers in case of supply disruptions.

What role do you think innovation can play to help Arizona maintain its role as a top mineral producer?
When I started working with AMIGOS 28 years ago, mining managers would give presentations that projected future mine life of say, 20-25 years. Now, more than 25 years later, those same mines are largely still operating with projected mine life, again of 20, 25, or even 30 more years. This is due to the amazing strides the industry has made to mine with much greater efficiency. What might have been considered waste 25 years ago is being commercially mined today, and this is only going to get better.

How do you see the future of mining suppliers in the state?
Our members are busy. With so much work to be done, it's a challenge finding and training employees. That is why it is important to have a strong partner as Arizona does with the University of Arizona. They are not only turning out quality engineers, geologists, metallurgists, environmental scientists, etc, they are also developing new technologies, particularly in environmental protection and remediation. ■

Mining Investment Environment

Looking beyond market valuation

Image of Cirano83 (iStock)

Mining is a risky business. In the short term, the current environment suggests mining executives and investors will continue to prioritize advanced-stage projects and operations with the lowest levels of risk amid rising interest rates and fears of an economic slowdown. But looking at the months ahead, new capital is needed in underfunded exploration assets to meet net-zero goals. Few jurisdictions offer the clarity and stability that Nevada does, suggesting the state appears ideally placed as a haven able to prompt a virtuous cycle of investment in 2023. Despite a harsh financial year, where 50-70% drawdowns were the norm for junior miners, Nevada's lithium explorers are still managing to access much-needed financing, albeit in a slightly different form than what the industry is accustomed to, often involving off-take agreements with end-users, such as automobile makers.

Venturing out of the comfort zone

For mining firms in Nevada and worldwide, the latter half of 2022 felt like a hangover. A lot of the commodity prices that reached all-time highs in 2020-2021 (such as gold's $2,076/oz in August 2020) decreased in 2022. Even miners of the commodities needed for the energy transition, such as lithium, which soared to its highest level at US$84,000/t in November 2022, have not been spared. With the commodity being up 20 times in 24 months, field experts forecast a correction. The market capitalization of main mining players decreased year-on-year since 2021: Albemarle lost 9%, Lithium Americas 30%, and ioneer 14% on a one-year basis. Christopher King, senior vice president at OTC Markets Group, the largest trading platform in the US for brokers and investors trading foreign-listed securities, recalled: "Trading volumes have come way down from those record levels that we saw in 2021. That year marked a record number of companies that joined our market across multiple industries, with the highest trading volumes that we had seen in a long time. Today, valuations and volumes for many of those companies have come down."

How to explain those valuation decreases? Having seen at least 180 new mining firms join the OTC trading platform in 2022, Christopher King recognized the difficulties for players to access capital in H2 2022 when rising interest rates and geopolitical concerns have dampened the overall market.

This might, however, be a short-term phenomenon. "I do not think this is reflective of what we think the next five to 10 years for the industry will be. I think this is a temporary pullback for our sector", explained James McClements, co-founder, and managing partner at Resource Capital Funds.

Nevada dreaming

New regulations aiming at reducing GHG emissions will hardly be achievable without a massive flow of capital and collaboration between investors and miners. As California hopes to realize its dream of 100% in-state sales of EVs by 2035, neighboring Nevada possesses the resources that, if fructified by investment, could make the path to net zero a success. Massive capital investment will be needed ahead, and it will not come entirely from the traditional market: Common equity and debt raised in mining have decreased from close to US$180 billion raised in 2012 to US$57 billion in 2021, and only around US$20 billion as of September 2022, according to data from Bloomberg and Resource Capital Funds.

As new sources of capital stream into the industry, private investors will likely grow their appetite toward early-stage mining assets with higher risks but potentially greater returns. The number one bottleneck in lithium presently is that many projects are at the exploration or early development level. This means investment in projects that have the potential to come online quickly (within 5 years) should be a priority. "You can have all the refineries in the world but if there is no feed the capital invested at the midstream level will be "stuck", commented a Trafigura executive at the FT Commodities Mining Summit in October.

In that sense, firms that can demonstrate good governance and ESG stewardship in the face of scrutiny from stakeholders such as downstream EV manufacturers will have a head start in the race for funding. Christopher King emphasized investors' focus on ESG practices when looking at environmentally friendly technologies being leveraged by lithium developers in Nevada, such as DLE: "ESG is no longer just a statement of intent. Companies need to show that they can produce large volumes of metals required for a low-carbon future. But they need to be able to demonstrate to investors that they are committed to both societal and environmental needs."

Raising early-stage exploration dollars is analogous to the riskiest forms of venture capital. Yet, CEOs in the lithium scene in Nevada are witnessing new types of investment that could lead to changing dynamics in early fundraising.

Off-take agreements between Ford and ioneer, who holds the late-stage Rhyolite Ridge in Esmeralda County, are expected for the carmaker to secure its supply of lithium for future EV production from 2025. Steve Hanson, CEO of ACME Lithium, observed: "I have never seen end-users step into the marketplace to secure supply to the aggressive degree that we have seen in the past couple of years."

Signs of further off-take agreements and increased interest from carmakers in early-stage lithium projects (Nevada being home to at least forty of these) are only half of the picture. Large banks, strategic partners, and end users are also open to assisting in financing early stage projects to secure long-term, stable supply. Stephen Rentschler, CEO of Nevada Lithium Resources, forecasted: "I have never seen so much interest in early-stage companies by strategic investors and metal users of all types. I think this interest will translate into market enthusiasm as soon as a few more strategic investments are made in the sector".

Entering 2023

The generalist investor is key for a virtuous market to take off, particularly as most US juniors are reliant on retail investors. A sense of urgency and public understanding of the role of mining must play if 2030 net-zero targets are to be met will likely draw investors back to the industry. "Despite crypto and speculative tech investment, I think mainstream awareness of the role mining plays in the energy transition will bring a lot more generalist capital back to the industry over the next few years", forecasted McClements.

For Nevada, Arizona, and other key producing states in the US, the high cost that comes with battery recycling, the lack of upstream expertise, and the difficulties in getting social licenses to operate at the mineral extraction stage will provide serious challenges. Meanwhile, minerals being extracted and processed in regions with low environmental standards and poor regard for human rights, are creating artificially low prices and inhibiting regions with higher standards from competing. Public policy can help redress the imbalance. ■

EY's top 10 business risks and opportunities for mining firms in 2023

Source: EY, 2022

2023 Rank	Risks & Opportunities	Index Score
1	ESG	—
2	Geopolitics	↑ 4
3	Climate change	↓ 2
4	License to operate	↓ 3
5	Costs and productivity	↑ 10
6	Supply chain disruption	★
7	Workforce	↑ 8
8	Capital	↓ 5
9	Digital and innovation	↓ 7
10	New business models	↓ 9

↑ Up from 2022 ↓ Down from 2022 — Same as 2022 ★ New entry

»

Being public here while you are already listed on a qualified foreign exchange offers a lower cost and less complex alternative to maintaining two stock exchange listings, all while adhering to regulatory standards set forth by the SEC and FINRA.

«

Christopher King

Senior Vice President
OTC MARKETS GROUP

Can you introduce OTC Markets Group?

OTC Markets Group provides critical market infrastructure to the US financial markets through a platform where the largest US trading firms quote more than 12,500 securities. There are two types of companies trading on our markets; domestic companies and international ones looking to access US investors. In the first category, many are small and early stage. The second type wants to efficiently target both institutional and retail investors in the US market—which are critical in the mining space—and for those companies, we provide a global gateway to maximize access to US investors. Being public here while you are already listed on a qualified foreign exchange offers a lower cost and less complex alternative to maintaining two stock exchange listings, all while adhering to regulatory standards set forth by the SEC and FINRA.

More than 2,000 mining companies are trading on our markets, including large companies such as Anglo American and Fortescue Metals. Just this year, more than 180 mining companies joined our premium markets, such as Lundin Gold, with about US$2.5 billion in market cap.

How did the mining firms in your market perform in 2022?

A lot of the commodity prices that soared in 2021 came down in 2022. 2021 marked a record number of companies joining our market across multiple industries, with the highest trading volumes that we had seen (over US$700 billion).

What are the key factors driving investment in mining firms?

ESG is key in terms of opportunities for companies. The green energy transition requires innovation and emerging technology to reduce carbon and minimize waste. How mining companies position themselves on ESG will contribute to investment attractiveness. We have seen this in Canada with several junior miners recently changing their names to match a new focus on a particular metal. These businesses are rethinking how demand for green and critical metals or minerals can generate a competitive advantage. We have seen larger companies pivot parts of their business to now include these commodities, but they're also moving away from oil and coal.

What is your view of the trends in junior mining investment?

We need more investment in mining. From an initial feasibility study to nominal production can often take more than a decade. More mines are needed by 2030 to meet global net carbon emission goals. Trading on OTC markets allows companies to raise the money that is needed to invest in these projects.

Many small companies, which represent up to US$2 billion in US market cap, are not knocking on the door of larger institutions. The companies are reliant on retail investors, and we help those companies to be as aggressive as possible in accessing US investors.

In which areas do you think capital flows are going in 2023?

Longer-term, there will be a need for sustainability and diversification through accessing new revenue streams from mining companies repurposing new and historical mine waste. This sends a strong message to a broader audience of investors, private and specialists alike. In the mining space, innovation and learning from other industries will likely lead to both cost savings and further efficiencies, which will attract broader interest from investors. It will also be necessary to embrace emerging technologies, such as data analytics, to automate operations, reduce energy consumption, and optimize machinery speed.

We see Nevada, Arizona, Western Australia, Saskatchewan, and Alaska as being very attractive places for investment in the future.

What will be the OTC Markets Group's key priorities in the coming months?

OTC Markets Group acquired EDGAR Online Inc., a premium supplier of real-time SEC regulatory data and financial analytics, from Donnelley Financial, LLC. The acquisition allows us to combine corporate disclosure databases with our market data to drive market transparency, operational efficiency and regulatory compliance.

Integrating this data into our platform will be a priority over the next few months so we can provide investors, traders and compliance teams with a more comprehensive view of an issuer and its securities. Our expanded data offering will now cover the full US public company disclosure dataset, including SEC Reporting, Bank Reporting, and OTCM's Disclosure and News Service. ■

Nevada

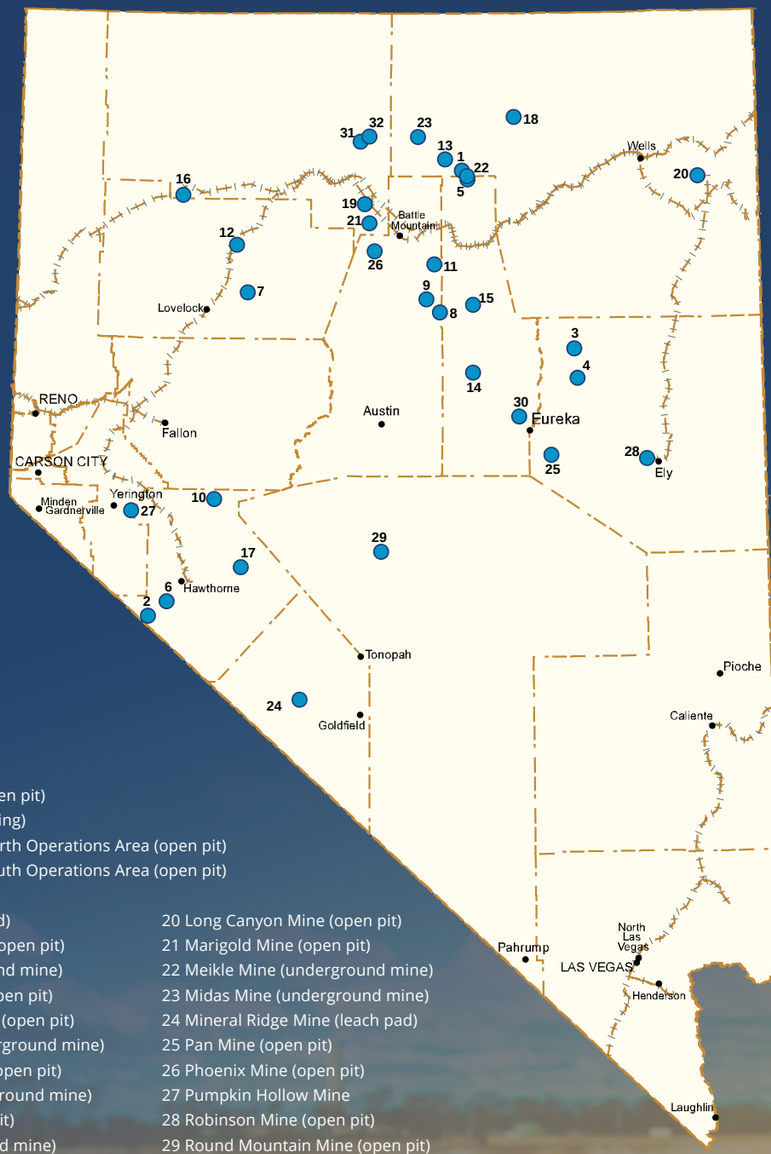
Production, Development and Exploration

"Nevada is known for innovation. We are at the forefront of conversations on the best ways to extract lithium, and our mining techniques using microscopic mining or heap leach technology, have been a huge uptick in how mining operates in the world."

Tyre Gray
President and CEO
NVMA

Image courtesy of Davel5957 (iStock)

Nevada's Major Producing Mines



1 Arturo Mine Project (open pit)
2 Aurora Mine (reprocessing)
3 Bald Mountain Mine North Operations Area (open pit)
4 Bald Mountain Mine South Operations Area (open pit)
5 Betze-Post (open pit)
6 Borealis Mine (leach pad)
7 Coeur Rochester Mine (open pit)
8 Cortez Hills (underground mine)
9 Cortez Pipeline Mine (open pit)
10 Denton-Rawhide Mine (open pit)
11 Fire Creek Mine (underground mine)
12 Florida Canyon Mine (open pit)
13 Hollister Mine (underground mine)
14 Gold Bar Mine (open pit)
15 Goldrush (underground mine)
16 Hycroft Mine (open pit)
17 Isabella Pearl Mine (open pit)
18 Jerritt Canyon Mine (underground mine)
19 Lone Tree Complex (leach pad)
20 Long Canyon Mine (open pit)
21 Marigold Mine (open pit)
22 Meikle Mine (underground mine)
23 Midas Mine (underground mine)
24 Mineral Ridge Mine (leach pad)
25 Pan Mine (open pit)
26 Phoenix Mine (open pit)
27 Pumpkin Hollow Mine
28 Robinson Mine (open pit)
29 Round Mountain Mine (open pit)
30 Ruby Hill Mine (leach pad)
31 Turquoise Ridge Joint Venture
32 Twin Creeks Mine (open pit, underground mine)

Source: Nevada Division of Minerals (2021)

Precious Metals Production

Making the most of high commodity prices while inflation lasts

Image courtesy of Barrick

Having maintained production targets throughout 2020 and 2021 due to a strengthened position as a critical industry during the Covid-19 pandemic, Nevada-based mining majors have upheld that trend throughout 2022. Broader challenges linked to declining ore grades and the difficulty of finding new economical deposits after the "low-hanging fruits" were picked over Nevada's 150-year mining history, however, sustain a trend of decreasing gold production in the state, from close to 7 million oz in 2005 to around 4.5 million in 2021, according to the Nevada Division of Minerals.

Despite post-pandemic recovery challenges and a gloomy inflationary picture driving rising production costs, the state remained amongst the most competitive places to produce gold worldwide. Newmont and Barrick Gold topped the chart for total reported gold production in H1 2022. The two heavyweights joined strengths in 2019 through an M&A to create Nevada Gold Mines (NGM), the largest gold-producing complex in the world, whose further scheduled access to high-grade ore planned in Q4 2022 suggests a strong future for Nevada's main producer.

Strong leadership, forward-looking investments, and an increased accent put on leveraging technologies to increase gold recovery are likely to continue being the main drivers for success in the gold production space in the coming year. NGM appointed a new manager in October, while Kinross established the "Kinross Nevada Model" in 2022 to leverage synergies and expertise to streamline the decision-making at Bald Mountain and Round Mountain. Structural changes will be key as gold majors are currently battling a valuation decrease: the top 50 precious metals mining firms worldwide saw a US$48 billion market cap decrease between June 2020 and June 2022, according to Applied Analysis data.

Indeed, the excitement of a new metals super-cycle seen in 2021 appears to have waned. BMO Capitals reports drastic decreases in expansionary capital expenditure by the major mining firms in the past seven years, with their EBIDTA doubling over that period. Nevada gold and silver majors, with NGM, I-80, and Coeur Mining leading the charge, appear to have progressed on a different trend than their global peers. A high commodity price allowed for higher production cashflows and a strengthening of the balance sheet. With high capital reserves, Nevada majors were able to allocate liquidity towards exploration.

Leveraging a strong commodity price to invest in the future

A high gold price offers opportunities for majors to consolidate assets, make technological investments and drive exploration programs. Majors worldwide continue to drive exploration investment, and Nevada has, again, led that trend in 2022.

Having produced over 10 million oz Au since the JV formation, NGM leveraged its solid 10-year exploration plan to increase reserves by 2 million oz and resources by almost 8.5 million oz. NGM forecasts a slight increase in production in 2022 compared with 2021, and is looking at a 20% expansion plan underground at the Carlin mine site, which ought

to be finalized in 2024. After five years, the firm finalized the construction of its third shaft at Turquoise Ridge and is actively drilling around the site to find potential extensions. In the Cortez Complex, the firm hopes to leverage its world-class Goldrush underground deposit, with a 20-year mine life. New executive general manager Peter Richardson, who replaced Greg Walker in October 2022, explained: "We have a robust 10-year plan and continue to explore and find more gold. High prices allow us to invest in our future."

Barrick Gold's president and CEO Mark Bristow acknowledged that the Goldrush underground project at the Cortex complex was key to helping drive the firm's future growth. Touching upon the main milestones of the JV and Barrick's outlook for Nevada, he stated: "NGM is Barrick's value foundation. As far as the original objectives of the joint venture are concerned, I can safely say: Mission Accomplished! We have created a whole that is truly greater than the sum of its parts."

He added that NGM's total economic contribution to the state in 2021, including taxes, royalties, salaries, and procurement spending, amounted to over US$2.6 billion, with US$8.9 million spent on social investments alone.

In the Battle Mountain Trend, i-80's Ruby Hill and Lone Tree operations are advancing at a pace likely to position the firm as the fastest-growing gold producer in Nevada. Having focused on exploration in 2022, the firm forecasts to be the second-largest producer in the state behind NGM by 2026, with a total production of 250-300.000 oz/y. The firm will prioritize restarting its processing facility at Lone Tree in 2023 and look beyond gold in the future. CEO Ewan Downie laid down his plan: "We are most excited about our new CRD (Carbonate Replacement Deposit) discovery immediately south of the pit (at Ruby Hill) where initial drilling is displaying some of the highest grades in CRD history. Our ambition is to diversify our production with the inclusion of lead, zinc, and silver."

Coeur Mining, the operator of the largest primary silver mine in the "Silver State", is no stranger to huge exploration and expansion investments. The firm spent US$240 million in exploration since 2017, including US$70 million in 2021. Adding a US$600 million investment at Rochester, the firm has in total seen a 100% increase in its silver resources. Mitchell Krebs, Coeur president and CEO, saw technological investments as the solution to offset the impact of higher production costs. These include high-pressure grinding roll technology at Rochester, the key to crushing high volumes of ore finely, and an on-demand ventilation system at the underground operations. He summarized "Regarding productivity and optimizing costs, we implement business improvement innovations to help offset the impact of higher costs."

Faced with declining ore grades and growing metal demand, the once-utopic prospect of going underground from an open-pit prospect is becoming ever more realistic, particularly thanks to new technologies. Kinross is exploring the potential of an underground mine at Round Mountain, with updates awaited in 2023. The firm is also leveraging drone technology to develop a pit at Bald Mountain – Little Bald Mountain - with extensive underground workings. Joseph Kemp, vice president, and general manager of the site explained: "Little Bald Mountain has a couple of large open stokes, which are hard to get into safely. Drones were able to map the underground area which allowed us to build a unique 3D model of what the underground development looked like."

Sitting on the largest silver resource in North America, with over 450 million silver ounces in the M&I resources, Hycroft Mining CEO Diane Garrett has planned a drill program for the summer of 2023 to bring the asset back into production. "Silver is key for the solar industry and so many applications whether you have a gas or electric vehicle," said Garret.

The operating environment ahead

Globally, geopolitics has increased as the second highest risk for mining producers according to EY. Due to Nevada's geographical position and political stance, firms in the state were less affected than their international peers by the direct effects of the Ukraine war. Yet, geopolitical risk will increasingly become embedded within broader strategic planning. Tensions with China in August particularly highlighted how geopolitical risks lead to resource nationalism. As I-80 CEO Ewan Downie highlighted: "If we were to have a real conflict with China, we must realize that they have most of the metals and processing facilities, and governments had better start recognizing that."

34>>

» Our miners are operating on the surface and running underground equipment. We have also been trialing battery-driven equipment underground. «

Peter Richardson

Executive Managing Director
NEVADA GOLD MINES (NGM)

What is your vision as the new executive managing director of NGM?

There are four key pillars to my vision. The first is improving safety. November 2022 was our first injury-free month in our journey towards zero harm, a big milestone for us. The second is executing our plans. To emphasize this and improve integration between sites, an organizational change ensures that all site general managers now report to a new position for head of operations. Delivering on our capital plans, expansion, and improvement projects is key. Finally, the future. We need to add ounces to the backend. The first step is exploration; we have a solid 10-year plan, which we want to improve to a 15-year plan and beyond.

What are some of the key upcoming works ahead at the Carlin and Cortez mine sites?

Since the formation of the JV, we have produced over 10 million oz Au, along with increasing the reserves by 1.9 million oz and resources by almost 8.5 million oz. We have improved our knowledge and understanding of our ore bodies and geology. At Carlin, we continue to mine the open pits and underground. We are working on expansion plans underground, notably at our Gold Quarry roaster, with up to 20% expansion there that will be finalized in 2024. The Goldstrike autoclave is being rebuilt, and we are changing the process from Resign In Leach (RIL) to Carbon In Leach (CIL), which will be finalized in Q1 2023. At Cortez, the key is getting the final Record of Decision (ROD) approval at Goldrush. We hope to get it by Q2 2023. We will then build the required new infrastructure and begin production ramp-up at Goldrush.

Can you expand on operational and expansion developments at Turquoise Ridge?

We finalized the Third Shaft at Turquoise Ridge in 2022, which was an ongoing project since 2018. We plan on increasing the production from that shaft, we have changed the ventilation schemes and the infrastructure is now set. We are exploring drilling around the Mega-pit, in the areas between the legacy Newmont and Barrick sites, and around Turquoise Ridge to find extensions.

Which technological developments are you leveraging at these operations?

Mining is going towards remote control and automation undoubtedly. Our miners are operating on the surface and running underground equipment. We have been trialing battery-driven equipment underground at Turquoise Ridge and Goldrush. We are looking at upgrading our open pit equipment with diesel-electric, and with automation potential. We have remote drills at our open pits. Automation is beneficial for safety and productivity reasons. When the mine is evacuated for blasting, a crew is still operating equipment from the surface, which does not lead to downtime.

Can you expand on NGM's ESG approach and recent community initiatives?

NGM has committed to a 20% carbon reduction by 2025, which will be achieved through the TS Solar facility and the modification of NGM's TS Power Plant providing the ability to use cleaner-burning natural gas as a fuel source. Regarding community initiatives, in 2021 we provided a total community investment of US$2.6 million. We launched the I-80 fund during Covid-19 and invested US$5 million into giving loans to small businesses. Post-Covid, this fund is transitioning to support business growth and start-ups in Nevada. In 2020, we convened advisory groups of local stakeholders and community leaders to identify how we could work together to ensure critical community needs were being met. These Community Development Committees (CDC) meet quarterly and cover Southern Nevada, Elko/Spring Creek/Carlin/Eureka, Battle Mountain/Winnemucca, Wells/Wendover, and Native American communities. Over US$5 million has been contributed to Nevada through the work of these CDCs. One of the first initiatives from the CDCs was to help the childcare shortage in our communities. We committed US$3 million to the Boys & Girls club daycare facilities, now named Nevada Gold Mines Early Learning Centers. NGM is also committed to improving community broadband in the Elko area, where we have partnered through a US$30 million investment with Anthem Broadband for them to build the infrastructure. Finally, we are committed to investing in our youth. We have partnerships with Great Basin College, the College of Southern Nevada, the University of Reno, and the University of Las Vegas and are investing even further down the line to help create the next generation of miners. ■

> Nevada Gold Mines is Barrick's value foundation. As far as the original objectives of the joint venture are concerned, I can safely say: mission accomplished!

Mark Bristow

President and CEO
BARRICK GOLD

How would you assess Barrick's performance in 2022?
We are continuing to build our balance sheet, our dividend policy is delivering sustainable returns and we have shored up our life-of-mine plans to ensure that our 10-year production profile remains intact. Our successful exploration programs are feeding high-quality prospects into an already bulging pipeline and we expect to grow our reserves net of depletion again this year.

Nevada Gold Mines is Barrick's value foundation. As far as the original objectives of the joint venture are concerned, I can safely say: Mission Accomplished! We have created a whole that is truly greater than the sum of its parts. From this sound base, NGM can now exploit the wealth of opportunities in its ambit, and we have recruited a future-facing management team – including a new North American regional chief operating officer and a new NGM executive managing director – to lead the company into its new growth phase.

While Nevada is Barrick's value foundation, our Africa & Middle East region is our most consistent producer of excellent performances on all fronts, as well as a rich store of gold and copper growth opportunities.

What are the primary drivers of Barrick's future growth, and what kind of balance are hoping to achieve between copper and gold?
Barrick's core strategy is one of long-term value creation. We continue to maintain a strong balance sheet and to develop our wealth of organic growth projects. Sustainability is the cornerstone of our business, as it has been for the past 20 years. We have adopted a holistic and integrated approach to this critical issue and are not only prioritizing the environment portion of ESG metrics. This is more attuned to the ethical and developmental needs of many of our host countries and is already delivering results.

Key gold projects that will help drive Barrick's future growth include Goldrush underground at Cortez in Nevada and the Pueblo Viejo expansion in the Dominican Republic. Both projects are expected to secure the Tier One status of these assets for decades to come. On the copper side, key growth projects include Reko Diq in Pakistan and the Lumwana superpit in Zambia.

Barrick was the first gold company to clearly articulate a strategy to grow in copper. We see our copper portfolio as a source of differentiation to our gold industry peers, providing shareholders with meaningful exposure to a key commodity of the future.

Can you touch upon the socio-economic benefits that the Nevada Gold Mines joint venture brings to the state of NV?
NGM is a key partner to the state of Nevada with its workforce of 7,000 making it one of the state's largest employers. In 2021, it's total economic contribution to the state, which includes taxes, royalties, salaries and procurement spend, amounted to over US$2.6 billion, with US$8.9 million spent on social investments alone.

NGM continues to invest in people, both current and future employees, through education partnerships and training programs. It supports the College of Southern Nevada and the Clark County School District where high school students can obtain certificates in industrial maintenance or diesel technology, and has renewed its partnership with Discovery Education for the Nevada Department of Education's outreach program. The company is also working with the University of Nevada and the Great Basin College in Elko to develop mining-centered programs.

What is your outlook for gold production in Nevada?
Based on our five-year attributable profile with costs normalized for current gold prices, increased production will come primarily from the Goldrush ramp up. Escalating volume is also a product of increased Crossroads production out of Cortez. Permitting impacts at Goldrush, Long Canyon, and updated assumptions for Robertson based on our experiences with Goldrush, together with resequencing to optimize the Life of Mines (LOMs), have lowered our near-term production profile versus the prior outlook. However, the impact over the next five years was nearly offset by additions such as Pipeline phases 11 and 12 at Cortez and ounces were increased beyond the 5- and 10-year windows. This updated 5-year outlook also reflects the inflationary impact of energy and key consumables pricing, which we are working diligently to offset. ■

> Interestingly, despite increasingly challenging operating environments, the industry's ounce production continues to maintain or improve. That speaks to the creativeness and technical expertise of the whole value chain of the industry.

Joseph Kemp

Vice President and General Manager – Bald Mountain,
KINROSS GOLD CORPORATION

What were the main highlights from Kinross in 2022, and the dynamics behind the "Kinross Nevada Model"?
There were numerous changes at Kinross last year. The most noteworthy change was the re-shaping of the Company's portfolio with the divestment of its Russian assets as well as the Chirano mine in Ghana. Our portfolio is now largely Americas-based with operations in Brazil, Chile, Nevada, Alaska, and a world-class project in Canada. We also own and operate the Tasiast mine in Mauritania.

In Nevada, the major change was at the decision-making level for our two Nevada properties, Bald Mountain and Round Mountain, which are located about 80 miles from each other. Kinross Nevada now takes a "one-team" approach for the two mines, which continue to operate as independent entities but now benefit from increased collaboration and improved sharing of best practices to increase operating efficiency while reducing the cost model.

What are the underground exploration plans at Round Mountain?
Kinross recently completed an optimization program at Round Mountain, which evaluated four primary options to exploit the significant resources at site. The Company is prioritizing underground opportunities at Phase X and Gold Hill and expects to start construction of an underground decline this year.

What are the key exploration milestones to look forward to at Bald Mountain?
In 2022, exploration focused on targets with the highest potential to deliver a near-surface mineral resource estimate. We also expect to submit an expansion permit application shortly, which would open the opportunity for new production areas at Bald Mountain. Kinross continues to explore the large Bald Mountain land package with the view to potentially extending mine life.

Bald Mountain recently won the 'Leadership in Concurrent Mine Reclamation' award. Can you expand on your reclamation initiatives?
Reclamation is something we are very passionate about at Bald Mountain. This is the second time we have been recognized for our reclamation efforts, and we have even received recognition from one of our US Senators. Achieving this recognition meant going above and beyond our commitments. To cite a concrete example, to minimize our environmental impact and support wildlife habitat, Bald Mountain undertook a project to backfill the pit with about 17 million t of non-ore-bearing material. Overall, we work openly and collaboratively with regulators through transparency and regular meetings.

How are you leveraging new technologies at Bald Mountain?
We continue to find applications for drone technology at Bald Mountain. Right now, we are developing a pit – Little Bald Mountain – and are mining out an area with extensive historic underground mine workings. Accessing large open stopes for mapping can be very dangerous, so we used drones to go in. By doing so, we were able to map the area and build a unique 3D model of what the mining sequence could look like.

What is your outlook for gold production in the coming years?
In Nevada and worldwide, substantial new deposits are being developed. Because of the demand for minerals, most companies are mining portions of their deposits that were not economical years ago. Doing this can be a challenge.

Interestingly, despite increasingly challenging operating environments, the industry's ounce production continues to maintain or improve. That speaks to the creativeness and technical expertise of the whole value chain of the industry. It is also a testament to the quality of our workforce. Naturally, I would like to see gold prices higher. Inflation is always something to manage, but we are hopeful that gold prices reflect that as well.

How can state and federal-level authorities streamline permitting processes?
The task is a hard one, as regulators are facing the same workforce challenges as other industry players. Overall, the industry's main hurdle is that of public understanding. There is a general lack of knowledge about the need for mining in our everyday products. More understanding of the benefits of mining would increase public interest in our industry and help with themes such as the length of the permitting process, for instance.

What are the main milestones ahead for Kinross Nevada?
There are exciting times ahead. Kinross Nevada's goal is continuous improvement. We plan on further reducing our operating costs at both sites, as well as leveraging more of the synergies to identify improvement and optimization opportunities. ■

Ewan Downie

CEO
I-80 GOLD CORP

What are i-80's latest production targets?
i-80 Gold Corp is currently advancing several projects that we expect will result in our company being the fastest-growing gold producer in Nevada. We will see limited production in 2022, around 20 to 30,000 oz Au, but with the development of the new operations, we expect to see significant increases year-on-year until 2025. I forecast this should make us the second-largest producer in the state after Nevada Gold Mines (NGM) by 2026, with a production of 250-300,000 oz/y. We are also advancing a very exciting polymetallic (base metals, gold, and silver) deposit at Ruby Hill that we are targeting to advance to production by 2026, which should result in our gold equivalent production closer to 500,000 oz/y.

Can you provide the latest updates at Ruby Hill, Lone Tree and the Granite Creek projects?
We had realized substantial exploration success over the past year including three discoveries at Ruby Hill. Our ambition is to diversify our production with the inclusion of lead, zinc, and silver.

We benefit from the fact that our Lone Tree processing facility is fully constructed, and we are now permitting to make changes to the facility so that it maximizes recoveries from our deposits and meets new environmental requirements. This facility is key to our growth, providing infrastructure that can process several ore types.

Granite Creek is our most advanced project. In early 2022 we started our development and test-mining program and are in the process of mining refractory ore to deliver to NGM as part of our processing agreement and initial 10,000 tons of material to test in their autoclave facility at Twin Creeks. On the exploration front, the discovery of the South Pacific Zone (SPZ) is expected to become the most important horizon for mining at Granite Creek. The goal is to begin underground drilling at the SPZ in H1 2023 and mining in H2 2023.

Mitchell Krebs

President and CEO
COEUR MINING

What are the most recent updates regarding expansion plans at Rochester?
We embarked on a large expansion of Rochester in 2020, which is expected to be wrapped up in mid-2023. On the back of this expansion, operating cash flow is expected to be about US$145 million a year, and free cash flow is expected to be approximately US$90 million a year. Production is expected to grow from 4 million oz/y of silver per year to approximately 8 million, and from 40,000 oz/y of gold per year to about 70,000 oz/y.

What were the reasons behind the selling of the Crown and Silver properties?
The sale of Crown Sterling is consistent with our strategy of monetizing non-core assets and prioritizing high-return growth from our North American asset portfolio, including the expansion project at the Rochester mine.

The strategic sale of the Crown and Sterling holdings to a subsidiary of AngloGold Ashanti Limited closed on November 4, 2022.

How does Coeur Mining remain an ESG leader?
ESG is key to being successful in mining, and we are aligned from the board level to frontline operators to implement sustainable goals. We aim to keep building on that leadership position, by continuing with the GHG emission reduction target we rolled out in 2020, and subsequently strengthening it to a 35% reduction by the end of 2024. What sets Coeur apart is that we tie our compensation to achieving these targets. We hold ourselves accountable, which is critical to be a credible ESG leader.

What are the advantages of operating in Nevada?
Companies from outside the US want to be in Nevada. The geology is second-to-none and the state is still massively under-explored. There is high-quality infrastructure, a diverse workforce, and a regulatory framework that is managed by people that understand the complexity of mining. If Nevada were a country, it would be the 5th largest gold producer in the world. It is fantastic that we have the largest primary silver mine in the "Silver State". Politically, all Representatives and the two Senators are open to mining-related discussions. But there remain challenges on the regulatory and agency side.

What is the near-term focus for Coeur Mining?
In the past two years, we have invested in our business. In the short term, investors don't always appreciate this, but those investments are expected to pay off and create significant value in the medium and long term. Over the past five years, we have invested about US$240 million in exploration, US$70 million of that in 2021 alone. That has led to significant reserve and resource growth. Over the last five years, our gold reserves have increased by 45% and silver reserves have increased by 100%. Our near-term focus is completing the Rochester expansion. We will prioritize capital there but continue to invest heavily in our assets in Mexico, Canada, and the US. ■

How are rising costs affecting your operations?
Cost escalation at high-grade mines is typically less than at lower-grade mines. The most affected mines are the lower-grade open pit operations because of the amount of material that needs to be moved to achieve production, goals requiring significant amounts of trucking (therefore fuel), and blasting. When you look at Granite Creek, the average grades are 10-13 g/t Au, McCoy-Cove is almost 11 g/t Au and Ruby Hill is looking to be more than 8 g/t Au, so we expect to be less affected.

Can you expand on i-80's community engagements?
Being an accepted part of the local communities in which we work is a necessity in our industry. We have always made this one of our number one priorities. When somebody who has never seen mining suddenly sees a huge open pit, they need to be educated to understand that in many instances these pits will one day be full of water and become flourishing fisheries. ■

Diane Garrett

CEO
HYCROFT MINING

Can you briefly introduce Hycroft Mining?
Hycroft has a long successful history of open pit heap leaching operations going back to the 1980s. We are transitioning that into the milling of the sulfide ores and we are completing our technical studies while conducting our largest drilling program in over a decade at Hycroft mine.

Can you expand on the initial drilling results released in September 2022?
Hycroft has over 15 million oz gold equivalent in its current resource, with over 10 million in M&I and another five million in inferred. We have the largest silver resource in North America, with over 450 million oz silver M&I. The caveat to Hycroft is that it is on the lower end of the spectrum when it comes to grade, about 0.5 g/t gold.

This drill program will last until the summer of 2023, when we will push out the new technical report on the sulfide milling operation. Hycroft has an enormous amount of infrastructure on site, so the only thing we'll need for the sulfide operation is the mill configuration for processing sulfide ores. We also have about 40 million t of heap-leachable material sitting at Hycroft. If we can drill out more on the heap leach, we can start that operation much sooner as we are already permitted for leaching and milling.

The Sprott and AMC investment in March 2022 has allowed us to launch this exploration program to unlock Hycroft's real value. It also brought an entirely new shareholder base who are very supportive which allowed us to do a follow on the market equity of over US$130 million. In such a volatile market, having this amount of cash in the bank affords us the staying power that is needed for the years to come.

What role can Nevada play in the US supply chain of precious metals?
Nevada has a lot of gold and silver, and silver is key for the solar industry and so many applications whether you have a gas or electric vehicle. With the Tesla Giga factory particularly, we are well poised to help support the increase in demand. There needs to be collaboration between the federal government and Washington. If we are going to meet some of these goals, we must hold companies accountable, but also shorten the red tape processes to get permits.

It takes a lot of time and capital to get projects running, and if you add a decade of permitting, it will force the US to look for the critical mineral it needs outside of the country.

What is the priority for Hycroft in the coming year?
Releasing a new technical report on the sulfide milling operations. We also have a very large exploration program, so we'll have continuous news out throughout the year. We will expand our plans for heap leach operations and transition toward the sulfide operation. We have US$150 million in cash, so we can unlock value, and are looking at M&A transactions. ■

<<28

» Technologies are being developed to retrieve minerals from previously mined materials. Cyanco is taking the lead on developing new technology that will help mines turn 'waste ore' into a new source of minerals.

Steve Cochrane,
US Sales Manager, Cyanco Technologies

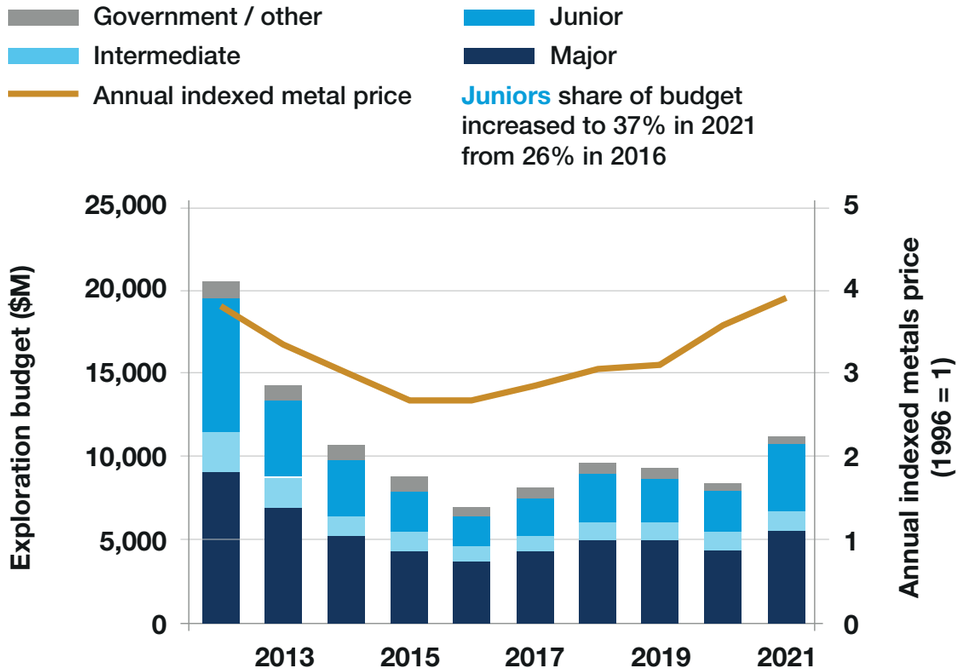
« Looking ahead, government aid for economic recovery has caused levels of inflation and interest rates at heights unheard of in 40 years. Added to this, a shrinking talent pool, higher energy costs and global supply chain disruptions are all indicators of continuously high costs for mining producers throughout 2023. But this environment is one of the key opportunities. Gold knows no political attachment and has been for millennia a unique currency to revert to in troubled times. Turmoil calls for stability, which the metal offers, and as forecasted by Ewan Downie: "The need for gold as a financial backstop has never been more important than today."

» Northern Nevada is one truck day away from 11 different states: we are the distribution hub of the West. Nevada also has the most robust environmental protection agency that is pro-business. They want you to be clean, but they want you there.

Corrado De Gasperis,
CEO, Comstock Inc

« The coming months are likely to be marked by organic growth through development, exploration and asset consolidation for Nevada's majors. Success will however come at a cost, requiring much higher capital to be put into projects at the exploration and development stage, and will only be obtained through strategic navigation of current exogenous challenges. Geopolitical tensions, raising interest rates and rising energy costs are forcing mining majors to come up with innovative ways to maintain two core objectives: shareholders' margins and meeting increasing metal demand. ■

Majors continue to drive nonferrous exploration, but juniors are catching up



Source: S&P Global Market Intelligence, February 2022

Precious Metals Exploration

Positive signs in a challenging environment

Image courtesy of American Rare Earths

Nevada's geological trends, home to past-producing mines and present giants responsible for millions of ounces of precious metals production, make it an ideal jurisdiction for explorers and investors to chase high profits. But even in arguably the best mining jurisdiction for exploration activities worldwide, juniors face challenges linked to attracting investment that present hurdles to the de-risking of their assets.

Nevada continues to retain all the ingredients for exploration projects to succeed. Besides its second-to-none geological endowment, the jurisdiction is politically, legally, and fiscally stable and Nevada's policies are strongly supportive of mining. The legal and regulatory conditions guaranteed to juniors through the federal Mining Act of 1872 can only be changed by Congress. Indeed, as put by Antonio Canton, President and CEO at Gold Springs Resource: "Nevada is the best mining jurisdiction in the world for exploration".

Unmatched trends

Nevada's world-renowned Carlin trend remains a popular spot amongst explorers. Having produced over 80 million oz Au since the 1960s, Nevada's Carling-Type gold deposits still contain over 255 million oz Au, making it one of only six gold belts this size across the world. Representing the bulk of Nevada's gold production, Carlin-type gold deposits contain "invisible" or microscopic particles of gold that are deposited within pyrite in sedimentary rocks. As the lion's share of this trend is already being exploited by majors, getting land on the trend during a strong market is often difficult for explorers.

In 2022, Westward Gold saw an opportunity to get a foothold in the Carlin trend and seized it by growing its land package at the North Carlin project. Colin Moore, president, CEO, and director of Westward Gold explained the decision: "In this current market, we have been conscientious when it comes to our treasury as nobody wants to have to dilute at the current share prices. The North Carlin project is in a great area surrounded by majors. We are taking a longer-term approach to this asset and are looking at creative ways to advance the project, and this could be a JV structure, an earn-in structure, or an equity commitment - a partner with deep pockets who is not afraid to go after higher-risk exploration."

In the Walker Lane trend's Tonopah district – the "Queen of silver camps" - Summa Silver hopes to build on high-grade mineralization intersected at the Hughes project in June 2022. The trend is endowed with around 80 million oz Au and 700 million oz Ag and produces epithermal systems that are easier to understand compared with other trends. In 2022, drilling at the Murray target returned 535 g/t Ag equivalent on over 4.6 m, and Summa Silver intends to analyze all open zones at the project with the perspective of pushing an N43-101 at Hughes in 2023.

Challenges in maintaining momentum

2021 saw escalating interest from politicians, investors and the public in the energy transition and the mining community's role became better understood. The exploration industry's response was a 35% year-on-year budget increase between 2020 and 2021, which led to a robust exploration

environment in Nevada, a boom in junior IPOs (five in 2021), and more mining claims in the Silver State.

A promising start to 2022 laid the hopes for juniors' ability to maintain the momentum gathered in 2021, but how this year has unfolded has drastically affected those dynamics. S&P predicts a decrease of between 10-20% in exploration budgets in 2023. Several Nevada-based juniors, however, plan to start drilling campaigns in Q1 2023 and will likely have to tap into the market for added funding.

The surge in exploration activity and holes drilled in 2021 and early 2022 created a backlog among assay and core drilling results from Nevada's metallurgy labs, pushing back deadlines for PEA releases, among others. Gold Spring Resources reached the first million oz Au M&I resources in 2022 at its Gold Springs project. The firm is now awaiting lab results before preparing the 2023-2024 drilling plan, to reach 3 million oz Au and advance on the permitting front in the next 24 months.

Ridgeline Minerals' four-property portfolio makes it one of the largest landholders in the state. Having completed an IPO in 2020, the firm understood that the presence of under-graveled deposits and recent discoveries such as NGM's Goldrush project made exploration at the Battle Mountain – Eureka Trend attractive. Battle Mountain is located downtrend of Ridgeline Minerals' Swift project, a Carlin-type gold deposit. The firm entered a US$30 million earn-in agreement with NGM in 2021, with the giant committed to funding the drilling campaign. The results of the ongoing campaign are expected early 2023. Despite this milestone, president,

» The next big discovery is going to come from data. Historic districts often have reams of old paper data that after 3D modeling produce targets.

Gallen McNamara, CEO, Summa Silver «

CEO and director Chad Peters recognized access to finance mechanisms as a hurdle to funding for Nevada-based juniors. He explained: "We do not have the same access to financing mechanisms as some of our Canadian peers. Through flowthrough financing, Canadian companies can raise a premium to their trading valuation to continue doing exploration work, whereas we are having to stick to hard investor dollars with no tax incentives offered in Nevada."

Breaking out from the pack or joining forces

The current conditions that favor late-stage projects and greenfield expansions should not hide the societal need for grassroots exploration. In that context, few regions have witnessed more drill turning and projects emerging than Nevada. The junior stage in Nevada has seen several alleys for players to demark themselves: partnering with majors, M&As, and technologies investments.

The need for consolidation through JVs, earn-ins, or M&As among the junior marketplace in Nevada is obvious. At least four material acquisitions took place in Nevada in 2022: Orla Mining acquired Gold Standard Ventures; Centerra Gold acquired the Gemfield project from Waterton Nevada Splitter; Calibre Mining acquired Fiore Gold, and AngloGold Ashanti acquired Corvus Gold. As the competition for funding is fierce, Derek Macpherson, president and CEO of Gold79, sees M&A activity as beneficial for actors in the state to unlock its true geological potential: "I think we need to see M&As as there are about 50 of us there. There needs to be consolidation as it is difficult to fund all these firms from the same pool of capital in public markets. This will lead to higher quality assets being explored and better attribution of capital."

Convincing majors to take a chance on explorers' projects remained key in 2022. Gold79 unlocked synergies with Kinross at Jefferson Canyon. In October 2022, both firms signed an exploration and option agreement whereby Kinross is to invest US$200,000 in Gold79 and commit to spending US$600,000 at Jefferson Canyon.

Attracting majors requires risk mitigation. After having gone public in 2021, Millennial Precious Metals aims to publish a PEA at the firm's Wildcat and Mountain View flagship projects, which host a combined 1.2 million oz inferred oxide Au. In 2022, the firm completed a mapping and sampling program that identified high-priority targets that president & CEO Jason Kosec intends to drill in 2023 as the second part of its de-risking strategy: "One of the most important things in the exploration business is risk mitigation. This program was designed to remove show-stoppers and show the potential scale of the project."

With dozens of drilling campaigns scheduled in Nevada for 2023, companies with substantial cash in the bank will be in a pole position in a market where money flows in droplets. ■

John Seaberg

CEO
NV GOLD CORP

» **The next multi-million-ounce discovery in Nevada will be undercover, and we are in an advantageous position as our land package is second to none regarding other juniors in Nevada.** «

Can you briefly introduce NV Gold?

NV Gold has about 20 properties in Nevada and one high-grade property in Switzerland. Our portfolio might be the most diversified exploration portfolio in Nevada, ranging from near-surface oxides epithermal properties like our Slumber and Triple T properties, all the way to Carlin-type deposits that are more bulk tonnage and lower grade but with leach potentials like SW Pipe and Pickhandle. We are actively focused on seven of our highest-priority targets with excellent discovery potential that are in the immediate neighborhood of active mining operations. All our projects are permitted and 100% owned.

What are the latest updates at the Slumber Project?

We had success with RC drilling earlier in 2022, and we have also done some mercury vapor work where we identified five new anomalies in the area. My priority would be to drill Slumber right now as we need to follow up on increasing gold grades up to 1.5 g/t to the north of the property, as well as testing some of the five Mercury-vapor anomalies, which are all outside the mineralized zone. However, we need to be conservative with our capital, since the financial markets are still low.

How promising are the results from the initial drilling program at Sandy in September 2022?

This drilling program marks the beginning of a medium-term exploration campaign. We drilled four RC holes at Sandy that successfully tested "a new zone" north of the 2021 drilling campaign. Based on the visual assessment the rock looks very encouraging having encountered a new zone of potentially mineralized quartz veining. Some assays are still pending. Another relevant asset is SW Pipe. We plan on a one-hole test, we've identified the target, and believe it has excellent potential to be another multi-million-ounce Carlin-type deposit.

Can you provide an update on the Notice of Intent approval at Triple T?

We permitted ten new drill sites at Triple T. We recently got that asset back in our portfolio and want to increase the zone of near-surface oxide gold mineralization that was encountered by Evolving Gold in 2007 and NV Gold in 2009. Budget and market conditions permitting, we will embark on that 10 RC drill campaign to find an economic near surface oxide deposit. There are lots of existing operating mines in that area, and we think Triple T could be an excellent ore source for those mines. Finding that ore source could allow us to consider a JV with an operating company.

How is NV Gold leveraging new technologies as part of its exploration strategy?

We have an extensive database of exploration data. We recently did an exercise with GoldSpot who ran that data through their AI software that generated an additional 31 targets based on geological data. We ran multiple iterations of the data and found opportunities based on geological samples and minerals indicative of being near a gold deposit. We have a mountain of data that took a long time to digitize, and now it is in a state where we can action it rather than the data just sitting in a warehouse. Without active interpretation and analysis, data does not have any value.

What is your outlook for gold pricing and demand in the medium term?

What is happening in Ukraine, in the UK, and the political situation in the US has led to unprecedented supply chain and inflationary issues. I'm still optimistic about a strong gold price, around US$1800-2000/oz in the coming months or year. for the last 2,000 years, gold has served as a safe-haven currency, and I believe it will come out as the ultimate reserve currency once again.

What are NV Gold's priorities in the next 6-12 months?

Unlocking the value of properties that have been underexplored. Pickhandle has never had a drill rig on it, so we are excited to see the results of our recent drill program. We have a potential sleeping elephant at Slumber, and our properties are next to majors' gold mines in Nevada. In the next 6 months, we'll see the results of these drill programs. The next multi-million-ounce discovery in Nevada will be undercover, and we are in an advantageous position as our land package is second to none regarding other juniors in Nevada. ■

Insights from the explorers

Joseph Kizis,
President and CEO, Bravada Gold

"We focus on Nevada for a reason. Exploration is easier to do here. The ESG standards are such that environmental rules are straightforward, and so is the permitting process. Logistics are so much better here, for the same costs of moving a couple of core drills in South America, you can do a whole drilling campaign here."

Herb Duerr,
CEO, Minquest

"Copper is very undervalued at this point. The market is not paying attention to the available stockpiles. Prices are down as investors perhaps believe we are going into a recession and there will not be any immediate need for the metal. But looking at EVs and clean energy, you need copper to generate and distribute the electricity."

David G. Watkinson,
CEO, Emergent Metals Corp

"I think the odds of funding lithium projects are better than gold or base metal projects at the current time because it is a hot commodity. However, these industries are cyclical. The Ukraine war and the Chinese economy have created global uncertainty, and this affects metal prices and investment."

James Hesketh,
President and CEO, Viva Gold

"Mining is essential to the shift to alternative energy. In several parts of the world, resources cannot be relied upon to be extracted, largely because of geopolitical tensions. So the environment for resource development, particularly in a place like Nevada, is getting better and better."

Mike Sieb,
President, Getchell Gold Corp

"Anybody who has worked in Nevada over the past years will have witnessed the activity there, the number of drills that are turning, and the projects that are emerging. More exploration produces more discoveries and produces more mines. Nevada is an example of a strong chain of custody, it is a land of huge gold and precious metals opportunities."

James Tworek
CEO, Element79 Gold

"Gold and precious metals have always been a counterweight in the fight against inflation and a source of security for an investment portfolio. Gold and silver prices have risen over the past two years. These indications will help drive global demand. When you talk about the actual physical resource, there's exploration capacity, milling capacity, then refining capacity that is needed."

Lithium Exploration and Development

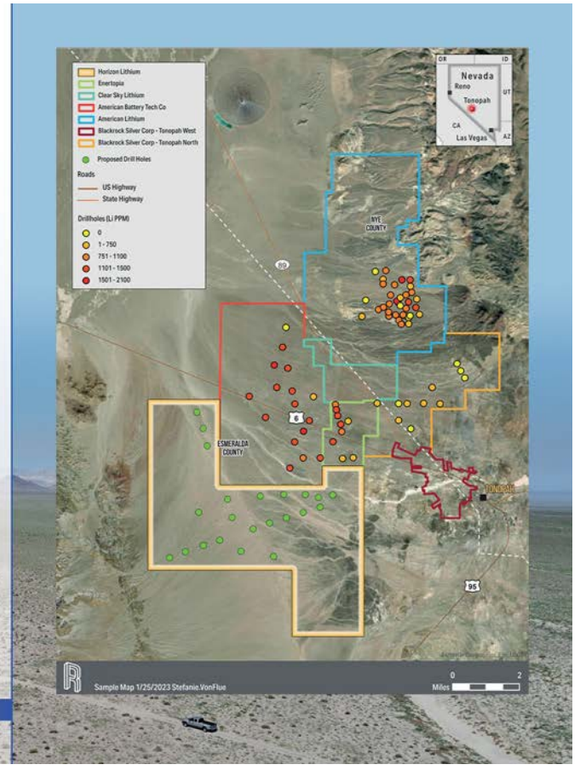
A highly competitive scene with clear cooperation perspectives

Image courtesy of Davel5957 (iStock)

Lithium prices surged 123% year-to-date in October 2022, according to Benchmark Intelligence.

Despite uneventful changes in market capitalizations, five of the 10 juniors on the TSX-V 50 (a list of the best performing TSXV-listed firms) in 2022 were lithium-focused, one of which being American Lithium, currently advancing the TLC project in Tonopah. Indeed, several juniors have made the move from a gold-heavy portfolio to a lithium-focused one since 2015. In Nevada, developers and explorers like Cypress Development Corp, Nevada Sunrise Metals, and Ameriwest Lithium saw in the past years the opportunity to benefit from the craze around the commodity to make the strategic shift.

Since mid-2022, several bills, grants, and acts at the federal level highlight the sense of urgency – beyond that of opportunity – for policymakers to increase domestic lithium production. Indeed, the Inflation Reduction Act, DOE Grants, and the Bipartisan Infrastructure Law highlight the tension between the requirement for minerals and reducing development time to meet the required supply. This is key in a country that aligned its future policy goals on electrification hopes: lithium demand is forecast to surpass 1 million t/y in 2025, with global EV penetration rates set to hit 21%. In the long term, this figure could represent 2 million t/y for the first time in 2030, with EV penetration rates set to hit 34%.



Eyeing production and offtake agreements

Currently sitting at the bankable feasibility study phase and final stages of permitting, ioneer's lithium-boron Rhyolite Ridge project aims to be a low-cost supplier of lithium for the US domestic market. Committed to sustainability despite being faced with water usage and environmental concerns, the project aims to be the most water-efficient lithium operation in the country and will use extraction methods similar to the copper industry, by extracting the lithium and boron through a vat leaching process. Bernard Rowe, managing director, explained the process: "We concentrate the lithium in the solution to extract it. We use large tanks (evaporators) to boil the liquid and drive off the water. The steam that comes off is captured, cooled, and condensed back into water that can be reused. Approximately 50% of our water gets recycled like that."

Besides its pioneering water-recycling approach, Rhyolite Ridge will also be known as the first greenfield operation in the US to fully use autonomous hauling systems. Relying on automation and technological equipment expertise from Cashman Equipment, Caterpillar's Nevada dealer. "These trucks will take the crushed ore from the mine site to the processing plant, about 3 km away. The trucks will be guided by high-precision technology, so every movement will be monitored and controlled through sophisticated guidance systems," explained Bernard Rowe.

In February 2023, Lithium Americas received a positive regarding Thacker Pass. This decision has the potential to change the face of lithium security in the US. Ahead of the ruling the firm had prepared for the future, particularly through innovations made at its Lithium Technical Development Center (LiTDC) in Reno, where the firm processes raw ore to final battery-quality lithium carbonate. Expanding on the firm's environmental footprint, as Thacker Pass will be reusing or recycling every drop of water over seven times, with an average recycling rate of 86%, president and CEO Jonathan Evans explained: "The operation will be a Zero Liquid Discharge facility, which is intended to prevent the discharge of industrial wastewater into the environment. This is an extensive commitment because it means all water that is filtered from tailings must be evaporated or recycled for reuse within the site's production process."

A noticeable trend in the coming years will probably revolve around offtake agreements between carmakers and lithium developers ahead of production. Rowe acknowledged that the full lithium supply chain is still a work in progress, yet Ioneer expects its lithium to be used in US EVs, and for the firm to be a key partner in the US domestic supply chain. ioneer signed in July 2022 a lithium offtake agreement with Ford and will deliver 7,000 t/y of lithium to the automobile constructor for five years, starting in 2025.

A hub for innovative and collaborative approaches

In a development brought about by unprecedented demand/supply dynamics, automotive, commodity traders, and chipmakers have started evaluating early-stage projects. The NDOM recorded in 2022 40 explorers, with 30 of them in Clayton Valley alone, 12 clay/hard rock projects, and over 30 lithium brine and DLE operations. Dozens of Nevada-based players exploring a few hundred miles from each other in the state's lithium-rich valleys are persuing a cyclical opportunity to become the next Nevada-based lithium producer.

In Clayton Valley, a new player is keen on disputing the hegemony of existing and developing giants: Century Lithium. Possessing its Chlor-Alkali plant to extract and process lithium, the firm expects to release a feasibility study in Q2 2023, after it discovered well-exposed lithium buried in claystone, running around 300,000 ppm. The project's target production is 20-30,000 t/y of LCE, which could support a gigawatt factory. Putting an accent on environmental stewardship and leveraging the state's potential for solar and geothermal power, Clayton Valley project will use Direct Lithium Extraction (DLE) technology. Touching upon leveraging the benefits of DLE at Clayton Valley, Bill Willoughby, CEO of Century Lithium, explained: "DLE is a series of steps related to ion exchange. We begin by breaking the clay down in a high-speed mill and moving this slurry into leach tanks. We add hydrochloric acid, extract lithium from the clay, clean the tailings, and then raise the pH. The solution is filtered and passed through our DLE process. This is unique and leads to a 99,5% recovery of the lithium extracted from the clay at this point."

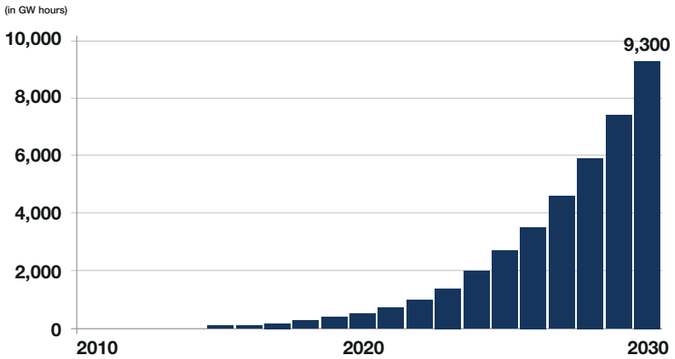
In Nye County, 90 minutes away from Las Vegas, Nevada Lithium Resources and Iconic Minerals partnered 50% each to advance the Bonnie Claire project, with an 18.37 t/y LCE. The project is permitted for further drilling, and both firms are actively carrying out metallurgy tests to determine the most efficient method of recovery. In September 2022, the firm encountered its highest-ever recorded lithium grade, with drilling results returning up to 5,570 ppm. Many projects are emerging, and merging, in Nevada, which will likely lead to common resources being shared. As put by Nevada Lithium Resources' Stephen Rentschler: "We will see the development of a large common infrastructure – rail, highway, and utilities - to help exploit the development of all the necessary minerals."

Recent formalized ventures in the lithium space potentially hide a key development amongst earlier players in Nevada. Faced with rising operational and capital costs, along with the shortage of skilled drillers notably, several juniors are considering teaming up. Steve Hanson, founder, president and CEO of ACME Lithium, whose unique portfolio gathers properties in the vicinity of the two sole operational lithium mines in North America (Silver Peak, Nevada, and Tanco, Manitoba), sees getting an initial resource as a catalyst in 2023. Acknowledging that Nevada will become a hub for DLE commercialization in the future, due to its smaller environmental footprint and CAPEX mostly, he highlighted the importance of partnerships going forward to bring that technology online at scale: "Ultimately, if DLE will be utilized, I do not see 10 separate plants, but groups collaborating and using the same processing facilities from several sites. Collaboration helps de-risk projects, keeps capex low, and increases speed to market.

Christoper Brown, president and CEO of HeliosX Lithium & Technologies Corp, who owns the Teels Marsh and Alkali Lake projects in Nevada, sees the collaborative approach going beyond operators, up to involving Washington. Regarding the shortage of skilled drillers – crucial to the success of establishing a lithium resource, as an overweight drill would flood zones and return zero indications of mineralization – Christopher Brown believes the government could create initiatives to subsidies drillers and allow operators to share costs: "One of the incentives government could do is support bringing drilling rigs to Nevada, especially for lithium. Bringing a couple of qualified drilling rigs to go to the depth and collect the information we need, then sharing the mobilization costs would economically benefit all players and unlock Nevada's lithium potential." ■

Demand forecast for lithium-ion batteries

Cumulative lithium-ion battery demand for electric vehicle/ energy storage applications (in GW hours)



Source: Bloomberg

Bernard Rowe

Managing Director
IONEER

» Rhyolite Ridge is a very advanced project that will be a long-life, low-cost supplier of lithium for the US. «

What are the latest updates at Rhyolite Ridge?
The project is now in the final stages of permitting. We are putting the financing in place and expect to be producing lithium and boric acid late in 2025. The initial mine life is around 26 years and will produce an average of around 22,000 t/y of lithium carbonate, and around 174,000 t/y of boric acid. There will be variations over time, but the lithium output is expected to be relatively constant. The 26 years estimate is based on our reserve, which is 60 million tons. However, we have already drilled a total of 146 million tons of resources. This means we could potentially double production or extend the mine life. Overall, Rhyolite Ridge is a very advanced project that will be a long-life, low-cost supplier of lithium for the US. The socio-economic impact is considerable. The construction phase will create approximately 500 direct jobs, followed by about 250 full-time jobs during operation.

Can you expand on ioneer's community initiatives?
We fully understand the importance of making sure our operation has a positive impact on the broader community and allows it to participate in the benefits of the transition to the new energy economy. That goes beyond providing jobs, it means being integrated into the community. About 200 people live in Fish Lake Valley, and I know most of them, as I have been working in the area long before Rhyolite Ridge came along. One of the most important things of all is communication and that includes listening, informing, and providing feedback to the community. For years, we have also provided updates to local elected officials and engaged with Tribal representatives. Beyond that, we have programs at the local school where our chemical engineers and scientists assist with STEM-type classes, we sponsor social events and help raise funds for projects such as the local emergency medical team.

What measures will ioneer leverage to make Rhyolite Ridge the most water-efficient lithium operation in the US?
There are several types of lithium mines. The only active producer in the US is a brine operation, Silver Peak. Highly saline water is pumped out into shallow ponds, the water evaporates, and lithium and other salts concentrate. This process uses the sun's energy to evaporate large quantities of water. Rhyolite Ridge is different. It is solid rock that we will mine and crush. We will extract the lithium and the boron from the crushed rock by using a vat leaching process, which is the same as is used in the copper industry. This process removes the lithium and boron from the rock and puts it into a solution (liquid). We then concentrate the lithium in the solution to extract it. We use large tanks (evaporators) to boil the liquid and drive off the water. The steam that comes off is captured, cooled, and condensed back into water that can be reused. Approximately 50% of our water gets recycled like that. It's a closed system, meaning we can recycle a lot of the water we use. In addition, making sulfuric acid from sulfur generates a lot of heat as the reaction is exothermic. Rather than letting it go to waste, we capture that heat and generate steam for the processing plant and electricity by running some of the steam through a steam turbine. We do not use gas from pipelines nor do we use grid power- we are entirely off-grid and generate nearly all of our energy needs in this way. The energy from the acid plant has zero CO2 emissions.

To what extent will Rhyolite Ridge leverage new automation technologies?
Rhyolite Ridge will rely solely on autonomous haul trucks, controlled by people in control centres. Being a greenfield site, it is much easier to implement these types of new technologies, compared to an existing operation.

Why is ioneer going to be a key player in the green transition?
We are confident that later this decade we will see a complete domestic supply chain from lithium chemicals to cathodes, to batteries and electric vehicles. When we negotiate offtake agreements, we ensure that the lithium must end up in cars manufactured in the US. We are positioning ourselves as a key partner in the US domestic supply chain. ■

» We have two industry-leading lithium operations that are potential near-term solutions in addressing the global supply deficit. «

Jonathan Evans

CEO
LITHIUM AMERICAS

What are the latest updates at Thacker Pass?
The US District Court, District of Nevada has scheduled an oral hearing for the appeal of the issuance of the Record of Decision (ROD) for Thacker Pass for January 5, 2023. We hope to receive a ruling shortly thereafter, in the meantime, the team has been moving ahead with pre-construction activities, including the selection of an engineering, procurement and construction management firm, and the hiring of key construction personnel to execute the development and construction plan for Thacker Pass. We are also evaluating potential investment, partnership and supply agreements to support the development of a North American supply chain. In addition, we continue to progress with the US Department of Energy Advanced Technology Vehicles Manufacturing loan program application.

Lithium Americas' Lithium Technical Development Center (LiTDC) in Reno continues to operate based on the Thacker Pass flowsheet, processing raw ore to final battery-quality lithium carbonate. As of September 2022, over 100 t of lithium ore were collected at Thacker Pass to feed the LiTDC to produce product samples for potential customers and partners. The LiTDC is also conducting ongoing test work to de-risk each step of the flowsheet, with results continuing to be in line with expectations. We are targeting the completion of a feasibility study (FS) for Q1 2023. The FS will reflect ongoing feedback from the strategic partnership and financing process, incorporate results of LiTDC operations and align with the anticipated timing of the ROD appeal ruling.

What was the decision-making process behind the recently announced split of Lithium Americas into two lithium firms?
After months of review, we have decided to advance with a separation. We have two industry-leading lithium operations that are potential near-term solutions in addressing the global supply deficit; both are distinctly different in terms of market dynamics, funding requirements, and path to full production. A separation would facilitate unlocking the full potential of each region's significant asset base to maximize value for shareholders and all stakeholders, as well as accelerate long-term growth by being able to grow and scale more quickly if independent.

Can you expand on Lithium Americas' community initiatives in Nevada?
In October 2022, we signed a Community Benefits Agreement (CBA) with the Fort McDermitt Paiute and Shoshone Tribe, the closest tribe to Thacker Pass at around 60 kilometers away, to establish a framework for continued collaboration and define long-term benefits for the Tribe. The CBA is a product of years of engagement, job training, and relationship-building between the Company and the Tribe. The CBA provides the Tribe with additional training and employment opportunities and support for cultural education and preservation. Furthermore, we have agreed to build an 8,000 square feet community center for the Tribe that includes a daycare, preschool, playground, cultural facility, and communal greenhouse to support reclamation efforts and provide income for the Tribe.

To what extent will Thacker Pass leverage new technologies?
Thacker Pass is being designed for low-water consumption, heavily relying on water recycling to meet its needs. The operation will be a Zero Liquid Discharge facility, which is intended to prevent the discharge of industrial wastewater into the environment. This is an extensive commitment because it means all water that is filtered from tailings must be evaporated or recycled for reuse within the site's production process. Thacker Pass will be reusing or recycling every drop of water over seven times, with an average recycling rate of 86%. The operation will also filter stack tailings, which is considered the most sustainable method of storing tailings.

The on-site sulfuric acid plant that will self-generate carbon-free energy for the processingplant through waste heat is designed to include a sulfur dioxide tail gas scrubber, a leading-class technology to minimize emissions and improve air quality. We are also exploring by-product options for some of the other minerals like magnesium sulfate found in the host clays.

What efforts must the industry and policymakers take to secure the US lithium supply chain?
Earlier this year, passing the Inflation Reduction Act (IRA) was a crucial step in enabling the North American battery industry to support building a domestic EV supply chain. Awarding grants and loans to boost US manufacturing of EV batteries and domestic mineral production is a key step of support. We're starting to see more investment throughout the EV supply chain and anticipate this to continue. ■

Bill Willoughby

President and CEO
CENTURY LITHIUM

» **Getting the raw material and producing a battery-grade product on-site will be a driving force for Nevada.** «

Can you briefly introduce Century Lithium and the Clayton Valley asset?
Century Lithium is a Canadian-based advanced-stage lithium company, focused on developing its 100%-owned Clayton Valley lithium project in Nevada. Our company is in the pilot stage of testing extraction and production through the production of lithium carbonate from our lithium-bearing claystone deposit and progressing towards completing a Feasibility Study (FS) and permitting to become a domestic producer of lithium for the growing electric vehicle and battery storage market.

What are the catalysts ahead at Clayton Valley?
We are nearing the completion of the FS, which we expect to be completed by Q2 2023, and the completion of all engineering parts. The last key piece of the puzzle is a chlor-alkali plant. Based on their reputation and expertise, we engaged ThyssenKrupp nucera to work on this part of the study. Once our FS is completed, we will start the permitting process with the BLM and State of Nevada, go through the NEPA process and carry out an EIS. We will do more information gathering to get a Record of the Decision with the federal government to grant us our mining license. We expect this to happen within the next couple of years.

Can you expand on your extraction approach and ESG focus?
DLE is a series of steps related to ion exchange. We begin by breaking the clay down in a high-speed mill and moving this slurry into leach tanks. We add hydrochloric acid, extract lithium from the clay, clean the tailings, and then raise the pH. The solution is filtered and passed through our DLE process. This is unique and leads to a 99,5% recovery of the lithium extracted from the clay at this point. Our process is energy dependent but we have the advantage of using salt brine as the feedstock to the chlor-alkali plant. After we exit the DLE process, we have a high sodium chloride solution with which we purify and feed the plant. We are in a great location for potential solar and geothermal power generation and are looking at those solutions to meet our ESG goals.

How will Clayton Valley feed the lithium market?
The growth curve over the next seven years shows the US is going to need 650,000 t/y of lithium carbonate, and this is more than what the world currently produces. The Defense Production Act and the Inflation Reduction Act are strong indicators of support at the federal level for projects like ours. Our target production is 20-30,000 t/y of LCE. Our project alone could support a gigawatt factory.

What role can Nevada play in leading the lithium charge?
Nevada holds the largest lithium resource in the US. If you add up projects with identified resources, you get to about 10 million tons of contained lithium, and 50 million tons of LCE, on a world scale, this puts Nevada third behind Bolivia and Argentina according to USGS numbers. The issue now is converting this into reserves and production. Nevada shapes nicely in that regard. The state is well-positioned, and several projects will come into production in the next couple of years.

What is your outlook for lithium project funding?
Last year was not an indicator, as we have seen a decline in all stocks in the lithium space. Moving into 2023 and seeing new stability, investments will increase, particularly from ESG-centric and green-energy-oriented funds, along with more offtake agreements. All that will come into play to build a good environment for project financing going forward.

How do you plan on attracting strategic partners and investors in 2023?
We are well funded with over C$30 million in the treasury and are working towards refining our process through to battery-grade lithium carbonate. This is the main attraction of clay deposits: getting the raw material and producing a battery-grade product on-site will be a driving force for Nevada. It all comes down to developing new technology to turn the millions of resource tonnes in the ground into economic lithium production. ■

» **Proving commercially viable lithium mineralization has the potential for tremendous value generation for investors.** «

Jason Latkowcer

President and CEO
PAN AMERICAN ENERGY

Can you introduce Pan American Energy and the firm's Horizon project?
Pan American Energy Corp. (CSE: PNRG | OTC: PAANF | FSE: SS6) is a North American mining exploration company engaged in expanding the boundaries of the lithium supply chain through the acquisition, exploration and development of mineral properties. The company has a diversified asset base in Canada and the US, including hard rock lithium (Ontario), lithium brine (Utah), and claystone lithium (Nevada). Our Horizon lithium project, a 17,334-acre land package, is highly prospective for claystone lithium and is in the world-renowned Big Smoky Valley, Nevada. We are adjacent to industry-peer American Battery Technology and proximal to American Lithium. We're actively exploring technology and partnership synergies and are thrilled with the government support in the region. For example, the Department of Energy recently awarded American Battery Technology the Bipartisan Infrastructure Law grant of US$115 million to build a first-of-its-kind commercial lithium hydroxide plant next door to Horizon.

What does your partnership with Respec at Horizon entail?
Our partnership with Respec, a global leader in geoscience, engineering, data, and integrated technology solutions for major industry sectors, is focused on designing and executing our maiden drill program at Horizon. Respec has evaluated the exploration program(s) of our adjacent peers and designed an up to 22-hole drill program that has been submitted to the Bureau of Land Management for permitting. This drill plan gives excellent coverage across the property and will help characterize mineralization near the surface and at a max drill depth of 1,000 ft per hole.

What is the long-term plan to create value for Pan American's shareholders?
First and foremost, we want to execute a best-in-class exploration program to validate our geological hypothesis at Horizon, and our goal is to develop a 43-101 compliant resource. In tandem with our exploration efforts, we are excited about opportunities for technology implementation and partnerships. As part of our strategy, we are looking at new technologies constantly and have built a technical advisory team to guide this effort. We want to do things better, faster, and more sustainably. Our diversified asset base presents an opportunity to move one asset to production more quickly and use subsequent profits to support the exploration of our longer-term projects.

How would Horizon play in feeding the lithium market?
According to the 2022 analysis from Benchmark Mineral Intelligence, annual production of 11.2 million t of LCE will be needed by 2050 – a 20 times increase compared to today. Benchmark anticipates that by 2040, all of the lithium mined last year will only meet one month's demand, even with the supply from recycled batteries. The reality is that it takes years for a lithium mine to come into production.

With the Department of Energy (DOE) grant to ABTC's Tonopah Flats project in September, what is your outlook for the funding of future lithium projects?
Our outlook on North American government support for lithium projects and critical minerals is at an all-time high. The DOE Bipartisan Infrastructure Law: Battery Materials Processing and Battery Manufacturing grant was valued at US$2.8 billion, and supported several lithium projects. We are also starting to see similar support in Canada. To meet carbon reduction goals, it is critical to support new technologies such as direct lithium extraction and claystone processing optimization.

Can Tonopah become the main lithium hub in the US?
All the indicators are there for Tonopah to be a successful US lithium hub. We are one of the best places for access to the market, access to existing infrastructure, access partnerships, and access commercial off-take customers. The opportunity of developing homegrown assets and getting them to market efficiently is what is going to set Nevada above all jurisdictions.

What is going to make Pan American a great story for investors in the coming months?
We believe we have taken the right steps to plan and execute a successful drill program Q1-2023 that gives us the best chance of success for discovery. Proving commercially viable lithium mineralization has the potential for tremendous value generation for investors. ■

Looking ahead: industry remarks on the financing outlook for lithium projects

Bernard Rowe,
Managing Director, ioneer

"In terms of what is required to take lithium production in the US from where it is today to where it needs to be, the simple answer is competitively priced capital. Most greenfield lithium projects have had to rely on relatively expensive capital, and that has held the industry back. The larger banks are now considering providing project finance, while strategic partners and end users are open to assisting in financing to secure long-term, stable supply. "

Bill Willoughby,
CEO, Century Lithium

"Moving into 2023 and seeing new stability, investments will increase, particularly from ESG and green-energy-oriented funds, along with more offtake agreements. All that will come into play to build a good environment for junior financing going forward."

Steve Hanson,
President and CEO, ACME Lithium

"I forecast that we will have a continuation of massive demand to accelerate projects in North America. We will continue to see M&A activity, to see capital flowing in that sector, and we will continue to see movement by end-users downstream, which has never been seen before. Lithium is up 20 times in the past 24 months, so a correction would not be surprising, but a high price helps projects remain economic around the world."

Jason Latkowcer,
President and CEO, Pan American Energy

"Access to grants, funding, and government support will only get strengthened in the future. It is a domestic homeland security issue now. We are at the risk of cyclical opportunities, and there are limited indicators that this support will lessen."

Howard Klein,
Founder, RK Equity

"I believe we are stronger in the marketplace, and for longer. There was an inflection point where the demand for electronics grew and reached an exponential level, then started growing slowly and finally parabolically. That's where we are with the electric vehicle. Demand will continue to grow exponentially in the coming years."

Copper and Molybdenum in Nevada and the Western US

Carving a share of the "Red Metal" and moly markets

Image courtesy of m-kojot

The copper story is tied to the green energy transition. In the US, the southwest is the main protagonist of that unfolding story, with Nevada's importance in the copper space increasing year after year. Nevada's copper production increased by 6% between 2020 and 2021, from 69,973 to 74,268 metric tons (t). Accounting for 6% of total US copper production, Nevada's share is still considerably more modest than its Arizonan neighbor, but it is nevertheless growing: back in 2017, Nevada accounted for just above 1% of domestic production, according to NVMA figures.

Technological innovation is vital for copper miners to expand the life of their mine sites. For the past year, production of the Red Metal has been dominated by the Poland-based KGHM at the Robinson Mine. Robinson, which produced around 124 million lbs/Cu in 2021, saw its mine life expand until 2039 this year, a decade more than initial predictions, partly due to technological improvements at the site. In 2021, operators began using an Epiroc-commissioned autonomous drill, and plan on purchasing others.

Down the line, Vancouver-based Nevada Copper – who owns one of the few new production-ready sources of copper supply in the US - expects to restart its Pumpkin Hollow copper mine in 2023 and completed an optimized life-of-mine plan in 2022 focused on accessing the larger and higher-grade stopes of the property.

The upcoming months are likely to be marked by greenfield explorations to further increase copper ounces on Nevadan soil and firmly establish the state as a solid copper player. The strategic importance of further exploration is considerable: The US currently imports 40% of its copper, with this figure forecasted to grow to 80% by 2030. Robinson Mine general manager Amanda Hilton laid down plans to drill more footage in Lane Valley in the summer of 2023. Exploration is underway with multiple targets identified at Pumpkin Hollow for surface copper oxide mineralization in the Tedeboy area. Taking into consideration NGM's Phoenix mine, in the coming years, besides precious metals and lithium, Nevada is likely to be increasingly known as a key player in the production of the metal driving electric transportation.

Promising increases in production will likely continue to be contrasted by a gloomy downstream smelting and processing outlook in the US in the near term. Asia, particularly China, retains the downstream strategic advantage, with 14 smelters compared with only three in the US. The European Commission highlights that 41% of world copper is processed in China. Smelters and refineries

are hard to permit in the US, with the last such facility being built in the 1990s. Exposing this vulnerability, Amanda Hilton said: "We are not in an ideal situation in the US in terms of processing copper. Most copper concentrate must be exported to Asia to be smelted and refined, then have it shipped back to the US. That is a risk for both our business and the industry."

A potentially critical need for molybdenum?

Lesser known than other alloys, better understood for their role in agriculture, plant production, and stainless steel, interest in the silvery-white metal has risen in recent months amid concerns about China's dominance in this market. The metal, 75% of which emanates from copper byproducts, is key for its high temperature and corrosion-resistant properties and is widely used in defense, aerospace, and other critical industries. Research by academia also indicate the metal's role in the green transition: by 2050, the International Energy Agency estimates that demand for molybdenum will at least double, if not triple, to be used in clean energy technologies.

New Moly LLC is uniquely placed to answer the forecasted growing moly demand. Created in 2021 to combine the Kitsault and Mt. Hope properties, which previously were owned by Avanti Kitsault Mines and General Moly, the firm owns 80% of the Mt. Hope project in Eureka County, Nevada. Mt. Hope is the largest permitted primary molybdenum project in the world, and holds more than a billion pounds of molybdenum in reserves, and boasts a 40-year mine life. Mt. Hope is likely to put Nevada in the spotlight as the home to the third US primary mine of molybdenum behind Freeport-McMoRan's Climax and Henderson Mines in Colorado. With a moly market of 600 million lb/y in size, Mt. Hope could represent 5% of the global supply with 35 million lb/y.

Moly has an exceptionally high-melting point, making it an ideal candidate for renewable energy applications, particularly in wind turbines and geothermal power. Some recent solar panels deployed in the US use moly near the bottom of each cell to help transfer the electricity generated from the cell to circuits external to the panel, for instance. Andy Caruso, president, and CEO of New Moly LLC expanded on the importance of the metal for wind turbines: "A typical wind turbine requires about 130 kg of molybdenum per megawatt of installed capacity. Geothermal generation of electricity requires very high-quality steel containing molybdenum."

Looking out West

There is a broader copper story unfolding in the Western US. Preserved from the Arizonan spotlights and Nevadan advances, Alaska, Idaho, and Utah have the potential to have their names associated with major copper production in the coming years. Indeed, all three states were listed in the top five mining jurisdictions in the US for investment attractiveness according to the Fraser Institute. Near Salt Lake City, the Kennecott mine was responsible for 143,000 t refined copper production in 2021, and the firm approved a US$1.5 billion investment to push production up to 2032.

Besides production in Utah, however, perhaps the most interesting story in the west is unfolding at the development stage. Alaska and Idaho both boast projects that could significantly change the copper production picture in the US, and mark key progresses in the drive toward electrification. Development of such projects will likely be prompted by a sense of urgency and necessity for the US government; rising capital and operating costs for new copper projects, the scarcity of new world-class deposits, the time and cost it takes to approve new projects in the country all make an increase in the red metal supply of the magnitude to meet forecast demand very challenging, to say the least.

Most recently, Codelco forecast an 8 million t/y deficit of copper in the coming 10 years. This is despite a surplus expected in the short term, following new projects in South America, Africa, and Asia coming online. Looking medium-term, the Western US could help meet the global supply shortage.

In Idaho, Phoenix Copper's Empire mine currently sits at the permitting and feasibility stage. Phoenix Copper has spent close to US$30 million on the property since 2017, and the latest data reveal the Empire open pit M&I resource increased from 39,800 t to 172,912 t copper equivalent. Advancing the world-class CuMo project in Idaho, American CuMo Mining Corporation will be a player to watch in the coming years. The molybdenum-copper deposit is known as the largest unmined open-pit moly project worldwide.

Looking north, key discussions that will impact the US' future domestic supply chain of copper are currently being held in Congress. These concern Northern Dynasty Minerals' Pebble project, the largest undeveloped copper project in the world with over 84 billion pounds of copper in the resources. With recent setbacks from the Environmental Protection Agency and the Transportation and Infrastructure Committee, the first two months of 2023 will be critical for the Alaskan project and the US' copper production ability.

Striking the balance between environmental protection and the need for a metal necessary to achieve green transition goals is a Cornelian dilemma the US authorities are struggling to resolve. Relying on foreign countries' resources presents dilemmas of material nationalism, but also – ironically – environmental and social ones. As exposed by Ronald Thiessen, CEO of Northern Dynasty Minerals: "The US does not produce a lot of copper metal, most plants produce copper concentrate, which is about 20-30% copper metal. The rest is dirt, which is sent to China to be refined and processed. China has about 40% of the world's processing and smelting capacity. We need to move towards much more copper metal production in a country that has the most stringent environmental, social and labor standards, or are we willing to get our metal from a country that has coal-fired plants to create copper metal?"

Nevada produces and develops an abundance of metals needed for the transition economy. State and federal players, associations, and companies are working in tandem to assert the state's place as a significant player in the EV market by bolstering production and switching the US position of net exporter of copper ore and copper concentrate. Yet, the high investment refineries require, added to the volatility of the commodity and China's cost-competitiveness means Beijing will likely maintain its grasp on the downstream process in the years preceding net-zero targets, despite calls by Nevada – and Western – miners to bring the whole value chain closer to home. ■

Amanda Hilton

General Manager
ROBINSON NEVADA MINING COMPANY (KGHM)

One of my hopes is that we can navigate through permitting hurdles and increase our smelting capabilities because we are vulnerable right now.

What are the latest production updates and social initiatives undertaken at Robinson?

Since 2021, Robinson has maintained continuous operation and has extended LOM up to 2039. When I started in 2004, the mine life was until 2008. On the exploration side, we plan to drill more footage in Lane Valley in the summer of 2023.

On the social initiatives front, KGHM provided US$500,000 for a new early learning center in Ely. This new early learning center will be operated by the Boys and Girls Club of Reno and will provide childcare services. Another initiative is a sabbatical for all our salary personnel every four years. The goal is to ensure their engagement level increases when they come back. We believe we are one of the first mining companies to offer this.

How do you leverage new technologies?

Because of Covid-19, we initially struggled to properly use an Epiroc autonomous drill that we commissioned in 2020. In 2021, we started over, and the drill is now functioning in autonomous mode for a high percentage of the time, and we plan on purchasing two more autonomous drills. The first benefit we see is at the safety level: We have an operator sitting in a chair rather than being on the field. The second is the efficiency of the drill: It can run more hours in the day and drill more footage.

Can you expand on the work you concerning the environmental regulatory framework in Nevada?

As Robinson has been mined for over a century, we have legacy items that need to be reclaimed because the regulations were different when mining started there. We took it upon ourselves to exceed the standards of today regarding items of the past. For two of the past three years we won reclamation awards granted by our regulators.

Nevada has one of the best regulatory frameworks in the world. The expectations are well-defined.

What initiatives must be put in place to address the current and future labor shortages?

We must continue to invest in our community colleges because they have great programs for our skilled workforce. At Ely Campus, we have a great mechanic and electrical installation program, which we invest in to grow future leaders. Three days a week, we have Robinson employees going to colleges and giving students hands-on projects that deal with welding. We need to expose students at a younger age to these trades, so they see if they have a passion for them.

How do you see ESG as a key business driver for major producers?

ESG-wise, we are looking at installing a 3 mega-watt solar farm. This project would already be on disturbed land. We are also working on decreasing our reliance on fossil fuels to power our operations. Another pillar of ESG is diversity in the workforce. I just concluded my year as the first chairwoman of the Board of Directors of the NVMA. Because of my gender, I have an even bigger opportunity to be a mentor and a leader to future generations.

Why is it key for the US to maintain a critical mineral supply chain?

Right now, we are not in an ideal situation in the US in terms of processing copper. At Robinson, we produce a copper concentrate that must go to a smelter. Most copper concentrate in the US must be exported to Asia to be smelted and refined, then have it shipped back to the US. That is a risk for both our business and the industry. About four years ago, China put a tariff on copper concentrate, and we were no longer able to ship our concentrate there. Robinson was the most impacted company in the US. One of my hopes is that we can navigate through permitting hurdles and increase our smelting capabilities because we are vulnerable right now.

There is a disconnect between the government's goals and what is feasible from a mining perspective. With the permitting constraints we have today, we are not going to achieve these targets. The Inflation Reduction Act will help overcome financial hurdles, with things such as installments for solar panels, but I'm not sure how much it will help in terms of domestic supply. ■

Pebble is a critical asset: it is the largest undeveloped copper project in the world, and it is polymetallic.

Ronald Thiessen

CEO
NORTHERN DYNASTY MINERALS

Can you present Northern Dynasty Minerals and the Pebble project?
Northern Dynasty's sole asset is the Pebble project in Alaska. We acquired it in 2001 and have spent over US$1 billion on the project to date. We have drilled over a million feet of HQ diamond core. Our resources contain large quantities of copper, gold, molybdenum, silver and rhenium. About 55% of those resources are in the M&I category – some 6.5 billion tons grading 0.40% copper, 0.34 g/t gold, 240 ppm molybdenum, 1.7 g/t silver, and 0.41 ppm rhenium, containing some 57 billion pounds of copper, 71 million ounces of gold, 3.4 billion pounds of molybdenum, 345 million ounces of silver and 2.6 million kilograms of rhenium.

We have done two PEAs, the first in 2011 – which envisioned 125 years of mine life, 75 years of mining, and 50 years of processing the low-grade stockpiles. The second in 2021 was based on the economic model we took into permitting in 2017, involving about 1.2 billion tons that envisioned a 20-year mine life. This is a very large deposit and there may be opportunities for different types of mining to be used, and process plant scale or throughput depending on the environmental footprint and metal prices at various times. The 20-year mine life plan that we submitted for permitting has a capex of about US$6 billion.

What does the October 2022 report by the Transportation and Infrastructure Committee mean for the project?
This report is a politicized document. It does not take facts or science, and most importantly the final EIS - the official record - into account. Tom Collier (former CEO of the Pebble Partnership) was called before Congress to give testimony about the federal environmental review of the project. In his prepared statement, Mr. Collier responded to unfounded accusations by project opponents that Pebble intended to use a permit for a 20-year project to build and operate a much longer and larger mining project. Nonetheless, the Committee has adopted the baseless rhetoric of Pebble opponents and is promoting the storyline that Mr. Collier's testimony was intended to mislead Congress into believing that Pebble's permit application for a 20-year mining project somehow foreclosed the possibility of future expansion—even though the Army Corps had already determined that future expansion of the project was reasonably foreseeable, based on Pebble's own disclosures.

How can US policymakers strike a balance between environmental concerns and the growing need to extract critical minerals?
It is challenging because anti-development groups do not believe that North America needs any mines and that all metals required for the US economy can be obtained via recycling. Moving towards a green economy requires electricity, which requires an enormous amount of copper.

The US currently imports 40% of its copper, and by 2030 this is forecasted to be 80%. We need to move towards much more copper metal production in a country that has the most stringent environmental, social, and labor standards; or are we willing to continue to source our metal from a country that uses coal-fired power plants to smelt, refine and produce the copper metal?

What are the next milestones at Pebble?
Permitting in the US has become extremely challenging. Any mine can take 10 years or longer in the permitting process, and this almost always involves litigation. It is getting rarer for one of the executive branches of the US government to issue a permit, so the applicant must take the permitting agency (in our case the US Army Corps of Engineers) to court and require them to adhere to the rule of law. We have had challenges with some federal agencies, such as the EPA, which is considering a proposal against any type of mining in the area where our mineral concessions are located. But Pebble is a critical asset: It is the largest undeveloped copper project in the world, and it is polymetallic. Overall, we feel we are well advanced in our drive to permit the project as we have a final EIS published by the Army Corps of Engineers. We now have our eyes firmly on the next step, getting a positive Record of Decision (ROD) which effectively is our federal permit. ■

There are only two primary molybdenum mines outside of China today: Freeport-McMoRan's Climax and Henderson mines, so Mt. Hope would offer the world a new source of the metal not controlled by China.

Andrew Caruso

President and CEO
NEW MOLY

What were the ambitions behind the creation of New Moly LLC in 2021?
New Moly is a privately held company that wholly owns the Kitsault molybdenum project in British Columbia, Canada, and 80% of the Mt. Hope molybdenum project in Nevada. These projects are two of the largest and most advanced primary molybdenum projects outside of China. New Moly came into being in 2021 to combine the Kitsault and Mt. Hope properties, which previously were owned by Avanti Kitsault Mines Ltd. and General Moly Inc., respectively. New Moly has therefore consolidated the expertise of these two companies.

The firm is now 70% owned by Resource Capital Funds (RCF), a leading private equity firm. They were the driving force between bringing the two companies together to offer a pure moly exposure in the market. We are now looking for strategic partners to invest and advance at least one mine into production in the next four years.

Can you present New Moly's portfolio?
Mt. Hope is the largest permitted primary molybdenum project in the world. When operational, the Mt. Hope open-pit mine will use one hydraulic and two electric shovels, and a fleet of 240-t mining trucks. The molybdenum market globally is approximately 600 million lb/y, so Mt. Hope could represent 5% of the global supply with 35 million lb/y. It's a significant asset, with more than a billion lb of molybdenum and a mine life of more than 40 years. M3 Engineering and Independent Mining Consultants (IMC) updated the project feasibility study in 2022, and following receipt of financing, Mt. Hope can be in production within three years. Regulatory authorities in Nevada are very supportive. Nevada remains a leader in progressive and supportive mining practices. The Kitsault mine project also has strong support. Key strengths of the project include a 16-year mine life, high ore-grade, well-advanced detailed engineering, and four of five key permits in place.

What is unique about the Mt. Hope assets?
About 75% of molybdenum comes from copper byproducts; there are only two primary molybdenum mines outside of China today: Freeport McMoRan's Climax and Henderson mines, so Mt. Hope would offer the world a new source of the metal not controlled by China.

The metal is important for its high temperature and corrosion-resistant properties. It has many applications downstream in terms of specialty metal uses for semiconductors, defense, aerospace, medical, and other critical industries—it is also important in the transition towards a green economy. Last year, the molybdenum market moved into deficit, and the price increased to a 14-year high. As of early January 2023, the price was more than US$32/lb. Market analysts forecast these robust prices to continue.

What is needed from a regulatory standpoint to accelerate development projects?
President Biden recently provided a US$2.8 trillion stimulus to incentivize new projects to provide critical minerals. It's fine to provide economic help, but regulatory and legislative mechanisms are needed that allow responsible mining projects that will uphold a commitment to environmental management and sustainable development practices to advance. We will work with the NVMA, communities, and industry players to address any residual concerns, however, a legislative fix may be required to create more certainty once projects have met the standards required by the agencies. We need to strike the right balance. If projects meet regulatory standards, they should go ahead—it is the security of mineral supply that is at risk here.

How important is molybdenum to a successful "green transition"?
According to Canada's 2021 Critical Mineral List, it is essential to Canada's economic security and transition to a low-carbon economy. The top applications of molybdenum for renewal energy are wind turbines and geothermal power. A typical wind turbine requires about 130 kg of molybdenum per megawatt of installed capacity. Geothermal generation of electricity requires very high-quality steel containing molybdenum.

What is New Moly's strategy to attract funds and find partners in the coming months?
Over the next 3-6 months, we will dialogue with potential investors who are interested in taking a strategic interest in either Mt. Hope or Kitsault or securing offtake agreements. We are also looking at M&A activity, any value acquisition, and medium-term producing copper-molybdenum assets that would complement our portfolio. ■

Arizona

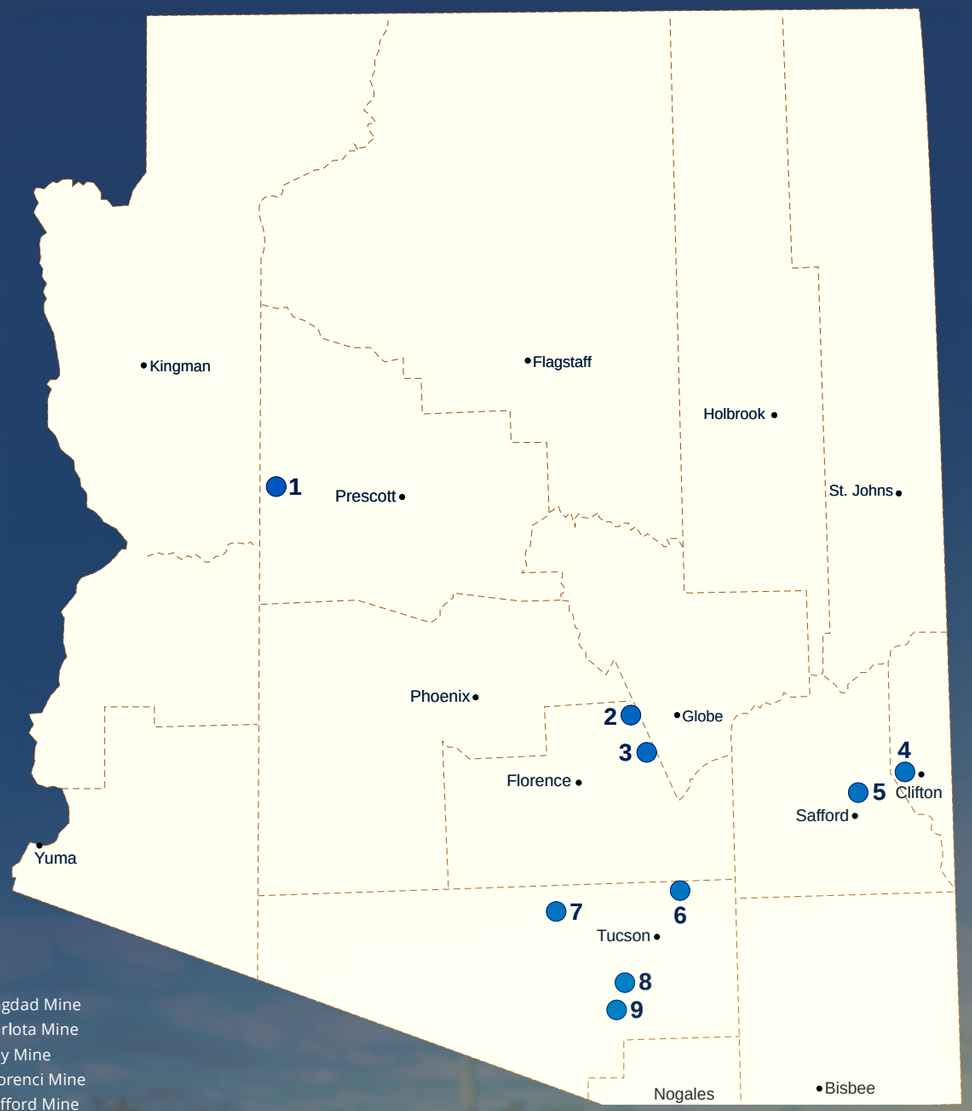
"Arizona has earned the title as the 'Copper State' for its abundant copper reserves and for producing 74% of the nation's copper. Mining is very important in Arizona and we have a copper dome on our state capitol, a copper star in our state flag, and a miner on our state seal."

Steve Trussell,
President,
ARIZONA MINING ASSOCIATION

Production, Development and Exploration

Image courtesy of Arizona Sonoran

Arizona's Major Copper Producing Mines



1. Bagdad Mine
2. Carlota Mine
3. Ray Mine
4. Morenci Mine
5. Safford Mine
6. Oracle Ridge Mine
7. Silver Bell Mine
8. Mission Complex Mine
9. Sierrita Mine

Source: Arizona Geological Survey, University of Arizona

Copper Production

Securing a domestic supply chain

Image courtesy of Freeport-McMoRan

Copper is undoubtedly one of the most versatile mined metals. It is used in nearly every industry and has become a shining star in the green revolution thanks to its conductive properties. Demand for copper has recently skyrocketed as it is required to modernize aging power generation and transmission infrastructure to accommodate fast-growing renewable sources, including solar PV, offshore and onshore wind, solar power, as well as nuclear and hydropower. Transportation is also electrifying quickly, with electric vehicles (EVs) progressively taking the center stage in most major markets.

Over the next 25 years, demand will only continue to increase as countries try to achieve global climate change ambitions. Studies show that demand will grow dramatically from 25 million metric tons (t) today to about 50 million t by 2035, a record-high level that will be sustained and continue to grow to 53 million t by 2050. If production levels do not increase significantly, demand is likely to remain unmet. Experts agree that substitution and recycling will not be enough to meet the demands of EVs, power infrastructure, and renewable generation. Therefore, unless a massive new supply comes online in a timely way, the goal of net-zero emissions by 2050 will remain out of reach.

The US – the world's fifth-largest copper producer with the world's sixth-largest copper reserves – is uniquely positioned to address the impending supply-demand imbalance. "Looking around the world, many copper reserves and projects are located in risky jurisdictions, which has been one of the challenges to bring on new supply", explained Stuart McDonald, president, and CEO of the North American mining company Taseko Mines, noting that today, almost 40% of copper production comes from Chile and Peru, which are both experiencing political and social instability.

In the past few years, copper production in the US has remained relatively stable despite the global economic rollercoaster. After a decline of 4.8% in 2020 prompted by the pandemic, the nation's red metal production recovered by 2.5% to 1.2 million t in 2021, mainly supported by rising output from the country's major producers, Freeport-McMoRan and Rio Tinto. Together, these two accounted for 66.8% of the total production with 821,000 t of copper in 2021, up from 783,300 t in the previous year.

In 2021, copper production from Freeport-McMoRan grew by 3% mainly due to the ramp-up from the Lone Star mine in Arizona, which started operations in 2020. "We always knew that Lone Star would be a huge opportunity for us. We were able to get the oxide resources into service and production over the past two years," revealed Joshua Olmsted, president and COO for the Americas at Freeport-McMoRan.

In addition to Freeport-McMoRan, Arizona hosts many other top US and global copper producers, including Capstone Mining Corp, Grupo Mexico, and KGHM, as well as some exciting development-stage projects which could soon be in production and help address the world's rising copper needs.

Among these development projects, Resolution Copper, a joint venture between mining giants Rio Tinto (55%) and BHP (45%) has been in the spotlight for several years. Located near the town of Superior in Arizona's famous Copper Triangle and on the side of the old Magma Copper mine site, Resolution is one of the most significant untapped copper deposits today, with an estimated copper resource of 1.787

billion t at an average grade of 1.5% copper. The proposed underground mine is expected to become the largest copper mine in North America, capable of producing up to 25% of US copper demand each year. It is also expected to create 3,700 indirect and direct jobs and contribute about US$1 billion annually to the state's economy.

While Rio Tinto and BHP have spent US$2 billion, they have yet to produce any copper, as the project has been going through a rigorous – and often challenging - permitting process with the federal government for over a decade. "We had our Environmental Impact Statement (EIS) published on the 15th of January 2021, only to have it rescinded by the incoming Biden administration on the 1st of March of the same year. So, we are in the process of getting the EIS republished," explained Andrew Lye, project director at Rio Tinto.

Arizona Sonoran's new resource estimate regarding its Cactus Mine project will likely put the company in the spotlight in terms of copper development projects in the coming months. The resource estimate now puts the project's total resources at 6.5 billion lb of copper, which could have a considerable impact on the US domestic copper supply in the coming years. As put by George Ogilvie, principal engineer, president, and CEO at Arizona Sonoran: "We see this project as one of the top five independent copper projects in the US, with the potential to start supplying copper domestically within the next few years.

Another company that has been tied up in permitting delays but stands ready to supply future copper needs is Canada's Hudbay Minerals. The company recently unveiled a Preliminary Economic Assessment (PEA) for its Copper World Complex in Arizona, which includes recently discovered deposits at the property as well as the Rosemont asset. The document came only two weeks after a US court cleared the path for the company to proceed with its planned Copper World mine.

Meanwhile, Hudbay's other major copper project in Arizona, the large and neighboring Rosemont, suffered a major setback in early May 2022 after a judge confirmed a 2019 ruling that halted the US$2 billion project on environmental grounds.

According to Hudbay, Copper World's two-phase mine plan has an after-tax net present value of almost US$1.3 billion and will generate an 18% internal rate of return, based on a copper price of US$3.50/lb. The Toronto-based miner also said it does not believe any federal permits are required for the first phase of the Complex mine plan as it sits on private land, rather than federal land. On the other hand, Rosemont, the second phase, will require federal permits as it is in the lands of the Forest Service.

"We are currently in the feasibility stage of phase one and we plan to complete the engineering this year. In parallel, we will begin the feasibility studies for this same phase," summarized Javier del Río, vice president for South America and the US at Hudbay.

Another project that could soon start contributing to US copper output is Taseko Mines' Florence Copper asset, which is currently in the final stages of permitting. Its small environmental footprint, low energy and water requirements, limited land disturbance, and numerous site redevelopment opportunities post-closure, represent a new era of American mining.

Florence Copper is designed as a two-phase development, with a production test facility (PTF) being its first phase, followed by the second-phase commercial facility. Taseko built the PTF in 2018 to demonstrate that it could produce copper profitably using the in-situ recovery process and to prove to the regulators it could operate that mining method safely and in compliance with environmental requirements.

President and CEO Stuart McDonald explained the key differences between in-situ copper recovery and conventional mining: "The big difference (...) is that we are not digging a hole in the ground or tunneling into the orebody but are actually drilling wells into the orebody and injecting a diluted sulphuric acid solution into it."

Florence has a unique situation where the ore has already been fractured, allowing the mining solutions to travel through the orebody and recover copper in solution. This copper-bearing solution then gets pumped to the surface through recovery wells, where it is processed "Through this technology, we can produce pure refined copper right on site, ready to be shipped to the US domestic market without the requirement of further processing," McDonald explained.

In sum, the US – and particularly Arizona – is uniquely positioned to address the impending copper supply and demand imbalance thanks to a great geological potential and investor-friendly environment. However, the lengthy and complex permitting process for projects on federal land, as showcased by Resolution Copper and Rosemont, raises serious doubts about the nation's ability to secure a domestic supply chain, rebuild infrastructure and reach its climate commitments. Policymakers must act decisively to improve regulations and legislation to break foreign reliance and make domestic mining more accessible and economically viable, always ensuring utmost care for environmental and social standards. ■

We already have a great set of assets and are excited about further exploring our brownfield opportunities

Joshua Olmsted

President and COO Americas
FREEPORT-MCMORAN

Can you provide an overview of Freeport-McMoRan's operations in the southwestern US, particularly the Lone Star project?
We are based in Phoenix, Arizona. In this state, we operate the Morenci, Bagdad, Sierrita and Safford copper mines, along with our smelting facility in Miami, Ariz. In New Mexico, we operate the Tyrone and Chino copper mines. We also have two mines in Colorado – Henderson and Climax – that are primary producers of molybdenum.

We always knew that Lone Star would be a huge opportunity for us. During the past two years, we were able to get the oxide resources into service and production. We started at a rate of about 200 million lbs/y copper, and now are looking at 300 million lbs/y. We're continuing to focus on mining and developing that oxide resource, which is not only generating a good return on investment, but is also exposing a major sulfide ore body. Lone Star has the potential to become a cornerstone asset for Freeport.

What expansion efforts are you carrying out at Bagdad?
In Bagdad, we process about 90,000 t/d of material to produce copper and molybdenum concentrate. Freeport sees a huge opportunity to expand and double the size of the concentrator and annual output. We have been doing engineering and scoping work over the past few years and recently began a pre-feasibility study on the project. Should we make the decision today to build a new facility at Bagdad, it would not come into production before 2026-2028 at the earliest. This fits into our broader strategy of leveraging existing assets in our portfolio for growth.

How does Freeport leverage new technological advancements?
We have been working with analytics for a while. Bagdad was a pilot where we used AI and modelling to leverage data we had gathered over time, and we have been using these tools elsewhere since. Freeport's IT group did a tremendous job in structuring our systems and in-house tools to leverage that data. Over the past few years, we continued to implement new tools that allow us to optimize processes. Our philosophy is not to use technology for technology's sake, but rather to improve operations. Leach technologies that help with copper recovery are a good example.

We have approximately 38 billion lbs of copper in our stockpiles that have been deemed unrecoverable based on current technology. We have a variety of leaching initiatives under way to optimize this resource. On the concentrator and sulfide side, we have started leveraging AI to model our data. Using AI for leaching is promising and something we are excited about.

What are the benefits of operating in Arizona?
Many of our operations have been around for decades – and even more than a century in the case of Morenci and Bagdad. This means we have long-standing relationships with our host communities, local governments and the state of Arizona. We work continuously to foster those important relationships, maintain trust and contribute to long-term shared value and resilience.

In 2021, our site in Miami, Arizona became the first of our US sites to be awarded the Copper Mark, which is a comprehensive assurance framework that promotes responsible production practices and demonstrates the industry's contribution to the United Nations Sustainable Development Goals.

Today, all our Arizona sites have been awarded the Copper Mark, bringing the company's total to 11, leaving only one site remaining.

How do you see copper trends evolving in the long term?
Copper is fundamental to achieve our societal goals, whether these are in terms of decarbonization or achieving net zero by 2050. We remain bullish on the long term: there is not going to be enough copper in the world to meet the demand driven by electrification and decarbonization trends. As a society, we need to recognize that and facilitate the responsible production of copper.

What are the key priorities for Freeport over the next years?
During the next two or three years, Freeport will focus on leveraging our existing assets, such as brownfield-type growth opportunities. We will continue to improve our understanding of the resources near our existing operations. We already have a great set of assets and are excited about further exploring our brownfield opportunities. ■

Our proposed underground mine is expected to become the largest copper mine in North America, capable of producing up to 25% of US copper demand each year.

Andrew Lye

Vice President
RESOLUTION COPPER

Can you give a brief introduction to Resolution Copper and a vision of the proposed mine?
Resolution Copper is located on the site of the old Magma copper mine in Arizona's Copper Triangle, an area with a rich mining history and many significant producers. Rio Tinto has been involved in the project since 2001, and in 2004 we formed Resolution Copper together with BHP to redevelop mining in this area. We sit right on the doorstep of the mining district of Superior, and we are very much part of the local community.

What production levels are expected once operations commence?
Our goal is to produce 120,000 t/d, if we are granted the required approvals. The mine is estimated to produce as much as 40 billion lbs of copper over 40 years. Our proposed underground mine is expected to become the largest copper mine in North America, capable of producing up to 25% of US copper demand each year.

What socio-economic impact will Resolution Copper have in Arizona?
Resolution Copper is one of the largest mining investments in the region. We have spent just over US$2 billion, 40% of which has been directed to our local area in Arizona. We have six communities surrounding the project, as well as 11 Native American tribes with cultural connections to the land. The relationship with communities can be complex but we have developed strong connections and outreach. The project will create 3,700 indirect and direct jobs, and it will contribute about US$1 billion annually to the state's economy.

We are also making great efforts to develop a workforce for the future. For example, we offer an annual scholarship program that provides financial assistance to local students pursuing higher education, while also encouraging students of promise to explore career opportunities in the mining industry and related STEM fields.

Can you walk us through the main milestones and challenges Resolution Copper has experienced in the last couple of years?
We had our EIS (Environmental Impact Statement) published on the 15th of January 2021, only to have it rescinded by the incoming Biden administration on the 1st of March of the same year. So, we are in the process of getting the EIS republished. It is a very thorough process that we began about a decade ago.

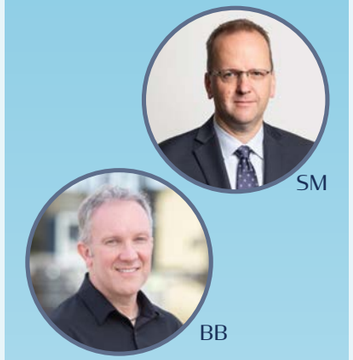
A major milestone for us in early 2021 was the successful closure of the old Magma mine site. We invested US$75 million to reclaim the old Magma copper mining tailings and the impacts from the smelter. Covid and meeting the needs of our workforce was another challenge. Balancing our operation with the flexibility our people are looking for in their work was important to us. The tightening labor market as we emerge from covid showed us the importance of adapting our work cycles as well as investing in our future workforce.

How is Resolution Copper approaching the use of water and energy at the project?
Resolution Copper is committed to becoming carbon neutral by 2050. The main way to achieve that goal is by looking at how we bring new projects online. To minimize our carbon footprint we are partnering with existing utilities. As of April 2022, 25% of the energy at our site is coming from solar sources through our partners at the Salt River project.

Water is a big focus in Arizona and considering that our mine will take 10 years to build, we have the chance to progressively implement new technologies to increase water efficiency.

Can you elaborate on Rio Tinto's Nuton technology?
Rio Tinto's Nuton technology is centered around producing greater amounts of copper with less impact on the environment, water resources and no large tailings storage facility. Rio Tinto has entered into a partnership with Arizona Sonoran Copper for the old Cactus Mine. So, as part of Rio Tinto's broader initiatives, we are working on how to maximize the production of copper from existing disturbed sites through the leaching technology which has many potential economic and environmental benefits.

What are the next steps for Resolution Copper?
The most important step is to complete the Federal permitting process by cooperating with the Forest Service to have the FEIS republished. ■



Stuart McDonald & Brent Berg

SM: President and CEO
TASEKO MINES
BB: General Manager
FLORENCE COPPER

Florence Copper is a critical project in the development of our company and has the potential to almost double our copper production and double our cash flow.

What is the importance of Florence Copper within Taseko's portfolio?
SM: As Taseko, we are focused on building a multi asset copper producer in North America. The company currently has one producing operation, our Gibraltar copper mine located in British Columbia (Canada) but has been focused on developing a second producing operation, Florence Copper. We are currently in the final stages of permitting and are looking forward to moving into construction within the next few months. Florence Copper is a critical project in the development of our company and has the potential to almost double our copper production and double our cash flow.

Can you elaborate on recent milestones achieved at Florence Copper, including the construction of a production test facility (PTF)?
SM: Taseko Mines acquired the Florence Copper project in 2014 and a major de-risking step was building a production test facility (PTF) in 2018. The purpose of the PTF was to demonstrate that we could produce copper profitably using the in-situ copper recovery process, and also to prove to the regulators that we could operate that mining method safely and in compliance with environmental requirements. The PTF was a great success on both of those fronts, and we have proven the technical feasibility and safety of the technology.

We needed to amend two permits to move from the test facility phase to a commercial-scale operation. We received the first one in December 2020 from the State of Arizona. We are now waiting to receive the final permit from the EPA, which we expect to have within the next few months. Meanwhile, we have started procurement of key equipment and have committed approximately US$60 million to secure these. As soon as we have our final permit in hand, we will be able to move smoothly into construction. We expect an 18-month construction period and to be in commercial production by 2024.

How does in-situ copper recovery technology differ from conventional mining?
SM: The big difference with in-situ copper recovery is that we are not digging a hole in the ground or tunnelling into the orebody but are actually drilling wells into the orebody and injecting a diluted sulphuric acid solution into it. We have a unique situation at Florence where the ore has already been fractured, and that situation allows our mining solutions to travel through the orebody and recover copper in solution. This copper-bearing solution then gets pumped to surface through recovery wells, where it is processed. Through this technology, we are able to produce pure refined copper right on site, ready to be shipped to the US domestic market without the requirement of further processing.

BB: The in-situ copper recovery method eliminates the need for haul trucks, a mill facility, and a tailings pond as there is no waste rock, and there is very little surface disturbance as you just have a wellfield. The total physical footprint of Florence Copper will be 212 acres. We use six times less fresh water than conventional open pit mining. In terms of energy, we use 71% less than a conventional mine while emitting 83% less carbon into the atmosphere.

Can you elaborate on the socioeconomic impact of Florence Copper?
BB: Over the life of mine Florence Copper will contribute about US$3.3 billion to the Arizona economy and US$2 billion in direct and indirect employment income for Arizonans. We will pay about US$500 million in state and municipal taxes. At full capacity we will create about 500 jobs in the county and 250 on site jobs.

What are the main opportunities and challenges of developing a project in Arizona?
BB: Government support for the sector has been strong given its role in providing jobs and contributions to the economy. However, developing a project is a long process. It not only involves discovering a deposit, but also showing it can be mined in an environmentally conscious way. This usually means a ten-year period before construction or operations can begin. The good thing about the permitting process in the US is that it is predictable, there is certainty, and the steps are clear. ■

Javier del Río

VP South America and USA
HUDBAY MINERALS

Can you give us an overview of the Copper World Complex?
The Copper World Complex is a traditional open pit operation that includes a copper sulfide ore processing plant and an oxide leach plant. We produce copper concentrates and cathodes with some molybdenum. It will produce approximately 86,000 t/y of copper on average over its 16-year life in phase 1. The project in this phase has an after-tax net present value, at a 10% rate, of US$741 million, which makes it quite attractive. And, combining phase 1 with phase 2 will have an after-tax net present value of US$1,296 million.

The first phase for the Copper World Complex only requires state and local permits because it is exclusively on private land. We have already acquired the surface rights and purchased 4,500 acres of land. However, the second phase, Rosemont, will extend the total life of the operation to approximately 44 years, and for this project, we need federal permits because it is on Forest Service and BLM lands. We are currently in full pre-feasibility of the project and plan to complete the engineering this year, and next year we will continue with feasibility studies for the project.

What is Hudbay Minerals' growth strategy in the coming years?
We are always on the lookout for opportunities that add value to our shareholders and stakeholders, so we are constantly doing due diligence. We are also aggressively exploring in different parts of the world; we have new projects in Manitoba (Canada) and opportunities to grow and optimize our operations. We want to crystallize opportunities around our operations. We have several opportunities at Constancia that could be satellite pits and we are seeing if it makes sense to develop them so that they can bring in more metal production. The same is true in Manitoba, Nevada, and at the Copper World Complex in Arizona, where we have high expectations. ■

George Ogilvie

President and CEO
ARIZONA SONORAN COPPER COMPANY

Can you provide an introduction to Arizona Sonoran Copper Company and to its Cactus asset?
Arizona Sonoran closed its initial public offering in November 2021 and is listed on the Toronto Stock Exchange under ASCU. In April 2022, we also listed on the OTCQX under the symbol ASCUF. Our Cactus mine project, which includes the Cactus mine and Parks/Salyer deposits, is a big copper porphyry system located entirely on private land in Arizona. The Cactus mine was a former producing open pit mine in the 1970s and 1980s and a significant amount of infrastructure was left on site. Our PEA issued in 2021 demonstrated a resource of approximately 3.5 billion lbs of copper (1.6 billion lbs in the indicated category and 1.9 billion lbs in the inferred category) over an 18-year mine life. In 2022, we also issued a 2.9 billion lb inferred maiden resource at a grade of 1.015% CuT on the Parks/Salyer project, thus bringing our global resources up to 6.5 billion lbs (1.6 billion lbs ind and 4.9 billion lbs inf). The new resource estimate demonstrates the scalability of the Cactus project and the potential for sharing future infrastructure.

What do you believe attracted Rio Tinto to join Arizona Sonoran as a shareholder?
Our proposed plan is to restart production of the oxide and enriched leachable material with an SXEW plant using a heap leach operation. Currently, there is no commercial technology to leach copper from a primary sulfide. The Rio Tinto group of companies has created a subdivision, NutonTM, which has developed a technology allowing for the leaching of a primary sulfide under a commercial application. If this NutonTM technology proves to be successful, Rio Tinto believes we will be more open to entering into a commercial agreement with them where they would share in the profits from the sale of copper from the primary sulfide. ■

Copper Exploration

Restarting past producing mines and creating value through new discoveries

Image courtesy of Florence Copper

There is a reason why Arizona has been awarded the title of "Copper State". If it were a country, the state would be the seventh largest copper producer in the world. Arizona has one of the highest amounts of copper reserves in the US, which has attracted a plethora of exploration companies, searching mainly for porphyry copper deposits and volcanogenic massive sulfide copper.

As with other commodities, the price of copper has been volatile since the pandemic. In the first quarter of 2022, prices for the red metal hit an all-time high, trading above US$5.02 per pound (lb). As of October, a global energy crisis centered in Europe, a slump in China – particularly the crucial property and construction sector – inflation, fears of recession in the US and a surging dollar have forced contributed to a moderate decline in copper pricing.

Still, market experts, producers and explorers remain bullish on the long term, particularly thanks to copper's central role in the green energy transition. "We are currently seeing a temporary recession of the global economy. However, we are bullish on copper in the long term. Its price will increase considerably due to the lack of supply: today, there are few new projects, and we need much more copper for EVs, electrical networks, and the green economy in general, which is where the world is heading," commented Javier del Río, vice president for South America and the US at Hudbay Minerals.

Renewed interest in copper led many exploration companies in Arizona to increase their focus on restarting past producing mines, as this can often expedite the development process. One of the companies following this model that has been attracting a lot of attention is Arizona Sonoran Copper Company, which closed its initial public offering in November 2021 on the TSX and listed on the OTCQX. Arizona Sonoran owns the Cactus mine asset, a former producing open pit mine in the 1970s and 1980s. Recently, Rio Tinto joined Arizona Sonoran as a shareholder, considering that the Cactus mine asset has good potential to go into production soon, as it already has many permits in place, including the right to take water from the ground for the next 50 years from an industrial-use only aquifer approximately 2,000 feet below surface.

Within the Cactus asset, 1.3 billion of the 3.5 billion lb of copper is contained in a primary sulphide (chalcopyrite). Because the copper concentrator was removed with the historic closure of the mine, Arizona Sonoran's proposed plan is to restart production of the oxide and enriched leachable material with a SXEW plant using a heap leach operation, but there is no commercial technology today that can leach the copper from a primary sulphide. That is why the Rio Tinto group of companies created a subdivision, Nuton, which has developed a technology allowing for the leaching of a primary sulphide under a commercial application.

George Ogilvie, principal engineer, president and CEO, elaborated on the company's upcoming plans: "Arizona Sonoran will complete a pre-feasibility study on the Cactus project, which will then lead to a bankable feasibility study in 2023, with the goal to put in place the project financing to start construction and development.

Another company that has been looking at restarting past producing mines is Eagle Mountain Mining, an Australian listed exploration and development company with the aim

of becoming a low emission producer of copper to supply the rapidly growing green energy market. The company's key property is the Oracle Ridge copper project in Arizona, which was historically in operation in the 1990s.

Eagle Mountain has recently been expanding and upgrading the amount of resource and has applied for a change of status for taking the project from abandoned to non-producing as it plans to undertake exploration drilling from underground. The company has also reached a significant milestone when Pima County granted a mine air quality operating permit, and the ADEQ approved an aquifer protection permit. "The existing infrastructure and approved permits will reduce capital costs and the time required to re-start potential production. To put the mine in operation we will have to re-construct the mill. However, given prior production at the project produced high-quality concentrate, this aspect of the restart is largely de-risked," explained Manuel Ramos, CEO of US operations.

Meanwhile, Copper Fox Metals, a North American focused copper exploration company with two development projects and an exploration project in British Columbia, has two exploration projects in Arizona. The Van Dyke project in Arizona is a past copper producing mine that was twice permitted for in-situ copper recovery. In 2020, the company published a PEA, which reflected an after-tax net present value of the project from US$149 million to US$645 million. The economic analysis is based on US$3.15/lb copper at a discount rate of 7.5% annual production of 85 million lb/y of copper cathode, and an increase in the mine life from 11 to 17 years.

In Arizona, Copper Fox owns two exploration projects in the Laramide copper province, an area that has been mined for copper for well over 100 years and hosts a substantial number of large copper deposits such as the Resolution copper deposit. Here, the company is focusing on new discoveries rather than past-producing mines. "Copper Fox considers these projects to have excellent potential to host porphyry copper deposits. For example, at Mineral Mountain the porphyry target is approximately 4,500 m long by up to 2,000 m wide, and at Sombrero, the target is approximately 3,000 m long by at least 800 m wide," stated Elmer B. Stewart, president and CEO.

Infinitum Copper is also trying to create value through discovery and exploration. The company started trading on the TSXV on March 16th, 2022, and on the OTC in April. So far, Infinitum Copper has two projects in its portfolio, La Adelita in Sonora (Mexico) and Hot Breccia in Arizona, but plans to build additional opportunities moving forward.

Infinitum's flagship La Adelita is a project that has been sheltered from extensive exploration, with less than 7,300 m of drilling in total on the property in the past. "We have several brand-new showings that we discovered in this exploration season, and we can tell from the geographic distribution of these showings that the overall system is several km in dimension," explained Steve Robertson, president and CEO.The company has already reached some encouraging results: "We have started to drill in the best-known area on the project, a high-grade copper silver skarn, and made a brand-new discovery at the south end of the property called Las Trancas, where we uncovered a trench that is over 9 m at about 16.5 g/t gold and 2% copper," Robertson revealed.

Another promising asset is Faraday Copper's Copper Creek flagship. According to Paul Harbridge, president and CEO of the company, the copper-molybdenum porphyry with associated high grade breccias is one of the largest undeveloped copper resources in the US, with 3.9 billion lb of contained copper in Measured and Indicated Mineral Resources. The company recently released a new mineral resource estimate for the Copper Creek project, which, along with the pending results of its recently completed phase 1 drill campaign, will form the foundation of a PEA that is expected to be delivered at the end of Q2 2023. "The project has the potential to be a combined open pit and underground mining operation that could last 30 years and provide many years of domestic copper production for the US," Harbridge stated.

> In Arizona, we are in the heart of the southwestern copper belt and our project has a long history of mining and exploration.
>
> **Paul Harbidge**
> **President & CEO**
> **Faraday Copper**

A relatively new player to the copper exploration space in southwestern USA is Zacapa Resources. Zacapa was established during the depths of the Covid-19 pandemic, as it's founders noticed that several major mining companies in the southwest, like Freeport-McMoRan or Rio Tinto, were focusing on cashflow and brownfields and were therefore releasing a lot of their good assets and people. Understanding the need of being countercyclical, Zacapa built its own team and consolidated several assets during this time and closed its IPO in early 2022.

Zacapa has five exploration-stage projects that the company is progressively moving through its exploration pipeline. It has started with its highest conviction porphyry copper project called Red Top in Arizona, in the heart of the state's Copper Triangle. Zacapa optioned this project from EMX Royalty Corp. and then identified a very interesting expression of advanced argillic and pyrophyllite alteration at surface.

Zacapa discovered veins that are commonly associated with a porphyry deposit, as well as abundant manganocrete and ferricrete at surface, which meant there were sulfides that had been mobilized by groundwater. Zacapa drilled six holes testing what geologists believed to be the potential core of the porphyry system. "Our plan for Red Top is to integrate the drill hole assays, geophysical, geochemical, mapping and remote sensing data and then make a decision on the path forward," stated Adam Melnik, CEO.

Next, Zacapa will drill South Bullfrog, one of its two gold projects, located in the Beatty district of Nevada, where four geophysical surveys and a raft of geochemical and interpretation work have helped establish drill targets.

Finally, Barskdale Resources is a base metal exploration company that has been gaining a lot of attention from investors, being one of the top five copper junior stocks in the TSXV during H1 2022. Barskdale owns two projects in the Patagonia region in Arizona, Sunnyside and San Antonio, as well as assets in Mexico. According to president and CEO Rick Trotman, the Patagonia region is unique due to its intact nature and potential for non-dismembered porphyry copper deposits.

Barksdale's second project, Sun Antonio, is located a few km from Sunnyside. The company will drill the project in the fall to determine if there is a porphyry deposit there and find out if the project is worth going through all the legal permitting procedures, which is expected to take a couple of years.

Mineral exploration plays a vital role in ensuring the long-term viability of the US mining industry. The road to address a demand gap that will keep growing starts with exploration. ■

Elmer B. Stewart

President and CEO
COPPER FOX METALS

> **Our strategy is to stay in North America, maintain the project portfolio that sustains our business model and take projects to the development stage.**

Can you give a brief introduction to Copper Fox Metals and an overview of the company's project portfolio in Canada and Arizona?
Copper Fox is a North American focused copper exploration and development company with projects in British Columbia and Arizona. Van Dyke and our interest in the Schaft Creek project are our two development stage projects with NI 43-101 technical reports. We also have three exploration stage projects, two in Arizona, and one in British Columbia. Our focus is only copper, and all our projects except the Van Dyke project contain variable concentrations of gold, molybdenum and silver, which potentially could be classified as by-product credits. Our strategy is to stay in North America, maintain the project portfolio that sustains our business model and take projects to the development stage, after which a board decision would be made to monetize the project into the industry.

Can you elaborate on the updated PEA for the Van Dyke project in 2020?
Van Dyke is in the Miami-Inspiration mining trend in Arizona. Due to the current mining activities, this area has excellent infrastructure and a skilled labor force. This project does not fit into our model, but the project was a past copper producer, was twice permitted for in-situ copper recovery (ISCR), and the purchase price was very attractive. Van Dyke is an advanced ISCR project, very similar to the one Taseko Mines is developing at Florence Copper. In 2018/2019, we conducted an updated resource estimate, and we were able to upgrade the resource classification from 100% inferred to about 1/3 indicated and 2/3 inferred. The updated resource estimate led to an updated PEA in 2020, which increased the after-tax net present value of the project from US$149 million to US$645 million. The economic analysis is based on US$3.15 a pound copper at a discount rate of 7.5%, annual production of 85 million pounds of copper cathode per year, an increase in the mine life from 11 to 17 years and increased metal sales.

What is Copper Fox's strategy to move the Van Dyke project forward?
I can say that Copper Fox is open to partnering possibilities as we are always assessing risk/reward scenarios related our projects. We are currently advancing the Van Dyke project to the pre-feasibility stage, and in doing that, advance the permitting process as well.

Could you elaborate on the potential Copper Fox saw at Sombrero Butte and Mineral Mountain?
Both projects are in the Laramide copper province in Arizona, one of the largest copper provinces in the world. The Sombrero Butte project was purchased as part of the Van Dyke project transaction. The mineral claims covering the Mineral Mountain project were located by Copper Fox in 2015.
Copper Fox considers these projects to have excellent potential to host porphyry copper deposits. For example, at Mineral Mountain the porphyry target is approximately 4,500 m long by up to 2,000 m wide, and at Sombrero, the target is approximately 3,000 m long by at least 800 m wide.

Could you provide an overview of the Eaglehead project?
Eaglehead is our most advanced exploration stage porphyry copper project located in the Liard Mining District of British Columbia. The project hosts polymetallic porphyry copper style mineralization with appreciable concentrations of molybdenum-gold-silver, like what we see at Schaft Creek. The work to date indicates the five zones of porphyry mineralization occur within an 8,000 m long by 3,000-m-wide area located in proximity to the surface trace of a regional scale fault system. Of the 126 drill holes (36,000 m) completed on the property, 120 drill holes intersected porphyry style mineralization over core intervals up to 540 m in length. Preliminary metallurgical test work indicates the mineralization responds well to standard flotation methods with high percentage metal recovery to a clean copper concentrate. Our 2022 plan was to complete a drilling program with the view to determining if we could move the project to a resource estimation, a major milestone in the development of a resource project. The Notice of Work for the drilling program is pending and due to changing weather conditions, the drilling has been delayed until mid-2023. ■

Critical and Energy Minerals

Energy transition and resource security bring a sense of urgency amidst inflationary pressures

Image courtesy of Dane Rhys

The energy transition will not occur without a strong supply chain of critical and energy minerals to manufacture and store the electricity needed for a successful transition away from fossil fuels. After a tumultuous path through Congress, the Inflation Reduction Act was adopted in August 2022. The landmark law represents the US' most significant effort to date to tackle climate change, and marks a new chapter in America's climate policy. A vast array of tax credits, loan guarantees and grants will contribute to the drive towards electrification, as Bloomberg predicts that battery-powered car sales will likely grow from 10% in 2021 to 40% by 2030. The development of lithium, rare earth elements and uranium projects are key to achieving electrification, from the baseload to the motor of the vehicle.

Uranium: Black Swans and opportunities

Could the main beneficiary of the 1973 oil embargo be the key to achieving the green transition? Uranium is today deemed crucial to answering the energy crisis, but this will not come without challenges for the US: self-sufficient in the radioactive element in the 1980s, the country now imports most of its uranium. And as close to 75% of nuclear power is generated between Europe, America and Asia, and Kazakhstan holds the lion's share of global uranium production with 40%, the uranium supply chain is more than ever impacted by the geopolitical turmoil that emerged on the Old Continent and resonated worldwide.

Still recovering on a reputational standpoint from the 2011 Fukushima disaster, the nuclear industry appears to be in a Renaissance period. A point of contention for the environmental movement for the past decade, uranium has in recent months taken center stage in conversations deeming the fuel to be a crucial green energy source. Arizona is believed to contain about 500 breccia pipes, some of them likely containing high-grade uranium.

Positive strides in terms of nuclear waste management appear to be outweighing public perception setbacks. Mark Chalmers, CEO of Energy Fuels, the leading US producer of uranium and vanadium, commented on the company's approach to reducing carbon emissions: "Our recycling programs allowed us to recover 6 million pounds (lb) of uranium that would have been lost to disposal".

Energy Fuels' White Mesa Mill is capable of recovering uranium through an "alternate-feed recycling program"; alternate-feeds are uranium-bearing materials that, if not recycled, are destined to become waste.

Processing radioactive residues to produce electricity will likely be a key factor in uranium producers maintaining their social license to operate. Acknowledging controversies around Energy Fuels' Pinyon Plain mine, a uranium mine located seven miles south of Grand Canyon National Park, Mark Chalmers said: "Pinyon Plain could produce up to one year of Arizona's total electricity (...) a state that currently gets a third of its electricity from nuclear power."

Several factors indicate that the US nuclear industry is gaining ground against its global competitors. Although in-

Mark Chalmers

CEO
ENERGY FUELS

What makes Energy Fuels a special investment?

Energy Fuels is unlike any investment. We have a long history of producing uranium and we recently entered into the rare earth space and isotopes.

Can you touch upon the potential of Pinyon Plain mine and recent updates there?

Pinyon Plain is a conventional underground mine and the highest-grade uranium mine in the US. It is a compact, easy-to-mine, easy-to-reclaim deposit. It could produce up to one year of Arizona's total electricity on only 17 acres, and has a very small environmental footprint.

The project has all permits necessary to go forward. In terms of timeline, we will move on to advance Pinyon Plain into production when there is an upswing in the market for uranium and rare earth prices.

How does Energy Fuels answer the community's concerns regarding Pinyon Plain?

Pinyon Plain has been a controversial mine since I built it in the 1980s. We continue to communicate as much as we can and are planning on doing further outreach with the Havasupai tribe to be responsible neighbors in the area.

How is Energy Fuels leading efforts toward the green transition?

Our recycling programs allowed us to recover 6 million pounds of uranium that would have been lost to disposal. On the ESG front, we are doing more than ever with communities. We set up the San Juan County Clean Energy Foundation. We plan to contribute 1% of our mill revenues to it.

What will be the highlight for Energy Fuels moving into 2023?

I anticipate extraordinary progress in the next 12 months. Energy Fuels will advance its rare earth program faster than anybody else in the world. We restarted our uranium production in the US, and plan to continue to be the largest producer of uranium there. Lastly, we are closing a transaction in a mine we bought in Brazil, which is a heavy mineral sand deposit. ■

Marty Weems

President North America*
AMERICAN RARE EARTHS
*up until January 2023

Can you expand on Western Rare Earths' work in Arizona as the subsidiary of American Rare Earths Limited?

Our flagship Arizona property, the La Paz rare earth and scandium project, has the potential to be the largest rare earths project in North America. It has a near negligible, low thorium content. La Paz has a profile that has responded very well to wet high intensity magnetic separation, meaning we save on capex and opex costs.

We were able to expand the JORC Resource to 170 million t at La Paz, up from 135 million t after some drilling in 2021. At that same time, we did some reconnaissance drilling at about 4 km southwest based on some favorable surface sampling. We believe we have found what could be a much larger twin ore body. The next step is an aggressive drilling campaign in that area.

What needs to be done to establish a domestic supply chain for rare earths?

We believe there is both market pull and government push to ensure a complete supply chain of rare earths in the US. The Bipartisan Infrastructure Law, the Chips-Plus Package and the Inflation Reduction Act bring about substantial incentives and resources. The volume of materials needed is going to increase, so the supply chain needs to be short, secure and domestic.

The real void in our industry is in the midstream, particularly extraction, separation, and purification technologies. The federal government has rightly focused money for programs in the Department of Energy (DoE) and the Department of Defense (DoD) to incentivize and help set up the midstream processing.

The Critical Materials Institute, of which we are Team Members, have been working on the rare earths supply chain for over a decade. They are bringing forward some exciting technologies that we have been able to partner on. ■

dustry leaders recognize that more governmental support is needed for the US to restore its competitive advantage in uranium production, disruptions on a global scale have presented unexpected – almost Black Swan like – opportunities for US and Arizona-based uranium producers.

The Southwestern Gold Rush – for lithium

A key component in EV batteries is lithium carbonate, and this element highlights the US' deficiency at the production and midstream processing level for critical minerals. In March 2022, US Energy Secretary Jennifer Granholm emphasized the importance for the US to reduce its reliance on foreign countries for the import and the processing of the "white oil". The US currently accounts for 1% of global lithium production, with the entirety of the mineral being produced at a single brine operation: Albemarle's Silver Peak in Nevada. This urge to reduce reliance is not trivial: as the lithium-ion battery revolution gains momentum, Benchmark Mineral Intelligence, a price reporting agency, anticipates the exceptional demand will only be met by putting into production 74 new lithium mines with an average size of 45,000 t/y by 2035.

Bradda Head Lithium's recent intercept at its San Domingo project and the commencement of drilling demonstrate that Arizona's role in the lithium space will grow in the coming years. Charles FitzRoy, CEO of Bradda Head Lithium, explained: "The results we gathered at San Domingo are really encouraging. So far, the program proves we have a viable pegmatite production that has a much lower capex than our clay programs."

Arizona Lithium's Big Sandy project also appears ideally placed to assist with the government's goals, having an Indicated and Inferred JORC resource of 32.5 m/t grading 1,850 ppm lithium.

A vital need to strengthen the domestic supply chain for REEs

From EVs to F-35 fighter jets, the future of US' economy and security also depends on rare earth elements (REEs). In February 2022, the Biden Administration pleaded to "break dependence on China" regarding critical minerals. In August, China raised its annual output quota of REEs by 25%, for the fifth consecutive year. REEs are vital to both the manufacturing and defense industries and are crucial for the electric traction motors in EVs. On the defense side, Arizona is one of only two US states that produces rhenium, a key component in alloys used in jet aircraft engines.

American Rare Earth's Marty Weems, president North America up until January 2023, commented: "China currently is the largest holder of REE reserves and is a net importer of the minerals as Chinese control about 80% of all midstream processing."

North of Phoenix, Western Rare Earth's La Paz project has the potential to be the largest rare earth project in North America, representing a beacon of hope – although an isolated one - for the defense industry at a time when military tensions between the US and China have reached their highest point in years, following US House Speaker Nancy Pelosi's Taiwan gambit in August. "Should China constrain our defense industry, we could have difficulties providing the necessary components for the fabrication of weapons (using electric motors, such as cruise missiles, submarines and fighter jets) within 90 days," warned Weems.

> There are several types of lithium exploration activities in states like Arizona and Nevada. For example, pegmatite mining has generally lower capital costs, but produces an intermediate product (6% spodumene concentrate). Brines, on the other hand, bring about higher capital costs to produce lithium carbonate, and in the U.S. they will mostly require direct lithium extraction (DLE) technologies.
>
> **Charles FitzRoy, CEO, Bradda Head Lithium**

The endowment of the Arizonian soil alone will not be enough to secure a domestic supply chain of critical minerals, and the government has recognized the need for its intervention to tackle the US void at the midstream level, where foreign countries still control extraction, separation and purification processes. New Department of Energy (DoE) and Department of Defense (DoD) programs to operationalize this supply chain are a step towards breaking foreign dependence. As the US and Western partners seek alternatives to Chinese REEs and Washington aims to boost its midstream process, the opportunity for Arizona to lead the charge for critical minerals is there for the taking. ■

Precious Metals: Production and Exploration

Restarting past producing mines to meet future demand

Image courtesy of Dulcey Lima (iStock)

Gold and silver remain on the fringe of mineral production in Arizona, with these precious metals being more abundant in neighboring Nevada. At present and since 2018, Elevation Gold's Moss mine is the only operating gold mine in Arizona, while several silver deposits are in development. But despite limited precious metals activity and being renowned as the Copper State, there is no shortage of opportunities for Arizona to grow its development and production of precious metals.

A five-month declining trend in gold price up to September 2022, pressured by higher yields and a stronger dollar amidst an inflationary cycle, did not prevent gold from remaining a top-performing asset in 2022. Traditionally viewed as a hedge against price pressure and a bastion in unpredictable markets, the World Gold Council anticipates the commodity to remain reliable, particularly as prospects of a formal recession increase.

Most silver produced in Arizona is a by-product of copper, gold, lead, and zinc mining, but explorers in Arizona appear intent and capable of accelerating the pace of discoveries in a context of growing demand pushed by the green transition. Indeed, despite not being officially deemed a strategic metal like rare earth, lithium, or cobalt, silver's high connectivity properties make it crucial in the production of solar panels and electric vehicles.

Gold and silver production amidst inflationary pressures

Elevation Gold's flagship Moss mine is the standout gold and silver project in Arizona. The project is in Mohave County, at the heart of gold and silver production in the state in the Oatman district, an area with historical production of 2 million ounces of gold (oz Au), and most of the output comes from the Gold Road and Tom Reed-United veins. Crushing around 11,000 t/d, Moss mine has measured and indicated mineral resources estimated to contain 490,200 oz Au and 5.75 million oz of silver (Ag) grading 0.39 g/t Au and 4.6 g/t Ag.

Despite high metal prices, FY2022 has so far been challenging for miners' capex. For the leading majors, capital expenditure is expected to increase in total by more than 20% this year, a rate not exceeded since 2014, according to GlobalDataPlc. For other players, rising costs impact day-to-day operations, particularly inputs in diesel power that fuels most of mine operations' heavy machinery. Elevation Gold's president Tim Swenseid commented: "Fuel prices are up 50% compared with a year ago. This is affecting input commodities, and open pit mining requires significant amounts of fuel."

Looking ahead, Florence Hill, located halfway between Moss mine and Gold Road mine, is a potentially promising gold project for Elevation Gold. Tim Swenseid expanded: "Florence Hill has been known as a good target for over a decade. We are finding encouraging structural, vein, and alteration features."

Having started exploration drilling in July 2022, Exploration Gold is planning around 3,800 meters (m) of oriented diamond core drilling and is expecting assay results to determine mineral grades in Q1 2023.

Reviving old mines

Arizona is home to several past-producing mines and restarting there is a way for mining firms to capitalize on growing precious metals demand. The state is a particularly attractive operation ground for miners willing to restart a mine, as companies can operate proven deposits in a mining-friendly jurisdiction, and use existing infrastructure, permits and licenses. Arizona Silver Exploration's Philadelphia flagship is a prominent example of this process. President and CEO Mike Stark explained: "Philadelphia mined approximately 44,000 oz Au strictly high-grade mining. Our recent results, as high as 41 g/t Au on a high-grade vein and 250 m of 1.32 g/t Au and subsequent grams of silver indicate that Philadelphia will likely develop into an open pit".

Two promising projects could also bolster Arizona's silver production in the coming years. Firstly, Silver Bullet plans to put the Buckeye mine back into production. "In September, Silver Bullet Mines began processing high-grade ore at our 100% owned, 125 t/d mill near Globe, AZ", specified Peter Clausi, VP of capital markets at Silver Bullet, which has signed an initial contract for the delivery of silver doré bars.

Globe is a familiar area for silver explorers, as it is located within the Arizona Silver Belt at the heart of which sits the Phoenix Silver project. Touching upon the recent sample results collected there, Gregory Crowe, president and CEO of Silver One Resources, explained: "When we do get our permit to drill there, we will test those extremely high-grade silver targets. We are getting values of up to 459 g/t Ag".

The presence of past-producing mines, a mining-friendly jurisdiction, and existing infrastructure all contribute to the competitiveness of Arizona in its attempt to carve itself a slice of the precious metals market. ■

The areas next to the Moss pit are really prospective for finding more gold.

Tim Swendseid

President
ELEVATION GOLD MINING

Could you introduce Elevation and your flagship mine in Arizona?
Elevation is a Canadian TSXV listed company. Our flagship asset is the Moss mine in Mohave County, AZ, 10 miles east of Bullhead City and 90 miles southeast of Las Vegas. We went into production in 2018 and have approximately 150 employees. We control a 168 sq km exploration land package, and there are historical workings nearby: the Oatman district produced over 2 million oz Au. Overall, the area seems under-explored.

The ore we mine is considered a low sulfidation epithermal deposit. This comes with advantages and challenges; the rock is extremely hard, we have to crush it to a very small size (at a cost), but the recovery is good, there are no contaminants and percolation through our leach pads is excellent. Our ore grade is low, though, which drives us to remain very efficient with tight cost control. The crusher plant we have is small, but through good operating practices we have been able to double the nameplate throughput. We currently crush about 11,000 t/d. Our main goal is keeping Moss profitable to finance exploration of nearby targets.

What is your vision for Elevation since being made President in August?
We are in the process of turning the company around financially. Our current reserves were published in the NI43-101 mid-2021 and are still applicable. The areas next to the Moss pit are really prospective for finding more gold; in 2021 and through May 2022, we drilled over 250 holes in order to figure out where to mine and where to construct future leach pads. We are also excited to be finally drilling in Florence Hill, a really promising target. We aim to stay profitable while continuing to explore with the ultimate ambition of becoming a significant producer.

Can you expand on your maiden exploration program at Florence Hill?
Florence Hill has been a known good target for well over a decade and is located about half-way between the Moss mine and the Gold Road mine, and our geologists feel it could be the source of mineralization in the district.

We are drilling there looking for epithermal veins and porphyry deposits and different kinds of alteration. We are on our first hole, and it has been good enough that we are going to extend it deeper than planned. We are finding encouraging structural, vein, and alteration features. We will know about any mineral grades when we get our assays back in Q1 2023.

How has Elevation adapted its processes to mitigate recent inflationary pressures?
We are coming up with ways to reduce costs to balance those pressures. We drilled two new water wells so 100% of our water comes from our own wells. Internal sourcing will lower our costs and actually be better quality for our processes. Besides that, mining contractors we work with can employ new technology to increase efficiency and minimize costs.

These pressures are unlikely to negatively affect our production at Moss. We have two sides to the deposit: the West pit and the East pit. The West is more of a disseminated deposit and the East pit contains a principal vein structure with higher grade. Overall, we produced 13,000 oz in the first half of the year and expect 20,000 oz in the second half of 2022, which reflects reaping the benefits of developing an additional push-back in East Pit. We also will not need to build an additional leach pad until Q2 2023.

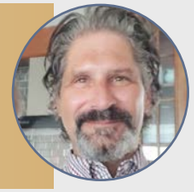
How do you view the regulatory framework for mining companies in Arizona?
Arizona is generally very pro-mining and industry friendly. Groups like AMIGOS are extremely supportive, plus they facilitate producers and explorers' supply chain processes; there are a large number of engineering and technology providers based in the state, there are outstanding mining and other academic programs and institutions, plus we enjoy fantastic support from the Arizona Mining Association (AMA).

What should we expect from Elevation in the next few months?
We hope it is the identification of more economic ore material next to our current operating pits to enable us to extend the mine life for 3-5 more years. The long-term prospect of Florence Hill is also very interesting, and we are drilling there now and will get results in the next few months. ■

Explorers: leveraging existing assets to make new discoveries

Steve Robertson,
President and CEO, Infinitum Copper
"Historic work done on the property (Hot Breccia) in the 1970s proved that there was an active hydrothermal system at depth which delivered several high-grade samples of over 1% copper and a few over 3% copper. We are bringing in modern exploration techniques, such as VTEM."

Peter M. Clausi,
VP Capital Markets, Silver Bullet Mines
"Some members of the team have been working on our Buckeye Silver project for over 50 years, and we were thrilled to announce that we are finally in production of copper and silver from this mine located in Arizona."



Rick Trotman,
President and CEO, Barksdale Resource
"In general, exploration in the US can often be very difficult and navigating the permitting process is not easy, so investors are willing to pay a higher price for assets and companies that can navigate this barrier for entry. We anticipate great success on this front."

Gregory Crowe,
President and CEO, Silver One Resources
"Before asking if there a deeper underground higher-grade system, we are focusing on getting to an earlier production on the silver oxide by potentially combining the near surface lower grade silver oxide mineralization – the fresh material – with the heap leach material left in 1997."

Stephen Twyerould,
President and CEO, Excelsior Mining
"We have had technological challenges there to bring our Gunnison Copper Project into production, but we are working on solutions, some involving well stimulation: making the recovery wells produce at a higher rate. We are working through some permitting and some modelling at present. The project will expand: following a PFE in 2022, we will carry out well stimulation trials in Q1 2023 and work on the optimization of the project from there."

Consultancies and Engineering

"Between federal and state regulations, no place in the world has better environmental protections than Nevada."

Jeff Parshley,
Corporate Consultant,
SRK Consulting

Image courtesy of KCA

Water Management and Environmental Regulation

Excellency in challenging times

Image courtesy of Ray Redstone (iStock)

Nevada: world-class resources in the face of climate change

There has been a common point among consultancies operating in Nevada in 2022: firms saw a net increase in the demand for their water-related services. Beyond Nevada being the driest state in the US and receiving only around 10 inches (241 mm) of rain per year, this shift in demand was also prompted by a firmer stance by authorities on closure and reclamation, environmental practices, and firms' need to manage a resource becoming ever more scarce. The above suggests that consultancies able to shift their focus toward water management will remain resilient in the years to come.

Nevada is a world leader in terms of environmental standards, and firmly intends to retain this position while balancing the societal need for mineral resources. Discharge of water from mining operations is regulated by the State of Nevada and by federal statutes, such as the Clean Water Act and Safe Drinking Water Act. On the environmental side, initiatives setting the state apart from other jurisdictions are the excellence in mine reclamation and the abandoned mine lands programs from the NDOM. Pledging not to reproduce the mistakes committed during eras of unregulated mining, stringent – yet comprehensive – environmental laws developed in the past decade have placed the model of Nevada mining as a leading one: "Nevada has consistently been recognized as a model for other jurisdictions that seek to replicate our environmental protection and reclamation standards for mining operations," explained Justin Abernathy, deputy state director for Energy and Minerals at the BLM.

In today's mining, mine closure must be thought of by operators before a single shovel hits the ground. In Nevada, an expert web of consultancies, environmental regulators, and associations have been collaborating for decades to get early-stage projects up and running. With a changing climate and Nevada's geographical position, one trend that will probably only strengthen in the coming years is early conversations between contractors and regulators about water, along with the role of associations–particularly the NVMA – when bringing all stakeholders together to ensure the project's environmental compliance.

Consultants at SRK Consulting's Reno office have known the regulators for decades. Similarly, Boulder City-born Broadbent Associates can leverage their long-lasting relationships with regulators built through 35 years of experience to facilitate dialogue ahead of permitting projects. Still, for all stakeholders, "There is a lot of work to be done in terms of water management," acknowledged Alan Driscoll, VP, director of mining services at Forsgren Associates and chair of the Suppliers Committee of the NVMA, who has seen a growth in activity in the firm's planning of reclamation bonds that will be needed in the backend of an exploration project.

The irony of excess water

Issues linked with water management are not always where one expects them to be. Mines are like small cities. They need water, wastewater, and facilities to manage these. In a context of resource scarcity, consultancies in Nevada have found that their services are more often than not used in the dewatering space of operations.

In northern Nevada, most mining in the Humboldt Basin for instance occurs in mines excavated 1,000 feet below the groundwater table. Mines that extend below that level must pump local aquifers to keep their pits and shafts dry. Jeremy Dowling, president of Piteau Associates, with contracts at the Robinson Mine and a strategic agreement with Freeport-McMoRan in mine water management, expanded: "Mine dewatering is needed in situations where the open pit will eventually deepen below the local water table. Groundwater will then seek from the rock to the mining voids. If not managed, this will cause concerns for the geotechnical stability of the mine and can cause it to flood."

Even amid droughts, Tierra Group's geotechnical experts primarily focused on managing excess water related to processing operations and tailings disposal. Pete Kowaleski, founder and principal engineer at the firm, discussed the tailings and water-related consultancy services he and Tierra Group offers, expanding on the design work to prevent excess water at the plant: "Facility siting is followed by a geotechnical investigation of the foundation conditions to characterize the foundation materials for use in the design to ensure there are no stability issues during construction, operations, or closure. The design work also includes a surface water management evaluation, diverting stormwater around the heap-leach pad, and associated infrastructure to minimize contact water volume."

Barr Engineering, which saw the demand for environmental site assessments significantly grow since 2020, is also a leading firm in the field of aquifer restorations, storing groundwater, and replenishing groundwater systems. Barr Engineering's vice president and senior geotechnical engineer Charlie Rehn explained: "Excess water from dewatered mines in Nevada can then be restored into nearby aquifers so that it is available for surrounding municipalities and mining operations."

Sustainable practices in tailings management

The awareness of the risks associated with poor mining practices, particularly in terms of tailings management, will be another factor keeping consultancies busy in the coming years. Worldwide, the growing annual rate of tailings dam failures, due to previously poor engineering, disposal of more rejects due to lower grade exploitation, and harsher environmental conditions have awakened public scrutiny to the sometimes-fatal consequences of tailings dam failures.

In recent years, firms in Nevada have mitigated that risk, particularly as modern tailings impoundments designed in the state incorporate geomembrane liners and underdrain systems for environmental containment. But majors work actively with local consultancies to remain ahead of the curve. Jeff Parshley, corporate consultant at SRK Consulting, explained that recognition of the critical aspects and risks associated with mining, particularly in terms of tailings management, drove growth for SRK's activities in Nevada: "We are extremely busy with the new GISTM. ESG standards generally and the concept of responsible investing have heightened the industry's awareness of responsible mining."

The introduction in 2020 of the GISTM, the acronym for Global Industry Standard on Tailings Management, will be a key factor driving growth for consultancies helping clients to identify gaps in compliance with the standard. Tierra Group provides a 'tailings stewardship' service, during which the firm audits, reviews, and supports projects to fit within the standard. Risk management then becomes vital during every board session, as for both miners and consultancies, there is a high volume of risk associated with the design, construction, operation, and closure of these large mine waste repositories.

Calculating risks brought by meteorological events will undoubtedly be key for mining firms in the southwestern US looking ahead. Reno is the fastest-warming city in the US, and firms across the sector are taking action as the environment fatally changes. The more extreme storm events witnessed during Nevada's summer monsoon season bring the need to understand how flash floods that occur at mine sites can be managed. As put by Jeremy Dowling: "The increasing number of flash floods prompted by climate change will be the next area of focus for the industry."

Arizona: involving consultancies as the energy transition accelerates

If climate change is a shark, water is its teeth. The expression, first coined in 2016 and since used by the environmentalist movement, is today ever more relevant as global economies feel the heat in dealing with climate change.

Arizona is no stranger to water droughts. The Colorado River hit dire lows in May 2022, forcing officials to impose water cuts as the southwestern US faced its worst drought in over a millennium, with the outlook for the coming years only getting drier. In July 2022, Arizona's Governor Ducey signed an unprecedented US$1 billion investment towards securing the state's water future. "Water is a very big topic in Arizona as we are in a desert", explained Steve Trussell, executive director of the Arizona Mining Association (AMA), adding: "The mining industry has been proactive and is on the forefront of water management".

Mining is by nature a controversial industry. Challenges that emerge ahead of the project permitting stages, such as environmental impact, land reclamation, and public scrutiny, are highly likely to keep environmental consultancies busy over the coming years. Water management is a key component analyzed before issuing mining permits in Arizona. Recurrent changes in regulations and swings in administrations in the past decade have made the process lengthier and harder to navigate for companies hoping to start mining activity. Consultants now present

> Due to the reclamation rules and the environmental impacts, there is a big focus on clean energy. The last coal plant that will exist in the state of Nevada is owned by the mining industry and there are already talks to retrofit that to a cleaner fuel. They are also already using some of the brownfield disturbed lands for solar and wind power generation.

Richard Perkins,
Founder and CEO, Business Council of Nevada and Canada

> Clearflow is a resource that the mining industry can leverage to optimize water reuse. Using Clearflows' patented Gel Flocculant product means these mines are now processing their water flows faster, while removing the metals containing arsenic and phosphorus.

Jerry Hannah,
CEO,
Clearflow

themselves as pilots for producers and explorers navigating the uncertain waters of mining permits.

Decades of unregulated mining activity in terms of water management have left scars on the Arizonian landscape that the modern mining industry has pledged not to reproduce. Mining in Arizona spans over three centuries, yet standardized environmental regulations did not appear until 1948 when the Federal Water Pollution Control Act - later revised as the Clean Water Act (CWA) - was passed. Scott Britton, director of Mining Plus, recalls: "30 years ago, water was a material that was to be managed to reduce costs as much as possible. Companies could evaporate tailing ponds or treat the water and discharge it into land and streams."

Going forward, regulators, investors, and the public will keep a close eye on ensuring that mining firms consider water as a precious resource from the first day of designing the project through to closure.

Arizona's water management landscape thus looks drastically different today. An Arizona Aquifer Protection Permit (APP) is required for any facilities discharging pollutants into the groundwater, and the mining industry's efforts to recycle, treat and use water more efficiently are coming to fruition.

A generational challenge, but one heralding opportunities

In a period where ESG goals are business priorities, with tighter water management regulations and increased public scrutiny on mining projects, opportunities are rife for environmental consultancies. Haley & Aldrich's VP, Eric Mears, named water resource management as the key driver for growth for the consultancy, and Civil & Environmental Consultants' mining director, Robert Livermore, saw a significant increase in demand for his company's services: "Our water resources and civil practices have been performing well over the past year."'

Parallel to scientific input, consultants play an ever-growing role when helping mining firms establish their social license to operate. Producers, developers, and explorers alike increasingly rely on public-relations firms to communicate their projects with local communities, investors, and the public. For example, since 2015, the Resolution Copper mine is being opposed by the Apache Stronghold coalition, for which Oak Flat represents a sacred site. Adam Hawkins, president of public relations firm Global External Relations, touched upon the company's role in helping clients achieve their social license to operate: "We help clients determining what messages appeal to the community, encouraging them to build trust by communicating effectively."

Environmental consultants can also act as a third party between mining firms and federal agencies to ensure the environmental feasibility of mining projects in Arizona. Most land in the Copper state is federal, where the delivery of permits can average between seven to 10 years. Eric Mears, added: "70% of the land in Arizona is federal, and this is where most mines are located. Federal agencies are preemptively denying permits or working to reverse favorable decisions."

Resolution Copper, whose authorization to mine has previously been revoked, is such an example. More than a drawback to investment attractiveness, the regulatory framework can also be a legal minefield. "Obtaining new mining permits is challenging due to sensitivity around environmental concerns," explained Randy Huffsmith, vice president of US mining at WSP.

Andrew Harley, mining director of SWCA Environmental Consultants, understands this challenge and helps early-stage exploration companies with their permitting strategy: "Some Australian or Canadian companies do not always fully appreciate the rigor of the permitting regulation they are confronted with in Arizona," he said.

Companies need to rely on a science-based, data-driven, and environmentally sustainable approach to obtain their mining permits; a thorny process, but an achievable and necessary one. "If the science is strong, and we have followed procedures correctly, then the legality of the project is strong," Harley concluded.

Managing water consumption will continue to be one of the main challenges for Arizona's mining industry, and will become costlier. The scarcity of the commodity highlighted by historic lows at the Colorado river in 2022 will force firms to come up with innovative solutions. To that effect, consultancies' expertize in terms of decarbonization, reducing water use and achieving sustainability will be a vital help for mining firms in making their operations comply with regulatory and social standards. ■

Consultancies: a crucial role

In southwestern US, water management matters perhaps more than anywhere else in the country. In Arizona and Nevada, consultants continue to tailor their offerings to help the mining industry overcome major challenges.

Randy Miller,
Vice President and Principal Engineer, Broadbent & Associates

"Nevada's water regulations are proven effective and world-class. At Broadbent, we thoroughly know these regulations, and our related services are growing in demand. We assist with groundwater and surface water monitoring to ensure that the water resource, wherever it is located, is understood, and handled in an appropriate manner. We also support water resource investigations, a critical component of permitting new projects."

Andrew Harley,
Mining Director, SWCA Environmental Consultants

"In Arizona and Nevada, we help early-stage exploration companies with their permitting strategy. Some Australian or Canadian companies do not always fully understand the rigor of the permitting regulation they are confronted with when they arrive in the Southwestern US."

Pete Kowalewski,
Founder and Principal Engineer, Tierra Group International

"Our current projects include working on a heap-leach design project in Nevada. The design work includes a surface water management evaluation, diverting stormwater around the heap-leach pad and associated infrastructure to minimize contact water volume. Both heap leach pad and tailings facility designs include containment design, selection of the liner system, and the civil design or layout of the ponds. We also work with our clients to ensure we can return that facility to a long-term stable landform (both geotechnically and geochemically) through planned closure activities."

Jeff Parshley,
Corporate Consultant, SRK Consulting

"The industry has always looked for ways to improve its operations, and the awareness of greenhouse gas emissions has been there for decades. As the production of battery metals needs to increase for society to reach its goals to transition away from fossil fuels, the emphasis on mining is higher than ever."

Robert Livermore,
Mining Director, Civil & Environmental Consultants (CEC)

"The mining industry has been very active in terms of water management. Water is a very critical resource in a lot of mining operations and most of them recycle up to 80% or more. The big issue is around the impact of water usage on surrounding communities that are experiencing shortages. Mining operations try to take advantage of stormwater storage, water-use efficiency measures, water recycling, and the use of dry stack tailings."

> We have expanded our services and are now offering more mining material handling and process engineering solutions.

Randy Huffsmith

Vice President
WSP

Could you provide an overview of WSP's main services in the US mining industry?
WSP has an extraordinarily strong environmental and geotechnical engineering practice. Over the last few years, we have grown significantly in the US both in terms of number of staff and revenue. WSP has focused on developing what we call our "design center concept." This combines our expertise in electrical, mechanical, structural, instrument, and controls engineering. This team is focused on designing and building mine infrastructure and helping plan for decarbonization for mining companies. It is a remarkably diverse and strong group with a large office in Phoenix and numerous other offices across the West that support our mining practice.

What are the advantages of WSP's design center concept?
WSP's design center concept has allowed us to take on a variety of work such as mine solution pumping systems. These solutions are used to get copper out of ore and are treated through a process called SX/EW. This has allowed us to integrate our historically strong heap leach and geotechnical design groups into more of a one-stop shop model. We have expanded our services and are now offering more mining material handling and process engineering solutions. There is an increased need to upgrade, maintain, replace, or expand mine infrastructure.

Which environmental services have been driving growth for WSP in Arizona?
Water is a major focus in the arid West where mining companies are seeking to become more sustainable. Our team of hydrogeologists, geologists, water treatment engineers and scientists provide resilient solutions that specifically focus on water, including water treatment, water use reduction, and modern technologies such as dry stack tailings.

What key projects has WSP done in Arizona around data analytics?
Noise control is an exciting area where we have been able to use data analytics. Prior to data analytics, noise recordings must to be listened to by a noise technician, classified, and catalogued. WSP uses data analytics to separate noises with software and identify what sounds are caused by mining or other factors. This is now accurately reported to the mine operators and regulators. We also use tilt meters to monitor slope stability for pits, tailings and waste rock dumps.

One of our clients in Arizona had a significant safety concern surrounding ore sample analysis at their laboratory. Most laboratories need to use strong acids for their processes. This client needed an innovative safety solution and partnered with a team including WSP to develop an automated ore assay process. Samples now enter the laboratory and are analysed without humans being exposed to acid.

How can WSP help companies navigate the regulatory environment?
WSP has a robust and diverse group of scientists that are able to evaluate and recommend mitigation for environmental issues that arise in new and brownfield mine design and permitting. We have biologists, ecologists, plant scientists, as well as geotechnical, water and environmental engineering managers that are experts in permitting.

There is a lot of environmental scrutiny on newly proposed mines, but a lot of changes have happened over the last 100 years in mining, and it is not appropriate to compare new mines to legacy mines that have caused environmental problems. Mining has become one of the most regulated industries and we have made tremendous strides in protecting the environment.

What trends are you seeing in demand for WSP's services?
There's a growing interest in project management and cost control. Being on schedule and on budget is important to our clients. The more components of a project WSP executes, the more we can help manage the overall cost of the project. WSP has significant expertise in modelling the mining process to look for opportunities to decarbonize by increasing the efficiency of material handling. Electrification of fleet vehicles is another area we support and see growth. WSP is involved in designing and building charging stations, cogen facilities and solar projects. Mines require a lot of power and at the same time are looking for ways to reduce their carbon footprint; these new technologies help address that need. In addition, when mines close, mining companies can potentially use the infrastructure and property to produce wind or solar energy and send power to the grid. ■

Robert Livermore

Mining Director
CIVIL & ENVIRONMENTAL CONSULTANTS (CEC)

> An interesting development we have noticed this year, mainly due to the energy crisis, is a resurgence in demand for our coal-related services.

Can you tell us about the origins of Civil & Environmental Consultants (CEC) and give us an overview of your mining services?
CEC was founded in 1989 in Pittsburgh, Pennsylvania, with one of its focuses being on the mining industry in that region. CEC works in the coal, aggregates, and hard rock mining industry. As our name states, we do both civil and environmental engineering, depending on the office location. Some of our services include environmental permitting, stream restoration, surveying (drone and underground), civil design, and air quality permitting/testing.

What services have been driving CEC's growth in recent years, especially in Arizona?
Our water resources and civil practices have been performing well over the last few years. In 2021, we saw 35% growth in our aggregates business. Another interesting development we have noticed this year, mainly due to the energy crisis, is a resurgence in demand for our coal-related services.

Can you share some insight into the mine permitting process in Arizona?
In the mining industry, there are two permitting avenues. The most difficult one is if you are trying to develop a mine on state or federal lands. As an example, Hudbay's Rosemont project was initially on Forest Service land, and therefore was subject to public scrutiny and open to litigation. The other permitting avenue applies to projects on patented mining claims in privately held land. In these cases, you just need to go through the normal state permitting process, which is much easier. One of the most important things to take into consideration in Arizona is the stringent water regulations. If you are processing minerals, you must apply for an Aquifer Protection Permit (APP) to ensure your operation does not affect groundwater. The Arizona Department of Environmental Quality is updating the Best Available Control Technology manual for the mining industry that helps set established design guidelines for engineering companies. If you are able to show that you can design/operate within these guidelines and are not impacting surface or groundwater, the permitting process is easier.

Can you highlight some of the key projects CEC has been involved with in Arizona?
Last year, we completed an Aquifer Protection Permit for a gold mine in the Prescott region. Within the patented property footprint, there was an old abandoned mine contaminating the local stream. To solve this, CEC designed and built a passive wetlands remediation system, and put metal adsorbing plants in each of the five ponds that can soak up minerals out of the water. We are also currently designing a two-mile stormwater channel to repair damage done by a flash flood in a region previously affected by a fire that resulted in a debris flow flood. We completed the due diligence for Ivanhoe Electric, which recently moved into Arizona and is looking at developing a large project near Casa Grande. This project is going to be interesting because Ivanhoe Electric will likely use in-situ copper mining techniques, one of the new technologies that is being used in Arizona and which was pioneered by the Florence copper project – now Excelsior's Gunnison copper project.

How does CEC manage to stand out from other consultancy firms?
Our clients and our people are the core of CEC. It is hard to compete with large international firms, but we are able to provide niche or smaller design projects that larger firms cannot get to. An example is a raffinate pond we just pre-designed for Carlota's Pinto Valley mine. CEC is very competitive in the US$100,000-200,000 project range.

What potential does Arizona's mining industry hold for CEC?
The whole industry has been talking about rare earths, and there are a couple of large deposits in Arizona that will likely be developed. We will continue to see major finds in copper thanks to the geology of Arizona and the abundant copper reserves in the state. This comes at a very necessary time given the push towards electrification and the ongoing energy transition. However, the mining industry will continue dealing with supply chain issues and shipping/supply chain problems, and will continue looking for ways to achieve cost efficiency while minimizing environmental or social impacts. ■

Mine Water Stewardship in Arizona

Expert Opinion Article by
Terry Braun,
President North America, SRK Consulting

On May 6, 2022, the Central Arizona Project and the Arizona Department of Water Resources (ADWR) held a public briefing on Colorado River Shortage Preparedness. The briefing started with three observations. First, the Colorado River Basin drought has lasted more than 22 years. Second, dry soil, higher temperatures, and low precipitation represent the driest basin conditions in more than 1,200 years. Third, the Colorado River was 36% of Arizona's water supply in 2020. The briefing ended with the certainty of increased reductions to Arizona's Colorado River allocation in 2023—beyond the 30% reduction instituted in January 2022. Two months later, the Governor of Arizona announced a US$1.2 billion, three-year investment in improving water infrastructure.

In 2021, copper mining (e.g., metal mining) in Arizona accounted for 74% of the domestic US copper production (USGS 2021). How do the major copper producers in Arizona navigate the sustained drought conditions, climate change forecasts, and complex legal frameworks of today? The solutions lie in an established strategy of long-term conservation planning and a sustained commitment to water stewardship.

Regulatory Brief

The most recent statewide water conservation measures announced in 2022 are the latest of a long series of forward-looking water strategies in Arizona, accelerated by the construction start of the Central Arizona Project in 1973.

Established in 1980, ADWR assumed responsibility for all groundwater planning and regulation in the state except for water quality. This legal authority included the development and oversight of mandatory conservation programs for groundwater use in four areas of heaviest groundwater pumping, classified as active management areas (AMAs). ADWR's legal authority on groundwater use outside of the AMAs requires users to demonstrate a reasonable and beneficial use. In this role, ADWR regulates "groundwater mining".

The Surface Water Division of ADWR administers permits, certificates of water rights, and claims to the appropriation of surface water in the state. This legal authority defines beneficial use as the basis, measure, and limit to the use of surface water. Mining is one beneficial use.

Established in 1987, the Arizona Department of Environmental Quality (ADEQ) assumed responsibility for surface and groundwater quality protection through various water quality programs. The Aquifer Protection Permit requires compliance with Aquifer Water Quality Standards at the point of compliance and operators to demonstrate Best Available Demonstrated Control Technology (BADCT). The purpose of BADCT is to employ engineering controls, processes, operating methods, or other alternatives to reduce the discharge of pollutants to groundwater to the greatest degree achievable.

ADWR provides specific conservation requirements for metal mining facilities in AMAs. The Tucson AMA (Fifth Management Plan, 2020) defined a series of water conservation-related best management practices (BMPs) for metal mining facilities. These BMPs are organized by water use categories including dust control, processing, conveyance systems, tailings storage facility management, system, and evaporation losses, cooling systems, and recycled and reclaimed water.

There are multiple other water-focused public agencies involved in conservation, storage, and strategic resource planning. In terms of water stewardship and metal mining, ADWR and ADEQ are the primary agencies of interest.

> **The best practice of life cycle assessment includes evaluating water supply and water quality impacts on mine operations, closure, and post-closure.**

Industry Best Practice

The best practice of life cycle assessment includes evaluating water supply and water quality impacts on mine operations, closure, and post-closure. This aspect of water stewardship is imperative for metal mine operations in the arid, semi-desert climate of Arizona. In this environment, large-scale metal mine operations have worked to maximize water use efficiency and promote the use of recycled, reused, and lower-quality resources for decades. Examples of best practices in Arizona include:

- Minimizing the use of freshwater and impacts on freshwater quality
- Modeling and planning for climate-related impacts in terms of engineering and promoting water-supply resilience
- Collaborating with other actors in the management of the water basins to manage and develop water resources in a sustainable and balanced manner, considering the social, economic, and environmental interests of the actors

Plans for new metal mines include the adoption of emerging technologies such as filtered tailings, reduced evaporation from water storage facilities, less water-intensive dust control, and increased water reuse overall. These plans, combined with adaptive management and stakeholder engagement, will guide metal miners through this complex landscape. ■

Jeremy Dowling

President
PITEAU ASSOCIATES

Can you introduce Piteau Associates (Piteau)?
Piteau is an international consulting firm. We are dedicated to the mining industry and have two main areas of service: geological engineering and mine design, and hydrogeology and water management. We have four offices in the US, with a presence in Reno and Elko, NV. We also have offices in Peru, Chile, South Africa and the UK.

Piteau works with all the major mining firms, along with mid-tiers and juniors, relying on a significant group of advisor-level technical staff who have been in the mining industry for upwards of 30 or 40 years. On the academic side, we publish a high volume of guidelines, are strong, and participate with several institutions in advanced education programs toward expanding R&D.

Can you expand on the work Piteau is doing in the southwestern US?
We have about 15-20 projects in Nevada, among which is the Robinson Mine. Typically, we do geotechnical engineering for open pit slope design and management, along with mine dewatering. There is widespread demand for water resource work in Nevada. On the permitting side, we assess the hydrogeological impacts of mining and then develop studies to support mine expansions. We have a strategic alliance with Freeport-McMoRan in mine water management and pit slope depressurizing. We provide service to all of the Freeport mines in Arizona.

What growth opportunities do you see for Piteau in the coming years?
There is a big shift towards underground block caving as it allows for more resources to be explored. Over the last 20 years, we have seen a large growth in such projects. We are looking to establish an underground block cave mining geotechnical practice and increase our block caving mining expertise: it will be an area of growth for everyone involved in mining. ■

Alan Driscoll

VP, Director of Mining Services
FORSGREN ASSOCIATES

Please introduce Forsgren Associates and the services you offer the mining industry?
Mines are like small cities; they need water, wastewater, roads, and bridges. This is where we come in. In addition to engineering, we provide planning and project management support services to help our clients make informed decisions. We also provide construction services to help our clients build their infrastructure. And lastly, we provide environmental services, from permitting to environmental compliance and eventually reclamation.

Can you expand on your projects in Nevada?
We recently completed engineering and construction management for a large dewatering project that included a 12-mile pipeline with a pump station, moving water from one basin, crossing a mountain, and discharging the water into rapid infiltration basins for percolation back into the groundwater. We routinely provide planning, scheduling, and permitting services for exploration and development projects, including mapping and calculations for reclamation bonds that will be needed on the back end. Overall, I would say that most of our work is related to water management - anything related to dewatering, drinking water, wastewater, and water supply.

To what extent does Forsgren intervene at the environmental stage?
We focus on environmental assessments for exploration and mine expansion projects. Developing and maintaining good working relationships with regulatory agencies has been critical to our success. We typically encourage our clients to engage with the regulatory agencies early in a project and therefore avoid going down the wrong path – saving both time and money. We work diligently with all stakeholders from the early stages to build trust and work together as a team.

What challenges do mining firms face in Nevada?
There is a lot of work to be done in terms of water management. The mining industry is doing a good job engaging with the communities they work in, and with their partners throughout the supply chain. ■

Engineering and Mining Contractors

Increasing precious metals recovery offers critical opportunities elsewhere

Image courtesy of Resolution Copper

Nevada: pioneering techniques for gold recovery

Few places can compete with Nevada when it comes to enhancing gold recovery. In the context of declining grades and harder-to-find deposits, gold ores in the past decade have been the subject of several investigations and research studies aimed at enhancing recovery and improving leaching kinetics. Based in Reno, Daniel Kappes, president, and CEO of Kappes, Cassiday & Associates (KCA), pioneered its heap-leaching expertise almost 50 years ago and has since contributed to Nevada's engineering radiation worldwide, while consistently coming up with new technologies to advance metallurgic test work and recover more gold.

Celebrating its 50th anniversary, KCA is not done leading engineering feats for the benefit of Nevadan and global majors and juniors. The firm, which specializes in laboratory testing, engineering designs, feasibility studies, and field construction and management, was notably contracted by Agnico Eagle at the Pinos Altos mine in Mexico, on a US$140 million contract for a mill/heap leach feasibility study. Nevada remains KCA's main US market, with more than 30 projects across the state.

A core question for precious metals mines to answer is that of optimizing recovery. Until a couple of decades ago, a recovery rate of 3 g/t Au would have been considered low-grade, and perhaps not economically viable. In today's context, majors need to adapt and leverage technologies that make 1 g/t Au deposits worth considering. A Nevada-born innovation is changing the picture of recovery: KCA's Carbon Converter. Dan Kappes explained his innovation: "It allows clients to turn their carbon fines and used carbon into a product they can leach, or smelt directly, to produce gold/silver bullion. The Carbon Converter can treat wet and dirty carbon fines, turning "trash" carbon into a valuable resource, and has demonstrated a gold and silver recovery of up to 99% in operation."

At the exploration stage, an early investment in engineering abilities can fundamentally impact the outcome of a feasibility study and the project's appeal to investors. Viva Gold contracted KCA to carry out a metallurgical optimization program at the firm's Tonopah gold project. KCA used a technique called pulp agglomeration and heap leach testing, which yielded results beyond initial estimations for gold recovery: "The test work showed that the yield was 91%, while the yield with an RPA at the same grade was 70%. For very little additional capital we can increase the gold recovery by about 20%," explained James Hesketh, CEO of Viva Gold. "The 91% indicated recovery is significantly higher than the 71% recovery estimate utilized in the 2022 PEA Technical Report," he concluded.

Resource nationalism driving demand

Geopolitical turmoil, global supply chain disruptions, and environmental standards have all highlighted the importance to mine domestically rather than abroad. In Nevada, the unfolding lithium story is driving growth for consulting and engineering firms that are seeing a bigger part of their mining-related expertise being focused on 'white oil' projects. The extensive talent available in Nevada means firms can rely on expertise from the permitting stage to closure, with key innovations along the way. Widely recognized as a leading engineering consultancy in open pit and underground mine design, planning, and engineering, SRK Consulting saw growing demand at the permitting stage for several new and ongoing lithium projects in Nevada, notably Lithium Americas' Thacker Pass along with Albemarle's Silver Peak operation.

The growing demand for lithium-related engineering expertise due to the recent boom in discoveries in Nevada has attracted several engineering firms from outside state borders. Respec, a South Dakota-based engineering consultancy with leading technology-related services, rode the lithium wave and saw its activity surge to half a dozen projects in Nevada in 2022, with a dedicated brine mining group. The firm partnered with lithium explorer Pan American Energy Corp. to design and execute a maiden drill program at the Horizon project in Tonopah. In October, ABTC engaged Respec to perform an independent analysis of exploration results at the Tonopah Flats project, which benefited from a DOE grant, and to generate and issue an SK-1300 compliant Inferred Resource report.

Out of Utah, Millcreek Engineering carries out process work and basic engineering for lithium processes. Once the projects advance through several stages of construction, Kevin Martindale, director of business development, noted a growing demand for augmented reality (AR) capabilities, as AR-powered programs render mining clients' plant designs more actionable. "We will take clients through an AR-type walkthrough: We put them in a room, give them 3D goggles, and they get to walk through the plant themselves. Clients can then see potential constructability issues and construction advancements," he explained.

MMR Constructor, an electrical instrumentation contractor, saw its mining share grow in the past years. Having worked with NGM and Freeport-McMoRan, the firm eyes growth opportunities in the sector. Resource nationalism means engineers and contractors will see growing demand for their services in the coming years, as put by MMR Constructors' west coast division district manager Darryl Sockwell: "For security, stability and independence reasons projects that large operators were going to develop internationally are now being considered in the US. This will be a long-term trend: We have already been approached about expansion projects to take place in 2023 and beyond."

Arizona: shifting gears in automation

Much like the rest of the US, Arizona has lagged behind other global key mining jurisdictions on the automation front. A February 2022 survey of global mining sites by GlobalData showed that, following a similar trend since 2018, Australia led technological penetration rates in major markets, with the Americas arriving fifth behind Europe, the Middle East, Africa and Asia.

Things finally seemed to be moving in 2022. Producers and developers have begun introducing autonomous fleets and solutions particularly useful for the efficiency, safety, and sustainability of their underground mining sites and projects. Arizona is home to several underground mines and projects - from Energy Fuels' Pinyon Plain, Freeport's Bagdad, to the proposed Resolution Copper mine – where inflows of water and high rock temperatures can make excavation dangerous, reinforcing the need for autonomous haulage. Service providers' expertise will be in high demand to dig ever deeper to meet the need for minerals. On 20 September, Stantec was awarded a US$16 million feasibility study contract to provide technical engineering at Resolution Copper. The proposed underground mine would leverage automation to operate at depths of up to 2,100 m and temperatures above 70 degrees C. Eagle Mountain CEO Tim Mason explained some benefits of leveraging autonomous fleets to reduce the Oracle Ridge underground copper mine's carbon footprint: "Having an electrical fleet allows for reduced emissions underground, which then also reduces the amount of ventilation required inside the mine."

Dozens of past-producing mines that are currently being put back into production will also drive demand for engineering firms' expertise. Currently, a core focus of Arizona's mining industry is on modernizing existing infrastructure, and engineering firms are key to meeting the technological challenge of switching to automated equipment and electric

Heap Leach Improvements: Best Design Practices

Expert Opinion Article by
Daniel Kappes,
President and CEO, Kappes, Cassiday & Associates (KCA)

»

Heap leaching is of course alive and well, and still pretty much centered on Nevada.

«

Heap leaching is of course alive and well, and still pretty much centered on Nevada. The 2022 International Heap Leach Symposium, organized primarily by Dirk van Zyl, was held in Reno in September and had an attendance of about 300 people split evenly between people working in gold, and those working in copper. There seemed to be an interesting divergence between the two camps. The primary concern among the gold people was the physical and chemical behavior of the ore. The copper people were almost all presenting various instrumentation techniques for measuring solution flow within the heap.

The trends in the precious metals mining industry are not heading in the right direction as far as technical sophistication is concerned. If you measure the success of a heap leaching operation in terms of return-on-investment, there seem to be as many failures in 2022 (on a percentage basis) as there were when the industry was young, in the mid-1970s. The success rate was getting better in the mid-1980s, but now it is declining.

Why is this? It seems to be a result of two developments:

Firstly, while there are more projects today, the labor pool of practical hands-on university graduates is not keeping pace. For years, the mining industry has been saying that a severe labor shortage is coming. It is here. It is compounded a bit by the fact that young engineers have exciting alternatives, and the schools have responded by reducing the emphasis on learning hands-on applications expertise. The Mackay School of Earth Sciences and Engineering is responding a bit by creating a Center for Mining Excellence in Elko under the direction of Dr. Sam Spearing. One of its functions will be to work somewhat like a Community College, and train people who might want to fill the gap between being a technician and being an "academic" engineer.

Another reason we are seeing heap leach failures is that we are pushing the limits of what is possible. Ten years ago, it was possible to get equity financing in the Canadian markets for small high-grade projects that show good return-on-investment (ROI). Now, the emphasis seems to be on increasing the resource ounces even at the expense of having a decent return or a risk-free project. Of course, the large mining companies are getting larger and so they need orebodies with more contained resources. But that does not explain why small companies face a large hurdle for their small but very robust projects. Just like with the shortage of field engineers, there seems to be a shortage of young ambitious people in the financial community who are willing to spend the time to learn the industry and truly understand the risk-reward relationships. A few companies have been able to overcome this with good and engaged management, such as I-80 Gold, which has accumulated a group of exciting northern Nevada projects, Fortitude Gold with their very robust Isabella Pearl mine, and First Majestic Silver which developed a portfolio of small mines in Mexico and has now acquired Jerritt Canyon in Nevada.

Meanwhile, the copper industry has embraced heap leaching in a big way. Traditionally, they have had dump leaches, which are low-tech economic margin processes for recovering more copper than it costs. But now they are paying much more attention to investing in proper heap design and stacking methods. The gold industry is used to the chemistry being fairly straightforward, but in a copper heap leach, there are a lot of important variables such as pH, oxygen availability, and the health of the various bacteria which are necessary to dissolve the copper minerals. There are a few true copper "heap leaches" in Arizona, but the majority of them are in South America. ■

mobility. Caltrol, a leading provider of automation, is helping some of Arizona's older mines to upgrade. Speaking of the developments that will drive its growth, Scott Bedell, Caltrol president, explained: "One of the trends is modernizing existing automation infrastructure. The West Coast is also leading the country in innovation around the energy transition, the transition to electric vehicles, and other alternative processes. We are partnering with leading companies to help automate their innovations."

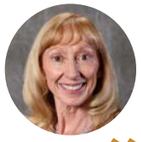
High-tech geospatial engineering provider Darling Geomatics also saw innovation-related services at past-producing properties drive growth: "A lot of our recent work has involved using our 3D scanners to give the owners a very accurate 3D model of their assets so they can retrofit and upgrade all the components that are part of the start-up process," explained Jon Heidmann, 3D scanning project manager at Darling Geomatics.

Leveraging the state's assets

Several world-leading equipment constructors and service providers have chosen the Arizona desert to grow technology and innovative designs to be used by the state's thriving producers and explorers. This is partly due to the benefits of being close to major mines, but also for R&D facilities to be able to leverage the state's abundant solar and wind force to create power. Caterpillar chose the Sonoran Desert as a testing ground for its innovative large mining equipment at its Tucson Proving Ground (TPG). Leading equipment manufacturer Komatsu chose Sahuarita, north of Tucson, as a home base to focus its research and development efforts to carry out the testing of its innovative autonomous haul vehicles. The Arizona-grown FrontRunner Autonomous Haulage System (AHS) now operates worldwide. Innovation-focused company Honeywell saw increased interest in implementing a remote operations center and automation solutions in Arizona, as explained by Americas director Darren Wyllie: "Not just in Arizona itself, but in many regions, we are seeing more interest from our clients about implementing remote operation centers (...) Part of our vision is to look how we can support the trend of autonomous mining to improve the productivity and safety of operations."

The trend of transitioning towards autonomy requires powerful communication and connectivity tools. Introduced to the Arizonian market in 2019, Starlink, a constellation of satellites in Low Earth Orbit (LOE), appears to be an answer for the lack of affordable and omnipresent cable connections at remote mining sites in the southwest that are necessary to enable teleoperation and autonomous operations. Clayton Thayer, business development manager at KP Exploration, an Arizona-based company that owns and operates RC and diamond core drill rigs, expanded: "KP Exploration utilizes a Starlink system at each of our project locations and an electronic app to stay in touch real-time with our exploration crews. The Starlink system allows our remote crews to always be in touch with emergency services. We believe it is a safety requirement."

» The reason why mines are currently reopening is because we have a critical shortage of certain minerals that are necessary for electric vehicles, solar power, wind power, and more broadly with goals that have to do with climate change. water reuse.



Mary Darling,
CEO and Principal Owner,
Darling Geomatics

«

Converging engineering expertise and digital capabilities

In the context of inflationary pressures and greater scrutiny from shareholders, process optimization is as crucial as ever for mining operations. Understanding this challenge, engineering firms continue to invest in innovation to achieve this. Bob Hoey, president at CAID Industries, whose main customer is Freeport-McMoRan, Arizona's biggest copper producer, explained: "We have supported Freeport with large automation projects in Tyrone, NM, and Sierrita, AZ. Projects like these (...) often bring a very attractive ROI due to labor savings and increased throughput."

Emerging technologies add value to engineering firms' services throughout the full life cycle of mining projects. In Arizona particularly, where majors have been at the forefront of driving further production plans in 2022 (Freeport-McMoRan is in the process of releasing a PFS at its Bagdad operation, and Arizona Sonoran completed its PFS in July 2022 for the Cactus copper project), technology is an opportunity to optimize engineering studies. By taking autonomous vehicles, advanced analytics, and digital tools into consideration at the earlier stage of projects, engineers can safeguard firms from the risk of running mines with outdated technology when the asset comes into production. Construction engineering firm Stantec covers the full life cycle of mining: "We are assisting a client with a PFS to expand its open pit (...) and assisting a major copper producer from small engineering studies to full EPCM execution," said Paul Stockburger, sector leader of strategic pursuits at Stantec.

Besides boosting production efficiency and enhancing financial output, investing in technology also means investing in worker safety. According to Deloitte consultants, mining companies are increasingly relying on contractors to create the next generation of integrated predictive safety systems. As the trend of remote mining gradually gains importance in Arizona, engineering firms increasingly rely on emerging technologies to carry out occupationally hazardous work from a distance. Jon Heidmann, 3D scanning project manager at Darling Geomatics, provided an example: "With a laser scanner, I was able to scan and model the large overhead cranes that are right next to the roof of the flotation building without having to climb a ladder to get there. This is an example of being able to capture something without having to get close to a dangerous situation."

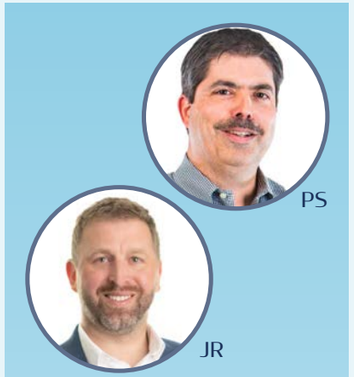
Mine closure and reclamation stages are under more scrutiny than ever before. Several mining sites throughout Arizona are currently in the reclamation phase, with some open pits remaining hazardous. Besides that, water shortages

and arid desert land make ecological restoration crucial to communities and wildlife affected by mining. Operators are proactively taking stock of those dynamics.

As ESG now tops key business risks for mining companies, the latter are turning towards engineers that offer 'greener' versions of mining components and that can help reduce their environmental footprint. This is particularly the case for scope 1 and 2 emissions – the first two categories of greenhouse gas emissions used by the accounting tool Greenhouse Gas (GHG) Protocol – as the power consumption of extracting and refining metals along with electricity purchases contribute to most mining firms' carbon heavy footprints. Ausenco currently carries out EPCM work at Hudbay's Rosemont project, and according to the director of minerals and metals, Jim Norine: "We have recently committed to growing our efforts in Arizona by hiring someone dedicated to supervising our ESG practices. Hudbay will be able to produce finished copper without ever transporting their concentrate to a smelter, which is crucial from an environmental standpoint."

Dams and tailings continue to present both technical and reputational engineering risks. As put by Eric Ownby, regional business development manager at Ames Construction: "Finding mining engineers focused on tailings is very difficult right now, because of the level of accountability that comes with it. Lots of companies will not touch such a project, because the risk associated with working with tailings is too high."

No longer considered the 'waste can' of mining operations, tailings are now at the forefront of mining firms' considerations, and service providers see an increase in the demand for their mine waste services. The Global Industry Standard on Tailings Management (GISTM) is a driver towards reducing harm to people and the environment. But like other key initiatives seen throughout the mining life cycle, the GISTM and the evolution of tailings management also expose a generational challenge for the mining industry; that of finding the right expertise. As put by Stantec vice-president of power and dams Jason Hedien: "The GISTM also exposed the talent gap when it comes to tailings engineers. How academia trains the next set of engineers is going to be critical for GISTM implementation." ■



Paul Stockburger & Jason Reynolds

PS: Sector Leader, Strategic Pursuits, Mining, Minerals and Metals
JR: Practice Leader, Mining, Minerals and Metals
STANTEC

The mining industry in Arizona has done well by integrating and involving communities in the discussions and planning, and educating the general public on the importance of mining for our future.

Could you provide an overview of Stantec's activity in the US and in Arizona specifically?
PS: Stantec has over 400 individuals dedicated to mining, minerals and metals in the US, and our resources are strategically deployed near our clients in Phoenix, Denver, Salt Lake City and Elko, along with several smaller regional offices. We add value by offering services across the entire life cycle of a mine: We start as early as resource assessment and work through putting the mine into operation, including mine planning and design, engineering and design of surface and underground infrastructure, water and tailings management, project delivery and execution, and ultimately through closure, reclamation, and post-closure asset transformation. Stantec is currently assisting a client with their pre-feasibility study (PFS) to expand their open pit and explore options to go underground. On another project, we began supporting our client with a basic engineering program almost three and half years ago for an in-situ copper mine and our involvement has continued into detailed engineering and will soon progress through full engineer-procure-construction-management(EPCM) execution. Finally, we are assisting a major copper producer from small engineering studies to a life-of-mine FS to full EPCM execution. We are also actively involved with tailings and waste management at two properties here in Arizona.

What role does Stantec play in supporting mine closure projects?
JR: In Arizona, we aim to consider the closure phase dynamically throughout the project phases to avoid it being a black box at the end of a project that requires major follow-on efforts. This supports clients in adapting their operational context to support closure.

PS: We integrate sustainable mining into all our services. The earlier we get involved in a project, the better we can provide clients with a sustainable closure and reclamation plan that will be accepted by the surrounding community and regulators. One of the refreshing things about Arizona and Nevada is that generally, local communities support mining. The mining industry has done well by integrating and involving communities in the discussions and planning, and educating the general public on the importance of mining for our future.

How are water shortages affecting the mining industry in Arizona?
PS: The industry is very focused on innovative solutions to address water shortages. With the technological advances in the extraction process, the industry is distributing and using water effectively and in a much more sustainable manner. These solutions reflect the community-driven way in which we approach our projects. For example, we partnered with an Arizona mine and a local firm based in Scottsdale that produces a self-contained water purification device that is solar powered and extracts, purifies and provides safe, clean and reliable water from the atmosphere for communities that presently do not have access to safe drinking water.

What role do the Global Industry Standards on Tailings Management play in the evolution of tailings management?
JR: For a long time, tailings have been considered the waste bin of a mine with limited investment and stewardship. The GISTM provides an important framework to appropriately design, operate and ultimately close tailings storage facilities in a community focused approach. Consequently, the standard has further widened the talent gap when it comes to tailings engineers – the industry simply has too few trained people to meet its ambitious needs and narrowing that gap with trained and experienced tailings engineers is critical for GISTM implementation.

Can you elaborate on the challenges and opportunities for copper mining in Arizona?
PS: Beyond challenges like water shortages and very lengthy federal permitting processes, the mining future is bright for Arizona and, we are certainly very proud to be an integral part of this future. The copper market is in a strong position, as the demand for copper is high and there will likely be a copper deficit at some point into the future. Arizona is ideally placed as the largest copper producer in the US: Resolution Copper on its own could produce up to 25% of the demand for copper in the US, and some additional properties are yet to come out of the PFS or feasibility stages and go into execution. ■

Jim Norine

Director Minerals and Metals
AUSENCO

» There is a drive to look at alternative technologies such as concentrate leaching. A couple of our clients are exploring this technology to produce finished copper without ever transporting their concentrate to a smelter – this is critical from an environmental standpoint. «

Could you introduce our audience to Ausenco's main areas of expertise in Arizona?
We began working in Tucson in 2019 with Hudbay's Rosemont project. Since then, our local team has grown from one to 30. We have been busy doing everything from studies to execution, including detailed engineering.

What are some examples of work Ausenco has taken on in Arizona?
Faraday Copper's Copper Creek project is a very exciting prospect that will bring a historic mining district back into production. We are one of the consultants providing the mine-to-mill assessment. We are the technical lead for the optimization of the processing plan, impoundment facilities and associated infrastructure design, including economic modelling and the metallurgical review. We are also helping Hudbay on the PFS for their Copper World project. It's always exciting to be involved early in a project as this is where we can add the most value by effecting our principles of fit-for-purpose design during the preliminary studies and then take the project to execution. That is what we did at the Las Chispas project in Mexico - we took if from a feasibility study to an EPC contract with price, schedule and performance certainty. The project was commissioned ahead of schedule in May 2022.

How does Ausenco leverage new technologies within the copper space?
We have an entire team at Ausenco that focuses on emerging technologies, particularly maximizing the return on investment and minimizing energy usage in the case of declining ore grades. We are also looking at alternate technologies to refine copper concentrates. Historically, these have been smelted, but smelter capacity is limited in the southwest. There is a drive to look at alternative technologies such as concentrate leaching. A couple of our clients are exploring this technology to produce finished copper without ever transporting their concentrate to a smelter – this is critical from an environmental standpoint.

What is your outlook on copper fundamentals and the role Arizona can play in future copper production?
We are moving towards electrification and green energy but I'm not sure everyone has thought about where the metals necessary for this transition, like copper, are going to come from. Our infrastructure must grow exponentially to support what's needed in electric cars. The demand for copper will continue to be strong, and Arizona will be a key part in this solution.

Other metals that support the green conversion, include lithium, cobalt and nickel. For these projects to advance we will likely need to see more funding and permitting reform at the federal level.

Given your company's global perspective, how would you compare Arizona to other mining jurisdictions?
The Western US is an exciting place for mining right now. Arizona is at the forefront of mining activity, the largest copper producer in the US, and currently one of the best places to operate a mine. We see opportunities from junior minors, but also from operating mining companies that need consultants like us. It is a great place for the up-and-coming miners.

How does Ausenco comply with increasingly demanding ESG standards, and what are the steps needed to reinforce gender parity in the mining industry?
ESG is just a new name for doing the right thing – something we've always done. At Ausenco, a huge part of our business is sustainability – through our dedicated Sustainability practice, but also in the way we do all our projects. We have historically done excellent ESG work in Canada and South America and have recently committed to growing our efforts in Arizona by hiring someone dedicated to supervising our ESG practices. This will allow us to focus on remediation, mine closure and tailings. Water management is also an important component of our work in Arizona.

Tucson is a great example of what's possible when we focus on diversity and inclusion. Half our staff are English-Spanish bilingual and almost half are women. By this time next year, we look to double our headcount, and we anticipate many of our new hires will be women. We are very proud to have such a diverse team and are keen to do more. ■

» If you think about the end use and reclamation requirements early on and incorporate solutions early, it makes the project much more efficient and improves the final environmental outcome. «

Dagny Odell

Owner
PRACTICAL MINING

What services does Practical Mining offer the mining industry?
We provide geological and engineering services to clients with projects in the exploration stage through production. Geological services include 3D digital modeling, mineral resource estimates and drill planning. Mine engineering services include open pit and underground mine design, cost estimation, ventilation systems engineering, economic analysis and geotechnical engineering. Our work requirements have covered everything from in-house scoping studies to feasibility reports. We can provide complete Canadian NI43-101 or US SEC S-K 1300 reports. We also provide LIDAR mapping services for surface or underground mines using multiple deployment methods.

How does Practical Mining leverage new technologies?
New technology needs to improve accuracy and/or speed up the project. Our LIDAR mapping unit can be mounted on a drone with completely autonomous capabilities and fly underground without GPS assistance. The unit can fly beyond the line of sight and communication range without operator control. It will map obstructions as it progresses, and employ obstacle avoidance measures to reach its destination and return. While doing this it is monitoring battery levels and will automatically return to the launch point when the batteries have only enough energy left to return to the launch point.

Compared to other mapping systems, our LIDAR system gathers higher-quality data in a shorter time frame without interrupting operations. The drone can reach and map areas unsafe for personnel entry. The data can be used to produce more accurate mine plans, improve mine-to-mill reconciliation, and map structures for further geotechnical analysis. We also designed and built a system to measure and record temperature, humidity and barometric pressure when performing pressure/volume ventilation surveys.

To what extent do you help improve clients' safety and sustainability processes?
Safety and productivity go hand in hand. Both start during the mine design phase; choosing a mining method or selecting equipment will have implications for both for years to come. By selecting the right combination of mining methods and equipment, consistent with geological conditions and mining requirements, safety and productivity will follow.

Our sustainability contribution is early in the design process, where we can lay out in a manner to enhance the final reclamation product. How you design a waste dump determines how well it will be reclaimed. If you think about the end use and reclamation requirements early on and incorporate solutions early, it makes the project much more efficient and improves the final environmental outcome.

How do you see the current labor shortage evolving going forward?
For technical staff, attracting talent starts at the high school level: we need to encourage students to pursue the STEM curriculum and the reward that comes from seeing a mining project move from exploration to production. For the trades, it is crucial to get people on board at the entry level and provide on-the-job training. Concurrently, companies must have a retention program that recognizes employee performance and dedication. The challenge for Nevada at present is finding quality people. It's not just about introducing new technologies but finding people that will use them in innovative ways, and people that are independent problem solvers.

What current challenges do you see in Nevada's mining jurisdiction?
The regulatory area is a big challenge. It is a multi-year undertaking to obtain project permits and begin construction. The industry needs to work with regulators to find ways to shorten that timeline while addressing the environmental aspects of a project. It can have an enormous impact on the return on investment. Another area that we need to work on is taxation. There has been a lot of political push for royalties on mineral production from federal land. Severance taxes, gross royalties, and net-smelter return royalties flow right into the unit cost of production, which increases the cut-off grade. Mineralization that could have been economic would be sterilized and left in the ground.

Do you have a final message?
Practical Mining will focus on the things we do well: Geological modeling, mine engineering, and public disclosure reports. We constantly have an eye open for new technologies that can improve our product, such as autonomous drone-deployed LIDAR systems. Our roots are in Nevada, and we have decades of experience working in and building mines here. ■

DS

MJ

Darryl Sockwell & Michael Judd

DS: West Coast Division District Manager
MJ: Business Development Manager: West Coast Division
MMR CONSTRUCTORS

We have tremendous growth opportunities, particularly in the western region where many of the larger mines are located. The schedule and demand in the mining sector is aggressive and I don't see it slowing down anytime soon.

Can you present MMR Constructors, Inc. (MMR) and the services you offer the mining industry?
DS: MMR is an electrical instrumentation contractor. We provide construction and maintenance services in the industrial sector, with mining representing about 40-50% of our district's current portfolio. We are embedded within certain mines as an electrical contractor handling day-to-day maintenance and also small and large capital projects.
MJ: MMR has been in the industry for over 30 years. Headquartered in Baton Rouge, Louisiana, we have over 30 offices throughout the country, and a handful internationally. This puts us in a position to have an extensive national labor force to execute projects in even the most remote locations.

How are customers in the southwestern US using your services?
DS: In the southwestern US, we are currently working with Asarco, have worked with Freeport-McMoRan, have done past projects with NGM, and are currently bidding on some future work with them. In Utah, we work with Rio Tinto and with Barrick in Idaho.
MJ: With electrical and instrumentation construction at our core, clients also utilize our telecommunications and security division as well as our commissioning and startup capabilities. More recently our Integration center has been able to help our clients with lead times for control panels and other fabrication services. Project services at the mining sites may include replacing the copper cleaner, installation of a new crusher, and retrofitting services throughout the site, to name a few.

Are any specific trends driving demand for MMR's services?
MJ: Given the demand and the acceleration of growth we are seeing in mining and electrification, owners and developers must plan so much further in advance. We have seen the challenges of the supply chain, equipment, and labor force, so they must now look ahead several years when planning to meet industry goals.

How is MMR addressing the current industry-wide labor shortage?
DS: Any contractor in the business is affected, and we are doing a lot as a company to address this including improved benefits and pay. The older generation is retiring, and we are not seeing as much of the younger generation coming to the industry. We place high importance on making our industry more attractive to the younger generation. In Arizona and Nevada, the remoteness of mines is a big issue in terms of attracting labor.
MJ: One needs to look at what is happening in other industries. We are seeing a boom in data centers, semiconductor manufacturing, and other emerging markets with aggressive construction schedules all competing for a limited pool of the industrial workforce. MMR has worked hard to stay ahead of the curve in recruitment, training, and career advancement opportunities to attract and maintain our labor force.

Can you touch upon the safety culture and training opportunities at MMR?
DS: At MMR, safety is the top priority for our CEO and owner. When something starts at the top and filters down, it is important to everyone and contributes to our safety culture. Everybody has "stop work" authority. If they see something unsafe, they can stop work immediately. We perform day-to-day training, focusing on the recognition of safety hazards. We have a behavioral-based safety program, where every employee identifies potential hazards, so from the second they walk on site, safety is on their mind.
MJ: The most dangerous job in the field can be one you've never done or one you've done a thousand times. We put that message into action and are constantly working to improve our safety culture not only for MMR personnel but few everyone onsite as well. As a result, many of our trade partners have adopted our protocols into their own model.

What will drive growth for your services in the coming years?
DS: The demand for precious and critical metals mostly. We need more copper and lithium to meet the demand we are forecasting over the next five years. The industry needs to grow, we need to incentivize the mines to help this growth.
MJ: We have tremendous growth opportunities for MMR, particularly in the western region where many of the larger mines are located. The schedule and demand in the mining sector is aggressive and I don't see it slowing down anytime soon. ■

Underground Contractors

Declining ore grades, increasing opportunities

Image courtesy of Juan Jose Napuri (iStock)

Will underground mining become miners' choice of necessity in the coming years? Faced with the inability to find economic open-pit deposits, moving towards brownfield underground operations is a trend that appears likely to be sustained in the coming years. Worldwide, the underground mining market is expected to reach US$25 billion by 2031. Declining ore grades in Nevada, Arizona and worldwide have forced operators to dig deeper underground into the earth's crust. In this context, the remoteness and harshness of the operating environment at Nevada's underground mines highlights the necessity to pick the right contractor, which like mineral resources, Nevada is endowed with.

In February, Kinross opted to go underground rather than pursue open-pit expansions at Round Mountain. Leading to higher margins and higher returns, the combined underground operation could produce about 150,000 oz/y at an all-in-sustaining cost of US$1,000/oz to US$1,100/oz. Familiar with such operations is Practical Mining, who in 2021 headed the PEA for I-80's McCoy-Cove mine, and in 2022 carried out mine-planning for an in-house study of the feasibility of the Round Mountain underground expansion.

Adding mine life and resources to existing operations is more important than ever for operators, and in that area, Small Mine Development (SMD) has been a reliable contractor for Nevada's majors for decades. One of the most prevalent examples of Keith Jones and his team's work is with NGM at Turquoise Ridge. Having had plans to establish a third shaft for almost five years, the major contracted SMD to rehabilitate and install high-capacity ground support in the older workings, ultimately enhancing the structure and ability to dig for more, and for longer. "It was originally thought that Turquoise Ridge would have a 10-to-15-year mine life, but some of these workings are now well beyond that, and resource expansion and operational improvements have added mine life requiring ground support upgrades," explained SMD general manager Keith Jones.

An example of cooperation in the southwest is at First Canyon's mine, which in recent years saw Practical Mining provide SMD with LIDAR scanning capabilities. About this asset, Dagny Odell, owner of Practical Mining, expanded: "We invested in a fully robotic LIDAR scanning system that can be deployed on a drone and flown underground and uses the light in form of a pulse laser to measure ranges beyond the line of sight and communications before return to the base point.

Looking ahead, this boom in underground activity in the southwest will undoubtedly bring about further capex shares devoted to innovative approaches to underground mining. ■

Keith Jones

General Manager
SMALL MINE DEVELOPMENT

We are open to working anywhere in the US where there are hard rock, metal, or non-metal, underground mines.

Can you expand on the work Small Mine Development (SMD) does at the Turquoise Ridge mine?
Our contract at Turquoise Ridge started with high-capacity ground support installation at the new, 2250 third shaft station. This excavation was in place before the shaft reaching it. After completing this work, we started rehabilitation and installation of high-capacity ground support in older workings. We then expanded into underground infrastructure development for the third shaft which is being sunk by Thyssen Mining and is coming online very soon.

What is your involvement at I-80 Gold Corp's Granite Creek mine?
SMD is doing the contract mining at the Granite Creek mine. We are involved in the development work required as we extend the decline deeper and develop new levels, and then we also do the production mining extracting ore, and backfilling as necessary. We are also doing the development project at the Cove project. This is an exploration decline that will allow for significant development drilling from underground. We started earthworks in February 2022, and expect the exploration declined to be finished in Q1 2023.

What role do contractors like SMD play to ensure safety at mine sites?
Safety is everybody's responsibility. We have policies and procedures in place that everybody must follow, and we provide the training, tools, and equipment to ensure that the work gets done safely. We are also participating in the Safety Journey program developed by Newmont, and this year, have incorporated it into our new hire training as a module. Due to the scarcity of labourers, we are constantly hiring new people and providing them with orientation courses and specific on-site task and equipment training.

What trends do you see in automation and electrification in the mining sector?
I believe Nevada companies will be late adopters of these technologies as they can be very expensive and major clients want quality contractors, but also demand fair pricing. In the contracting space, it is difficult to sell these technologies as the value to the client comes with a premium. There are still many unknowns with electrification technologies, and although we support electrification and have operated some electric equipment, it comes with a premium that we cannot yet justify in our margin. In many cases, such as at Jervois' Idaho cobalt project, you also cannot change 100% over to the grid for electric power as there is not enough power to support the entire operation. As an industry, we are at a stage where we cannot mine the battery minerals fast enough to support the electrification trend, and secondly, there is not enough power generation on hand to replace the BTUs that come from fossil fuels.

How achievable are the net zero by 2030 goals?
I do not believe we will be able to flip the switch and transition into electrification that fast. We have a multi-tier challenge where we not only have to manufacture a substantial number of batteries, but also mine the battery metals required for production, and we are no way near supply balancing out with demand. Permitting is still an issue in the global mining industry as it can sometimes take up to 10-15 years just to get the project approval. We are facing the challenge that we do not have nearly enough mines coming online to supply the battery minerals required for the energy transition. For the transition to be successful, the government must let the industry and technology drive it at such a pace that it is sufficient and will work. There must be an openness to all technologies and solutions, including nuclear which is not mentioned in the green energy world, but in my opinion, is one of the solutions to transition from fossil fuels.

What is your outlook for the future of underground mining?
The future for underground mining looks bright as mining is essential for everyday life. As deposits become deeper and more difficult to find, underground mining will flourish. Small Mine Development will continue helping our clients bring their underground projects online and meet their production goals. We are open to working anywhere in the US where there are hard rock, metal, or non-metal, underground mines. ■

Keaton Turner

Founder and CEO
TURNER MINING GROUP

We are soon to be breaking into Nevada with a big workforce and equipment fleet and are here to stay for a long time.

What services does Turner Mining provide the industry?
Turner Mining Group is a true mining partner, focused on servicing clients across North America. We also partner with our clients as an equipment and machine solution provider, where we deploy assets on a rental or lease basis. Our mission is to make the mining world a better place. We do that through our three values: heart for people, eye for safety, mind for innovation. We think the industry is primed and ready for change, and ultimately, the next-gen miner.

Can you expand on your presence in Arizona and future expansion plans in Nevada?
In Arizona, we work for Origin Mining Company at the Mineral Park mine. The work consists of hauling ore to leach pads, waste, and preparing to feed ore to a mill in the coming months. We teamed up with Komatsu Mining to build our fleet.

Nevada is a priority growth area for us. At present, we have some of our equipment solutions on a Kinross gold project. We are soon to be breaking into Nevada with a big workforce and equipment fleet and are here to stay for a long time.

How does Turner Mining help improve customers' safety processes?
It is hard for mining operators to have a profitable operation when they have incidents. Drilling operations carry risks, so safety is at the forefront of our work. Each site has at least one safety representative, with multiple sites having several. We combine top-down and bottom-up approaches to build a safety culture from within the organization. Any creative idea about approaching safety does not go to waste.

What is Turner Staffing Group's role in tackling the current labor shortage in the industry?
The greatest challenge our industry currently faces is labor. Any mine in the country is struggling with attracting, training and retaining young people. Trying to retain young workers is the hardest part of that 3-step cycle. One of the things we have done best at Turner is getting people excited about mining. Our COO Thomas Haun has stepped aside and is now running Turner Staffing Group. Almost every mine has a job opening, we need to connect those people who want a career change by using our network of people: We have 4,000 applicants in our system at any given time.

The mining industry needs a facelift. A strong social media presence is key for the industry to show its modern side and help it tell its story better.

How does Turner Mining help customers achieve their ESG goals?
ESG has become a buzz word in our industry as a great way to raise money for investors. Going beyond that, we want to have a positive impact in the community. Stigmas at the local level can often be a challenge for mining operations, despite there being plenty of social initiatives the industry can do to involve local communities. A lot of major players at the corporate level do not appear to care about what is happening at the local level. That is an issue. Some of the most useful work we do is helping clients with their waste and spillage. Small actions at the site level make a big difference state-wide.

Is the future bright for contractors offering automation services in the drilling and blasting space?
Absolutely. We are less than a decade away from seeing full automation on a large scale. Future tech advancements will be beneficial for the industry. Mining is one of the oldest industries, as part of its evolution I see it advancing to machines than will not require fuel. It is coming, the question is who will be onboard earlier.

Mining is a very capital expensive industry that bring loads of people, social and environmental risks. Outsourcing is a way for operators to step back and ask if they can deploy capital in a better way through employing contractors with a local understanding.

What are Turner Mining's main goals in the next 2-3 years?
It has been a wild ride so far. We made loads of progress in the past five years, and we continue to think we can have a positive impact on the industry, particularly in the lives of the thousands of employees we work with. ■

Equipment, Technology & Services

"Mining is going towards remote control and automation undoubtedly."

Peter Richardson,
Executive Managing Director,
NEVADA GOLD MINES (NGM)

GBR Series • ARIZONA & NEVADA MINING 2023

Image courtesy of Stantec

Equipment and Technology

Exemplarity in modern mining practices

Image courtesy of Coeur Mining

Nevada: driving the road towards sustainable mining

According to EY, ESG remains the number one risk and opportunity for mining firms for the second year in a row. OEMs, technology firms, and service providers are on a mission: Decarbonizing mines. Interest in autonomous mining and remote operations has grown exponentially in Nevada, a state where technological penetration rates have historically lagged behind global peers.

Maturity, evidence and ROIs

Several factors have contributed to Nevada majors' lateness in terms of autonomous adoption in comparison with Australian, Canadian, or Latin American peers. First, Nevada is home to several legacy mines that have been in operation for decades, making automation technologies harder to implement and working cultures less flexible. But Nevada's industry is a progressive one. What operators really struggled to encounter in the past was evidence of the need for technology, with little proof of return on investments or clear commercial benefits. Beyond automation, as digital transformation reshapes mining, the failure rate of AI and machine learning remains high, justifying shareholders' hesitancy towards an often 'black-boxy' concept. But safety and ESG-related reasons are prompting a change. As put by Chris Rains, CEO of Inforight, a data and analytics firm: "I forecast that we will see an increase in Nevada in terms of technological penetration in advanced realms such as image recognition."

Today, more than catching up, majors and developers intend to leverage local resources to become leaders in future-facing discussions, as seen with Rhyolite Ridge, the future first greenfield site in the US to use automated haul trucks. Caterpillar's Reno and Elko-based dealer Cashman Equipment will provide the lithium-boron project with the MineStarTM Command for hauling, after having completed a technology system supply agreement with the Australian firm in September. Touching upon this partnership, Mike Pack, president of Cashman Equipment, explained: "An autonomous approach is being taken primarily because of location, as it is an extremely difficult area for people to access. We have also found that autonomy is the safest and most effective way to run a haul vehicle or load tool."

Nevada Gold Mines (NGM) is leveraging the latest technologies and the highest level of automation from Sandvik electric haulage trucks at Turquoise Ridge's third shaft, while Robinson Mine is using autonomy leader Epiroc's Pit Viper 271 blast-hole drill rig. And as Peter Richardson, executive general manager at NGM, forecasted: "Mining is going towards remote control and automation undoubtedly. This is what we are doing at our underground mines; our operators are sitting on the surface and running underground equipment. Equipment is being operated by people in Remote Operation Stations on the Surface (ROSS)."

Opportunities for OEMs: net zero roadmaps and strong commodity prices

Through the creation of technology centers or antenna facilities, global equipment manufacturers have grown their footprint in Nevada and the southwestern US in the past two years. Sustainable-led operations and strong commodity prices have pushed up demand from operators for more underground electric vehicles notably, in their push to reduce their GHG. Germany's Liebherr and Canada's MacLean were early understanders of this trend. NGM operates a fleet of Liebherr trucks at the Cortez mine, and MacLean set foot in Elko in 2020 to support the joint venture's underground fleet.

Making the automation step does not have to mean replacing equipment. Upgradable and integrated solutions are becoming a key requirement for majors with large and decade-old operations. Liebherr's open protocol approach allows it to operate on any existing systems, LIDAR, or radars. US divisional director Shane Kuhlmey explained NGM's demands: "Customers want today's technology with the ability to upgrade products as we improve on it. You can take a diesel operating haulage truck, and if we have battery technology in the future through our partnership with Williams Engineering, that battery technology will be able to adapt to the truck that we build today."

This push towards electrification and sustainable innovation is prompted by ambitious net-zero roadmaps. And for Nevada's operators, the first step towards success is reducing their equipment's emissions. In the coming years, the state's giants will likely use zero-emission power haul trucks like Liebherr's T264 or Epiroc's Minetruck MT42, the world's first underground mine truck made using fossil-free steel. In the meantime, Kuhlmey assessed OEM's missions in the green economy: "The OEM is responsible for developing the technologies the customers didn't know they needed. We are responsible for eliminating the reliance on fossil fuel in our equipment and are expected to improve efficiencies and minimize the cost of the decarbonization transition."

Overcoming the fourth utility conundrum

Inseparable from automation discussions is the topic of connectivity. The challenge of the 'fourth utility' is particularly prevalent in Nevada. Automation requires extensive connectivity, along with solid broadband and wireless networks. The heat, harshness and remoteness of mine sites in Nevada pose a challenge to technology providers and firms trying to maintain their networks.

Having been acquired by Epiroc in 2021, 3D-P is on a mission to provide wireless networking and connectivity to Nevadan mine fleets. The firm's service offerings, particularly the Intelligent Endpoint product line, are custom-built for the Nevadan environment. President Ron White shared: "Our Endpoints may seem expensive because they are custom-

Mike Pack

President
CASHMAN EQUIPMENT

Cashman Equipment has a large technology group dedicated to mining, where we are leading the charge with regards to semi-autonomous and autonomous fleets within the state.

Can you introduce Cashman Equipment and the services the company offers the mining industry in Nevada?
Cashman Equipment employs approximately 1,000 people, and we operate in almost all of Nevada and eastern California. We are primarily a mining dealer with approximately 75% of our revenues being derived from mining. Besides the sale and rental of equipment, we also offer product support services to our customers. Cashman Equipment has more than 400 technicians, most of which are dedicated to the mining industry. Cashman Equipment has a large technology group dedicated to mining, where we are leading the charge with regards to semi-autonomous and autonomous fleets within the state. The division is broken up between the Trimble Platform, which is more for the construction segment, and Intermountain Mining Technologies (IMT) which is 100% dedicated to the mining industry. IMT is based out of Elko, and we have offices throughout the state. Finally, we have a power division that represents and produces off-the-grid power for mines, such as our Caterpillar generators, as well as a pumping division - Sierra Pump Solutions - where we support large underground or surface pumps.

What does the demand for your products look like in Nevada?
Demand is strong for new equipment for two reasons. Firstly, many larger mines, like NGM and Kinross, have been operating for a long time with the same fleets. We either have the opportunity to rebuild their fleets or sell them new equipment. The demand for the refurbishment or replacement of old fleets will continue over the next five years. Secondly, there are many junior miners exploring and looking to start up mines in the state over the next few years, which will increase demand for equipment. Regarding underground electric solutions, the R1700 electric vehicle will be available in 2023. It has been running in Canada for several years and is now ready for more production, and we expect a great demand for it in Nevada.

Can you expand on your work with ioneer regarding autonomous haulage at Rhyolite Ridge?
There are three parties involved in establishing a fully autonomous site at Rhyolite Ridge – ioneer, Caterpillar, and Cashman Equipment. An autonomous approach is being taken primarily because of location, as it is an extremely difficult area for people to access. We have also found that autonomy is the safest and most effective way to run a haul vehicle or load tool. Rhyolite Ridge will be Nevada's first autonomous greenfield site.

Cashman Equipment will install and maintain all the hardware and software on site. Our technology team will be on site full time to build up this fleet.

How do you see the adoption rates of autonomous fleets evolve in Nevada?
The industry found that autonomy pays well for itself in any situation, but the reality is that there is currently more demand for autonomy than there is production of autonomous capabilities. Demand for autonomous fleets continues to increase and Newmont is planning for a fully autonomous site with Caterpillar and Wagner Equipment by 2026. In terms of adoption, Western Australia came first, South America second, with the US, Europe, and Asia now starting to catch up.

What are the main drivers behind the push for autonomy?
Electrification is the biggest driver for the adoption of autonomous equipment. In today's world, the goal from an ESG perspective is an autonomous site that is electrically driven. We are on a journey where we are trying to help the mining industry break it down by segment, moving to autonomy and then electrically driven autonomy.

Electrically driven mines are going to fit well in certain applications, but not necessarily all. The real balance we must figure out is regarding the power to generate electricity to drive these batteries. Until power generation and technology to make electrically driven mines worthwhile comes together, we are going to be at a roadblock where only at certain mines it will pay off effectively quickly and those companies will want to drive towards ESG goals quicker than others where the ROI is slower. ■

Shane Kuhlmey

Divisional Director, USA
LIEBHERR MINING

That was NGM's requirement: being able to upgrade existing trucks without having to buy new ones. Customers want today's technology with the ability to upgrade products as improvements can be applied to it.

Can you provide an overview of the services Liebherr Mining provides the industry in the southwestern US?
We bring to market equipment used for open-pit mining and the hard-rock sector. We have trucks ranging from the 240-tonne payload to ultra-class trucks, along with a full line of electrified excavators, and our mining dozers. The mining markets of copper and gold have higher demand than normal due to strong prices, and with strong prices come strong opportunities for suppliers like us.

The US is the second largest opportunity for Liebherr globally from a standpoint of machine consumption. The western US is interesting because of the importance of copper and the continued importance of gold, along with the emerging lithium mining technology. In Arizona, we operate a fleet of ultra-class haul trucks for Asarco. We provide on-site support and help at their manufacturing facilities in the west. NGM also operates a fleet of Liebherr trucks at the Cortez mine.

What is Liebherr's approach toward integrating new technologies in Arizona and Nevada?
We are working on placing new electrified excavators in these states. We have a 150-tonne excavator and a PR 776 mining dozer in stock in Elko. Customers have requested autonomous mining solutions through our partnership with Hexagon. Our system is an open protocol, meaning we can operate on anyone else's systems: we can give clients the LIDARs and the radars, and leave the system open so that any other type of autonomous solution can log in and make our units work on their system. What we have also done is create upgradeable equipment. That was NGM's requirement: being able to upgrade existing trucks without having to buy new ones. Customers want today's technology with the ability to upgrade products as improvements can be applied to it. Liebherr's answer to this challenge is a modular approach, which allows the machines to be energy-type agnostic and drive train agnostic, enabling an upgrade or retrofit on existing equipment to zero-emission drives. You can take a diesel operating haulage truck, and as soon as we have battery technology through our partnership with Fortescue Future Industries and Williams Advanced Engineering, it can be installed on the truck we build today.

Can you expand on Liebherr's "Zero Emission Mining Program"?
Liebherr's roadmap for zero-emissions is 2030, and we believe we are absolutely pioneering zero-emission mining. Customers are asking for mining suppliers to be focused on zero-emission mining. The initial partnership we have in zero-emission mining is with Fortescue Metals Group. We work with them on developing and supplying mining haul trucks that integrate zero-emission power technologies developed by Fortescue Future Industries and Williams Advanced Engineering into the Liebherr T 264 haul truck. We anticipate that delivery of the first haul trucks in this partnership will happen in the coming two years.

What is the role of OEMs in developing new technologies toward a more sustainable way of mining?
OEMs can positively impact the industry by working to offer zero-emission equipment. Liebherr is already working towards developing these zero-emission solutions, such as the Trolley Assist System and a hydrogen engine, which was recently presented at the Bauma tradeshow in Germany.

How is Liebherr addressing the current industry-wide labor shortage?
Skilled labor is the number one threat to the industry today. The labor pool has shrunk, and there are more technologically advanced products. The landscape of what a technician means to the industry has changed. Mining customers struggle to identify operators. As an employer, Liebherr has an attractive benefits package. One of the firm's core values is its employees, we invest in training for our people to continue to grow. From a retention standpoint, automation will be interesting in the coming years: we can operate our dozer via a remote seat, which increases the focus on safety. We hope the more comfortable and safer environment for operators will entice labor to join the industry.

What are Liebherr's USA division's top priorities in the next two years?
We are fully focused on expanding our capabilities to serve the copper and gold markets and bringing new product offerings to those customers. Long-term, our vision is zero-emission, autonomy, and electrification. ■

Jared Pratt

Vice-President of Business Development
EPIROC

Despite the US not being a leader in technology adoption, a shift is happening, as we're able to quantify the productivity gains and cost savings using our customers' operational data.

What is Epiroc's strategy in the Southwest?
The southwestern US is home to some of our largest customers, and is served by three service centers in Temecula, California; Elko, Nevada; and Tucson, Arizona, where we support both the mining and construction businesses in the region. This year has been phenomenal for the industry. A lot has happened in both our underground and surface mining operations, and our customers in those regions have expanded their operations to take advantage of the market conditions. Technology was a key area of investment for them this year. The US has lagged in technology adoption compared with some other mining areas of the world, but we are starting to see substantial increases in adoption rates for our digitization and automation technology.

Can you elaborate on the Elko Exploration Competency Center?
It is an Underground Mining Competency Center serving the exploration business, as well as serving and supporting our underground mining business and strategy in the US. This was a goal we started the year with, and we put a lot of effort into defining what a world-class competency center needs to be. We are starting to see the adoption of new technologies; this competency center will support battery automation and all the advanced technologies that we have in the underground space.

How important is sustainable innovation to Epiroc?
Our new fossil-free underground mine truck presented in December is just one of the examples of how we are helping companies achieve the sustainability goals they have set for themselves. We have developed and acquired products with the latest technology available for the underground and surface to support our customer's ESG goals and objectives. Battery-powered equipment is a big focus for us and we will deliver our newest battery electric vehicles in the US mining market in early 2023. Despite the US not being a leader in technology adoption, a shift is happening, as we're able to quantify the productivity gains and cost savings using our customers' operational data.

What were the main incentives to acquire 3D-P and what synergies have you unlocked since?
The backbone of any autonomous solution is solid connectivity with machines. Poor network coverage and quality are often stumbling blocks preventing successful adoption and growth. Communication has to be good, and it is better if a single entity can determine where the fault is and what changes need to be made. Epiroc and 3D-P work closely together and were a perfect match in that sense, whereas collectively we have the solutions to act as a single provider and create a stable backbone on which to build and scale these solutions. The synergy removes connectivity and network reliability as risks to the success of the projects.

Are you seeing ESG goals driving demand for your services?
ESG is part of every conversation we have with the big companies in the market. Companies realize that we are leaders in this space, and are actively developing solutions for today and the future. There are several opportunities to drive sustainable goals with both existing and new fleets with our products and solutions. For existing fleets, reducing carbon footprint comes from the optimization of the operation and equipment – minimizing fuel burn. Our automation building blocks deliver on this objective. If you can optimize mining operations through digitization and leveraging automation, it is possible to reduce the carbon footprint.

Do you plan any more acquisitions in the future?
Our CEO has made it very clear that we will continue to acquire technologies that complement our existing portfolio to achieve our digitization and automation strategies. We have made and announced eight acquisitions this year, most of them in the area of technology and battery infrastructure. We will continue to take aggressive action both through organic growth and external acquisitions.

What will be the key milestones for Epiroc in Arizona and Nevada in 2023?
The most important milestone in achieving the vision and delivering on the strategies we have set for our Competence Centers in Tucson and Elko, which are both under construction today. We are investing heavily in training our people and improving our capabilities to take advantage of the market opportunities. We will continue to expand our presence in technology solutions and remain a leader in sustainable innovation. ■

Raphael Carmona

Vice President, Sales Area North America - Sandvik Rock Processing Solutions
SANDVIK

We need the crusher stage to be as efficient as possible to provide fine material before entering the milling process, which is one of the most critical processes for a mining site.

Can you briefly introduce Sandvik Rock Processing (SRP) Solutions and its presence in the southwestern US?
SRP Solutions is Sandvik's business area that is dedicated to processing equipment. Today we have in our portfolio the crushing and screening equipment as the first stage of the combination process in the mining segment. We have crushers and screens of different types. We recently acquired two different companies: Kwatani in South Africa, a leading supplier of screens and feeders for mining, and the mining division of Schenk Process Group, complementing our screening equipment portfolio. We currently have a facility in Elko and plan to continue growing our presence.

What does demand look like in Nevada and Arizona?
In Nevada, customers demand more efficient processes and more technology. Our crushers are well recognized as the Avant-guard in terms of technology, so we want that to continue, particularly by implementing remote sensors, monitoring of machines, and ensuring we can reduce electric consumption before the milling process.

Currently, we have a strong presence in Arizona, as we have proven our crushing technology. We have other products, wear plates, used for very high abrasion processes. When it comes to transfer shoots, the HX900 product provides up to 20 times more life than a standard steel plate. These lead to less cost-per-ton and less exposure to risk.

How do your products help mining firms?
The biggest value we add is our crushers' reliable and high reduction rate, along with the high-level monitoring equipment we offer. We need the crusher stage to be as efficient as possible to provide fine material before entering the milling process, which is one of the most critical processes for a mining site. It is about reducing the feed for the milling by reducing either capacity or energy spending.

How important is innovation to SRP?
It is key. The future is here. Technology means more productivity, less exposure to risk, and a better approach to sustainability. SRP has been at the Avant-guard of remote monitoring for crushers for decades. This allowed us to design our remotely operated Automation and Connectivity System (ACS) device, which controls and monitors signals to protect crushers and help operators. This technology is unique and offers customers to connect the crushers and have data in real-time. You can have your device thousands of kilometers away from the mine site, yet have access to live data, and this is the closest we are getting to having AI operating on crushers. When it comes to technology, we want a single software platform gathering all data from the crushers, so the customer to be able to monitor all of them in a centralized space.

How does Sandvik contribute to the decarbonization of the mine?
Productivity, safety and sustainability are related. More efficient equipment will have a positive consequence on one's decarbonization plans. Our crushers already operate with electric motors. But we are always looking to improve the efficiency of the crushing itself, as an efficient crushing stage means a better milling stage, and that stage is the one consuming the most energy. This is how we can provide a better decarbonization value chain.

Can you expand on the adoption rate of new technologies in the Southwest?
Change is coming. Arizona is ahead of Nevada when it comes to adopting new technologies regarding our crushers. Change hurts. It is easier when people start seeing the benefits of technology, then we believe things will get more traction. All our customers want automation and connectivity. Connectivity is becoming the biggest challenge, as people are still a bit skeptical regarding how they can share data and what data they can share, so this is a roadblock to creating trust.

What are SRP's key priorities in the next 6 months?
Growth, whether it is organic or through acquisitions, is on the agenda. We are looking for further acquisitions that make sense from a business standpoint. We look for firms that will help our customers achieve their sustainability target. We want to develop our footprint in Arizona and Nevada and help clients reach their sustainability targets there. ■

Ravi Sahu

CEO
STRAYOS

Could you introduce Strayos' mine-to-mill platform and how it benefits its mining customers?
Strayos' mine-to-mill platform provides AI solutions, machine-sensing solutions, and software solutions to optimize drilling, blasting, and crushing processes as well as site optimization. These drive major improvements to our mining clients' efficiency, profitability, and sustainability.

Our mine-to-mill optimization starts at the first part of the operations value chain: drill and blast planning. Our platform allows clients to optimize their drilling processes and understand the ore body better through the data that has been collected from the remote sensing systems. This data is fed into the site's digital twin and automated CAD analyses and AI Insights are generated in addition to the 3D model. This allows for an accurate and informed digital operation planning process. Clients are able to use the Intelligence not only to optimize drilling operations, but also to understand how drilling interacts with other site operations like blasting, loading, crushing and other site data like geology and design. Our AI also generates predictive modeling, which informs clients about the potential outcomes of their designed processes. We also have extensive blast design, prediction, and analysis intelligence tools that tie into the drilling intelligence and inform downstream operations.

Downstream, we have a suite of ore dilution analysis and movement analysis that helps the operator optimize the loading and hauling processes. Regarding crushing and milling, we have sensing systems which are a blend of hardware and HPI systems installed in the crushing machines to understand their capability. By collecting data at every stage we can create a scenario analysis, for example, of which blast design resulted in better energy consumption at the mill side.

Can you provide examples of the use of Strayos AI solutions by clients in Arizona and Nevada?
In Arizona and Nevada the mines use subcontractors like Drilling and blasting contractors that use our platform. They are more interested in the ore dilution side, the hauling side, and ways to improve ore fragmentation. Our dilution control services are more demanded by gold mines. Companies in both states are really starting to understand and embrace the benefits of AI for their operations, particularly how technology helps them look into the future.

How are AI and machine learning transforming the mining industry?
The mining industry is perfectly suited to take advantage of machine learning: there are actual business outcomes mining companies can derive from data such as safety, sustainability, and efficiency. AI and machine learning are also transforming the industry's approach to safety. Autonomous remote sensing techniques prevent staff from going unnecessarily into harm's way. ■

Ron White

President
3D-P

What synergies have you observed in 2022 since being acquired by Epiroc?
We were acquired by Epiroc in mid-2021, but are still running much as a separate entity doing our own business. The partnership is still expanding to a degree. During 2022 we have focused on a couple of key territories where we could leverage Epiroc's reach, and where Epiroc could leverage our expertise, particularly America and Australia. For drilling autonomy and remote controls, Epiroc and its customers need solid networks. We're helping deploy those networks, and where networks already exist, they are leveraging us to audit those networks, verifying they can support the autonomy or remote-control requirements.

How important are the Arizona and Nevada markets for 3D-P?
These are huge to us. Arizona is 3D-P's original home. Freeport McMoRan is one of our strongest customers globally. Nevada is key for us, we are actively expanding in the state, with a particular focus on 2023. One of our key value propositions is around the wireless network and the connectivity to the fleet. Today the wireless network is often referred to as the "fourth utility". It's critical in the success of many of our customer's primary objects such as productivity and safety enhancements. We offer several levels of engagement. At the lowest level is the network audit we have been providing to many of our Epiroc customers. And we go all the way up to full network design and deployment, similar to our engagement with Freeport, where we are engaged with helping choose the right technology solutions, and then designing, deploying, and supporting their fourth utility.

How is the focus put on ESG initiatives affecting your activities?
We have recently announced our Refurbished Parts program. In the event a customer is replacing their older Intelligent Endpoints, 3D-P will buy them back to reuse any recyclable components. A key part of this program is then based around offering our customers e200 IEP devices where we have utilized those refurbished components. In the event we can offer those devices not only do we pass the component savings on to the customer, but we are extending our standard warranty by a full year. Additionally, the Intelligent Endpoint can act as an onboard datalogger, logging critical vehicle health and utilization information from the fleet. In this capacity, we can help our customers baseline and report on their ESG initiatives and mandates.

How does 3D-P answer the challenge posed by the harshness and remoteness of mine in the southwest?
Our Endpoints may seem expensive because they are custom-built specifically to be capable of handling the extreme temperatures, vibration, and harshness of mining. But looking at the true costs of downtime on equipment, quality technology is a good investment, and our cost gets way down. The industrial and even "ruggedized" devices we find off the shelf today are not built for mining fleets in harsh environments. We will not compromise on quality; we build products that are right for the mining industry. ■

Derek Cooper

Managing Director US/CAN
HEXAGON

How are mining companies in southwestern US using Hexagon's solutions?
How are mining companies in Southwestern US using Hexagon's solutions?
Hexagon has a well-established background in Arizona, dating back to the MineSight software in the 1970s, now known as HxGN MinePlan. Today, mining clients need to make decisions fast. This is where our Power of One approach comes into play. Mines generate loads of information; they are chaotic, busy, and traditionally one individual will have to go through data from several sources and try to analyze it. The Power of One solution is one common set of hardware collecting data and sending it to one centralized platform from one vendor where you can access all the information you need to make the best decisions. Not only is this inherently easier, but on the sustainability side, more efficient decisions lead to less waste. One of our clients is migrating to our Power of One approach and they use a GPS antenna, multiple CPU boxes, multiple screens...That's multiple pieces of hardware connected to multiple data platforms. Recently, they learned they can consolidate all that with one set of hardware, from one vendor with one platform for analytics and reporting. This changes the way logistics work, the way maintenance works, and the way analytics works, and the process can be incremental. Clients can start with our base hardware and build modules as they go. This is the future of the industry—allowing a client to mature on their own schedule and the solution grows with them.

How can Hexagon's AI and hardware innovations help clients minimize downtime?
AI involvement in the decision-making processes makes operations easier and more predictable. When it comes to camera analysis solutions, such as our HxGN MineMeasure solution, clients can detect material sizes at the dig face and make decisions fast, before material reaches downstream equipment. Another example is our semi-autonomous drill solution combining AI and control systems. These solutions replace repetitive human actions that can lead to bad decisions several hours into along shift or a nightshift. The program determines how fast you should run the drill, how much down pressure is needed and provides increased consistency, resulting in better productivity and safeguarding of equipment. In that sense, our partnership with Phoenix Drill Control, that began in February 2022, allows us to develop technologies so clients can get as much as they can from their drills.

What is Hexagon's role in addressing the labor shortage in the mining industry?
The first step is education. Hexagon is partnered with the University of Arizona, and we recently developed a training program for our employees to help staff understand the industry. These days, less people are drawn to working in mines, so the best thing we can do is help the industry highlight its high-tech side. Innovative solutions like our drilling automation will help mining companies attract and retain talent. This particular technology enables a mine to hire someone with little to no experience and make them as productive as someone with 10 years of experience. ■

built specifically to be capable of handling the extreme temperatures, vibrations, and harshness of mining. But looking at the true costs of downtime on equipment, quality technology is a good investment, and our cost gets way down. The industrial and even 'ruggedized' devices we find off-the-shelf today are not built for mining fleets in harsh environments."

Looking to expand its connectivity-related product line in the state is Sandvik's Rock Processing (SRP) division. The firm recently designed a remotely operated Automation and Connectivity System (ACS) device, which controls and monitors signals to protect crushers and help operators. Providing real-time data, this device allows operators to operate the crusher away from the site. Manipulating this hefty amount of sensitive data is key for operators. As put by Raphael Carmona, vice president of sales area north America at SRP: "Connectivity is becoming the biggest challenge, as people are still a bit skeptical regarding how they can share data and what data they can share, so this is a roadblock to creating trust."

Network outside Nevada's main metropolitan areas can be unreliable, and further system interference caused by the number of contractors setting their networks at the peripheries of mine sites can cause downtime for operators. This further increases the need for reliable infrastructure in the state: When autonomy is at play, any wrong interferences will force machines to shut down for safety reasons, meaning a stop in production. "The backbone to any autonomous solutions is connectivity" concluded Pratt.

Arizona: challenging the status quo

Digitalization, automation, and innovation became in recent years inevitable topics to address during mining firms' board meetings, and this trend is forecasted to grow in the years ahead. Data science, modeling, and scenario planning allow decision-makers to make more efficient cost decisions, but these tools provide advantages beyond financial insights. As put by Rockwell Automations' mining, metals, and cement manager Paul McRoberts: "Automation and robotics is the largest growing business in mining in efforts to reduce the workforce and create a more remote, efficient, and safer environment."

The Covid-19 pandemic accelerated a growing trend that emerged in the past decade: digitalization to improve miners' safety and efficiency. Global technological companies with operations in Arizona, such as Hexagon Mining and Strayos, lead the charge in offering Arizona's biggest mining producers process intelligence, platform development, and cloud adoption services.

Investment in Remote Operating Centers (ROCs), remote sensing systems, and autonomous sensing techniques is expected to grow as leaders mine digital transformation for the future. But moving away from the traditional human-centric approach to digital autonomy will not come without hurdles. Among challenges, enabling transformation through flexible leadership will be key to miners' success. Another key topic for companies to consider early on is cybersecurity. Over the past years, cyber threats evolved at an alarming rate for asset-intensive industries, particularly mining.

Mining's automation drive

From the upstream of operations, mines generate vast amounts of data, and technology-focused firms offering integrated platform services are likely to have their hands full. Analyzing data can provide value in terms of improving ore fragmentation and understanding ore dilution and hauling processes. Through its 'Mine-to-Mill' platform, for example, Strayos leverages Artificial Intelligence to optimize clients' drilling, blasting, and crushing processes. "Our platform allows clients to understand the ore body better through the data that has been collected from the remote sensing systems. Prediction modeling based on AI informs clients about the outcomes of their drilling processes," explained Strayos' CEO Ravi Sahu.

Analyzing information on a centralized platform, rather than putting together multiple data points, is crucial to improving an operations' efficiency and minimizing downtime. With 'Power of One', Hexagon Mining offers clients a single set of hardware collecting data and sending it to a centralized platform. Beyond making logistics, maintenance, and analytic processes more efficient, Derek Cooper, managing director of US/CAN at Hexagon, explained: "AI involvement in decision-making processes makes operations more predictable."

Scott Bedell, president of Control, sees similar trends in a growing reliance on technology: "There has been a transition over the last decade to utilizing preventive technology to minimize maintenance costs and downtime."

The adoption rate of new technologies in the mining industry is currently at its highest point, according to Deloitte Insights. Yet charting the path toward automation requires mining leaders to challenge conventional thinking in terms of productivity, investment, and trust in automated processes. "Companies are asking for more return from past automation investments," explained Scott Bedell.

Automation adoption faces a peculiar challenge in Arizona. Changing processes takes time, money, and a different approach to command-and-control management. Such dynamics do not always resonate positively with decision-making teams of mines that have been active in the state for decades, sometimes centuries. "Most mining companies in Arizona have been here long. They have invested in equipment, and possess the older infrastructure and existing systems. Automating an entire fleet is not realistic," explained Derek Cooper.

But beyond Arizonian and company culture borders, the appetite to adopt new technologies also depends on a company's financial situation. "The industry is facing the challenge of willingness to look at – and invest in – new technologies," explained Mining Plus' Scott Britton.

Nevertheless, in an era where remote working is the new norm, leadership teams are presented with the opportunity to streamline the adoption of new technologies on the path toward full automation. In a period of a looming recession and tightening budgets, the responsibility of leadership will greatly influence further decisions to heavily invest in digital solutions that require companies to be patient before reaping the rewards of their investment.

Addressing a blind spot: cybersecurity

Will it take a catastrophic event targeting the mining industry for Arizona-based leaders to list the cybersecurity of their operations at the very top of their concerns? The exponential rate at which cyber threats are growing globally appears to have provoked a shifting mindset among key decision-makers. "The world's leading mining companies now unanimously report that cyber threats are among the principal risks facing their organizations", according to Marsh, a leader in insurance broking.

The mining industry's strategic position in global supply chains makes the industry a viable target for cyberespionage campaigns – BHP was targeted by attackers trying to access market pricing for commodities in 2011. Indeed, 71% of participants in EY's 2021 Global Information Security Survey have seen an increase in the number of disruptive attacks in the past 12 months.

Mining is a critical industry, and all mining organizations today are digital, at least to some extent. In October 2021, mining supplier Weir was targeted by a cyberattack that shut down its core IT systems, resulting in millions of dollars of revenue slippage. Other scenarios in which a hacker could shut down a remotely operated system, drive autonomous trucks into each other, or shut off the air supply of an underground mining operation would be of major risk beyond

> Typically, we find that our design/build projects that integrate new technologies and machinery transform a dangerous and labor-intensive process to become not only far safer, but also more efficient and economical.
>
> 
>
> **Bob Hoey,**
> **President, CAID Industries**

the financial realm for miners. Heightened digital reliance, as seen with the increased use of the Cloud and cloud-based software such as AWS, will increase the likelihood of such scenarios playing out and the need for companies to put mitigation measures in place. "What may not be a priority now might lead to future risks; untested backups can be obsolete and leave a company exposed," commented Ravi Sahu, whose firm Strayos develops security protocols for Arizona-based clients.

Addressing the risks that come with automation will require a change in cyber awareness throughout all layers of mining organizations. Educating staff will be the key to improving cyber resilience throughout the industry. "Most breaches are human error as opposed to hackers penetrating systems on their own", explained Derek Cooper. "The best thing mines can do is educate people to look out for threats themselves. ■

Scott Bedell

President
CALTROL

Can you introduce Caltrol?
Caltrol is an automation company that was founded in 1934. We operate on the West coast and have offices in California, Arizona, Nevada and Hawaii. We provide control systems, valves and instrumentation, reliability programs, software, and multiple engineering and technical services to optimize our customers' operations.

Mining represents around 40% of our activity in Arizona. We work with all the mining majors and several independents. Our experience in this industry has allowed to us to build mining-specific applications and solutions to help our customers with automation modernization, as many of the mines in Arizona have control systems that are coming to end-of-life. We are currently in conversations with Lithium Americas and their project in Nevada, the team working on the Hell's Kitchen project in the Salton Sea.

To what extent are mining companies in Arizona and Nevada adopting automation as part of their processes?
Automation is increasingly becoming more important to operating mines. Companies are asking for more return from past automation investments and additional, relevant data for decision-making. There has been a transition over the last decade to utilizing preventive technology to detect potential failures before they occur. Advanced Process Control is another area where mines could realize major operational improvements and we are starting to see more interest in this area.

Remote mining and autonomous mining are increasingly important. There are efficiency and safety gains, as well as an opportunity to gain real-time data. This has led to an afflux of data into the cloud and we are in discussions with several of our clients about how to best manage and utilize it. In many cases, what started as a pre-emption to predict failure has left us with data we can now use for optimizing plant operations and reducing emissions.

What are the main trends that will continue to drive growth for Caltrol in the Southwest US?
One of the trends is modernizing existing automation infrastructure and leveraging OT Data in the cloud. Another trend is that customers are looking for more industry-specific solutions and service support. Without referring to sustainability as a trend, the focus in this area has increased drastically.

The West Coast is leading the country in innovation around the energy transition, the transition to electric vehicles, and other alternative processes, such as organic plastics. We are partnering with these leading companies to help automate their innovations. Caltrol has participated in nine green diesel conversion projects, and we worked with SoCal Gas on their Hydrogen Home of the Future. We are helping our long-time customers in traditional industries with their ESG journey and environmental goals by providing point solutions that reduce or eliminate emissions or water usage. ■

Braden Lusk

President Americas
DYNO NOBEL

Could you share some details of Dyno Nobel's latest innovations in blasting technology?
As technology advances, we have developed some unique products. One of these is ΔE (DIFFERENTIAL ENERGY), a proprietary bulk explosive. We are also applying ΔE2 (Delta E Squared) technology, which utilizes data from drills or other sources that characterize rock properties to allow targeted placement of energy in the blast hole. It enables mine blasting load plans to be sent directly to our state-of-the-art bulk emulsion trucks to help ensure boreholes are loaded as designed using our DynoLogix software. We have seen great results with these technologies. As we progress, we will use these materials combined with our latest generation electronic detonating systems, our DigiShot Plus 4G, to control the blasting outcomes the way we need to.

In addition, we are investing heavily in developing technologies related to more efficient energy use and looking at automated loading and wireless initiation systems.

What can you tell us about DigiShot Plus 4G system and how digitalization is shaping the company's innovation focus?
The DigiShot system has evolved over several years and the Digishot Plus 4G system is top of the line in the market. One of our products that work well with DigiShot Plus 4G is our Commander Blaster System. It provides flexibility for larger mines in their blasting initiation sequences and remote firing.

Digitalization affects every aspect of the company. We are working to understand how our customers can improve their milling processes by providing real-time data-driven information. For example, using ΔE2, we can program the drilling and loading truck to deliver the right amount of explosive energy to each hole at different levels. Then, we receive digital records for our blast reporting. This wealth of data over the life of a mine allows us to understand and track the blasting history and gauge efficiency.

What impact can Dyno Nobel have on the productivity of mining operations?
Our goal is to discover our blasting procedures' outcomes and change our processes to provide the customer with the desired outcomes. This requires strong relationships, expertise on the side of both companies, and a digital interface that makes it easier to map and implement the desired results. So, being able to integrate previously disconnected systems and being able to connect data from machines at the mine site to our systems has been critical.

What is Dyno Nobel's approach to training and education, and could you give some insights into the Nobel Academy?
Dyno Nobel has launched several programs inside the company through what we call the Nobel Academy. It starts with our blaster and operator training and goes all the way to leadership training. Dyno Nobel not only trains its staff but also our customers' employees on how to safely operate with our systems and products. ■

> **We do customized supply to our customers' drawings and have a mechanical engineer who is extremely conversant in designing castings.**

Howard M. Portz

CEO
WESTERN CAST PARTS

Can you give a brief overview of Western Cast Parts?
Today, WCP remains a small company with only four people permanently on the team. Our geographical footprint spans across Canada and the US, with also some business overseas. Most of our suppliers are either in in China, India, or the Middle East. We like to visit our suppliers on a regular basis to ensure that they are providing the right materials, testing, and everything that we need to supply the mining industry and major equipment manufacturers in North America.

Can you elaborate on the products WCP offers to the mining industry?
When I established WCP, our focus was more on manganese castings; this includes crusher parts, mill parts, and miscellaneous things like feeder pans. Over the years, the company has broadened our product portfolio to include alloy steel, high chrome irons, carbon steel, heat resistant steels, and sometimes on request nonferrous metal products like brass and bronze. We do customized supply to our customers' drawings and have a mechanical engineer who is extremely conversant in designing castings.

How has demand for your products evolved?
The mining industry is cyclical, and therefore in our 27 years of business we have seen peaks and valleys. That is the way it has always been, and we have set up the company to be adaptable to this. 99% of our products are made specifically to customers' orders. We thus do not hold inventory, which helps us keep our costs low and maintain a competitive advantage in the industry. We are able to react quite quickly to the trends. For example, commodity prices have been great over the past year and our business reflects that – we have been extraordinarily busy. With global supply chain challenges experienced over the past few years, we have been as upfront as possible with our customers, and we have all worked well together to mitigate this challenge to still make things happen.

What is WCP's R&D approach and innovation strategy?
Since WCP is basically a brokerage company, we rely on our partner foundries for R&D. They do a great job in working within their companies to try and improve the materials we work with, which we can then pass along to our customers as applicable. ■

Drilling, Energy and Mining Services

A compressed but highly resilient backbone

Image courtesy of Barrick

Operators in the southwest can rely on a wide array of service providers that act as the industry's backbone in overcoming infrastructure, drilling, and access to equipment challenges. Still surfing the exploration wave seen in Nevada in 2020-2021, Nevada-based drillers had their hands full in 2022, with no signs of decreasing tempo as drilling campaigns start in Q1 2023. Globally, drilling activity was near a 10-year high in 2022, a trend that does not seem to have decreased despite inflationary pressures and fear of a recession. This is particularly the case for gold projects, highlighting Nevada as a hub for growing activity throughout the industry's value chain.

Copper, gold and silver majors' intent on capitalizing on booming prices in 2020-2021 led to a sharp rebound in demand for drillers in Nevada. However, supply chain disruptions, a scarcity of both available and trained labor, and new methods related to lithium drilling continue to present a challenge.

The robust outlook for metal demand will force firms to mine deeper underground. Operators will need increasing services and supplies, including mining fluids – such as water-based mud, oil-based mud, and air – to assist with the drilling of boreholes underground. Based in Spanish Springs, Jentech Drilling Supply proposes high-quality drill rods to mining firms, and besides acknowledging a heightened demand for these rods, general manager Steve Antonini noticed the demand for drilling fluids: "This space has evolved over the years and today, we have various kinds of fluids and mud engineers who assist drillers to mix the right fluid for the specific ground conditions at the site. As mining continues to go deeper underground, drilling fluids will evolve as they become more and more needed every day."

Boart Longyear, the world's leading provider of drilling services, saw a staggering 18% increase in revenue in H1 2022. The firm saw increasing demand for its surface core and RC drilling services in the southwest, with, for instance, an updated drilling program at South32's Eastside project's East Pediment in Nevada, consisting of approximately 20 holes for a total of 5,000 additional meters. Asked about his outlook regarding future demand as prices remain high and companies need to drill to meet mineral demand, CEO Jeff Olsen answered: "I believe this increased drilling activity will continue into 2023, and we are anticipating strong business for the foreseeable future."

Drillers have found in technological advancements answers to both inflationary pressures and a scarce labor pool. Used along the Carlin trend, Boart Longyear's TruScan field drill sample system uses unique XRF technology and helps mining firms to adapt their exploration stance and improve cost-effective decision-making. Technology is also a way to achieve workforce diversity which is much needed in the industry. As put by Olsen: "Technology gives women access to do jobs previously seen as inaccessible. Today, we have women in all parts of our operations - some drill crews are led by women, and they do heavy equipment maintenance."

Servicing the infrastructure for the energy transition

Nevada is renowned for its quality infrastructure that provides easy access to its remote mine sites, such as paved roads and electricity. The state, however, faces broadband and connectivity challenges, the scale of which could threaten the good development of mining operations should sporadic outages occur. Indeed, the Elko area is the third worst-served area in the US. Serving mines takes long lines that need to run along a vast territory, exposing them to outside risks like weather or wildlife, further highlighting the necessity to modernize the power grid.

NV Energy, which serves about 90% of Nevada's electricity needs, is up to the challenge. In 2022, the firm launched the largest infrastructure investment it has ever made; the Greenlink Nevada transmission project. It should run from southern Nevada, up the west side to the Fort Churchill area (where Nevada Copper is located), and from there it will run across the northern part of the state to Ely, near Robinson. The firm works with mines to increase use of renewable energy and is actively looking at providing solar panels at mine sites and combining them with battery storage to advance customers' ESG initiatives.

NV Energy president and CEO Doug Cannon stated: "People have been talking about electrification for a while, but not many states have taken the lead on it. Here, we have the Nevada Electric Highway that allows someone to drive from Reno to Las Vegas and that person will see there is access to electric charging infrastructure along the entire route. We have EV chargers that run from our border with Utah to the one with California. This defeats the concept of range anxiety."

Down the line, service providers are essential in making sure mines can access key parts needed for their operations to function. This is particularly relevant as the whole industry faces supply chain issues and disruptions due to geopolitical and environmental events. Based out of Denver, but with an extensive presence in Nevada and the southwest, particularly at the Robinson Mine, CAP Logistics built a name for itself by transporting mining supplies and equipment to the most remote locations. Speaking of the importance of delivering raw parts to mines, founder and CEO Gayle Dendinger explained: "As Nevada mines are remote, we have years of experience shipping heavy equipment to and from uncharted and unpaved locations. Downtime for a mine can be hundreds of thousands of dollars per day, if not per hour." ■

> Nevada has a competitive advantage in its strategic location. We have both I-15 and I-80, which allow for tremendous ground access. We have the Nevada Electric Highway that allows someone to drive from Reno to Las Vegas with access to electric charging infrastructure along the entire route

Doug Cannon,
President and CEO, NV Energy

> I believe this increased drilling activity will continue into 2023, and we are anticipating strong business for the foreseeable future.

Jeff Olsen

CEO
BOART LONGYEAR

Can you give an overview of Boart Longyear and the services the company offers mining companies in the Southwestern US?
Boart Longyear is one of the largest global drilling companies, offering drilling services, drilling products, and innovative technologies to the mining sector. We offer our full range of services in the Southwestern US, with surface coring and reverse circulation (RC) drilling being most in demand in both Arizona and Nevada. We also do a significant amount of sonic work, as well as water work. Boart Longyear has offices in Phoenix, Salt Lake City, and in Elko, Nevada. Quite unique is that we have an extremely large fleet of our LF 160 Surface Coring Drill Rigs in Southwestern US. These rigs have all the safety features customers are looking for and are therefore high in demand. One of the first companies to start using the LF 160 was South 32.

What are the reasons behind Boart Longyear's 18% revenue increase in the first half of 2022?
Our customers, particularly explorers, are in a good place. Most of the mining companies have been de-levered over the last few years and do not carry a lot of debt, but in the lean years, they used some of their reserves to save money and now need to replace those reserves. Commodity prices are currently strong, particularly copper and gold, and companies are again out drilling as demands continue to increase. I believe this increased drilling activity will continue into 2023, and we are anticipating strong business for the foreseeable future.

How is Boart Longyear mitigating current inflationary pressures?
Many of our products are significantly made from steel. Although inflation appears to be a longer-term situation, supply chain issues are starting to alleviate, and we believe this trend will continue. Drilling services have cost pressure in terms of higher consumable costs, and labor inflation is a big cost pressure. Energy is still an issue for us as it is also a significant part of our cost base.

Inflation can to some degree be mitigated through the benefits of using technology. For example, our TruScan technology has demonstrated that mining companies can significantly save money by changing their exploration processes and improving the effectiveness of the information that they gather using those technologies. Boart Longyear is also introducing our downhole survey product, TruGyro, into the market this year.

To what extent is ESG a key business driver for Boart Longyear?
Boart Longyear is focused on having strong ESG practices and we are committed to being a leader in this space. In 2022 we published our first ESG report and have strong ambitions to continue down this pathway. We are putting in the effort to increase diversity in this sector through new technologies. Technology gives women access to do jobs previously seen as inaccessible. Today, we have women in all parts of our operations - some drill crews are led by women, they do heavy equipment maintenance, and we have female welders. Our new technologies and the way we are educating people about the possibilities of working for us is opening a whole new part of the workforce, which is a great benefit in a period where access to workers is limited.

How do you incorporate safety and training measures into your day-to-day work?
We have the strongest safety track record in the drilling industry. Drilling has a lot of risks to it, and we spend a significant amount of effort in our safety processes and systems. Also, new technologies can engineer out risks on safety that we could not before. For example, rod handling applications that allow for lower lifting demands, and automation technologies allowing drill rig operators to be further away from the rig.

What challenges and opportunities do you see operating in Arizona and Nevada as mining jurisdictions?
There are drought conditions in the Southwestern U.S., but many times as mining companies go deeper underground, they actually have the opposite problem and need to dewater those mines. Boart Longyear assist clients in de-watering, helping develop new areas for mining underground. The attractiveness of Arizona and Nevada is primarily the existing infrastructure for getting to mine sites and operating the mines. ■

> Nevada is a relatively mature market where mines have targeted and mined the "low-hanging fruit," those large oxide-ore bodies that can be effectively treated by cyanide heap leaching.

Steve Cochrane

US Sales Manager
CYANCO

How important is Nevada to Cyanco's operations?
Over 30 years ago, Cyanco made the strategic decision to build our production facilities in the center of Nevada's mining country, and our Winnemucca plant remains the heart of Cyanco's operations today. We manufacture both Solid and Solution sodium cyanide at this facility and are very close to many of our North American customers. Because of our proximity, we have been able to develop a robust Nevada supply chain that is unmatched for its reliability of supply, including vendor-managed inventory controls at the mines.
The highest concentration of mines in Nevada is located along the I-80 corridor and in the Tonopah and Eureka regions. These mines use a lot of reagents, so it is essential for Cyanco to deliver to them daily. Despite ongoing global supply chain constraints, Cyanco has leveraged the expertise of our logistics and supply chain teams, and we're proud to say that we did not miss any customer shipments, even throughout the worst days of the COVID-19 pandemic. Our infrastructure in Nevada, alongside the road and rail systems, plays a large role in the success of Cyanco and the mining industry here.

How is Cyanco's Applied Technology Team helping minimize the environmental impact of cyanide?
The focus on ESG in today's mining culture is key to the industry's effort to minimize environmental impact. Cyanco actively collaborates with mines to improve their ESG performance, starting with the optimization of their cyanide usage. When mines use the optimal volume of a reagent to extract precious metals, they gain production efficiencies on the front end and reduce waste at the back end. We also play a role in the final phase of the cyanide circuit, helping customers design and implement efficient detoxification systems, so no harmful materials or pollutants are released into the environment. Cyanco also helps customers achieve and maintain their International Cyanide Management Code (ICMC) certifications. This voluntary certification program helps mines safely use cyanide and limits the risk to human health and the environment. As a founding member of ICMC, Cyanco also holds itself to the highest safety standards including best-in-class production and maintenance procedures, packaging that minimizes the risk of spills or incidents, and the use of ICMC-certified transportation carriers who follow optimized supply chain routes when delivering products.
Our Applied Technology Group also invests in developing innovative new technologies, and we are actively looking at non-cyanide lixiviants right now. Cyanco's joint technology agreement with Cycladex, for example, is focused on the treatment of refractory ore, which is more difficult to process with traditional oxidation processes. We see an opportunity to re-process tailings that still contain valuable minerals, a concept that is very aligned with the new circular economy and the push to reduce resource consumption.

Can you expand on Cyanco's social initiatives?
Cyanco was the first vendor to join Nevada Gold Mines in their I-80 Program initiative, which helps businesses along the I-80 corridor with low-interest loans. Another example of our involvement is Cyanco's sponsorship of a laboratory-training opportunity called "STEM Sisters." This program is run by the University of Nevada, Reno and it allows young women coming from socio-economic hardship to participate in real-world laboratory experiences in areas such as microbiology, immunology, and thermal ecology. STEM Sisters also provides them with the opportunity to experience STEM-related fields beyond the lab and helps encourage more female engineers to join the mining industry. Our vision is to build technical skills and opportunities for Nevadans and fill future jobs in the growing mining and related economy.

The sodium cyanide market is set to reach $3 billion by 2031. What are the drivers behind the planned exponential growth?
Nevada is a relatively mature market where mines have targeted and mined the "low-hanging fruit," those large oxide-ore bodies that can be effectively treated by cyanide heap leaching. However, there are many areas in the world with new mining projects on the horizon to supply the growing demand for precious metals. For example, more operations around the world are targeting underground sulfide ore bodies that require treatment with autoclaves and roasters to oxidize those ores for cyanide treatment. There are also several large underground projects being developed in Nevada to extend the lives of current mining operations.
In addition, with the rise in gold prices over the years, ore that used to be categorized as "waste rock" is now considered to be economically viable ore. Technologies are being developed to retrieve minerals from previously mined materials, building on efforts to minimize mining's footprint and operate in a sustainable manner. Cyanco is taking the lead on developing new technology that will help mines turn "waste ore" into a new source of minerals. ■

Innovation in Geology

New approaches in exploration prompted by brine deposits

Image courtesy of Coeur Mining

Southwestern-based innovative minds are likely to remain at the forefront of addressing the secular-long challenge of interpreting and characterizing mine sites. Variable soil, rock strata, and complex host-rock formations all contribute to challenges when exploring areas of mineralization. As population growth, urbanization and climate change trends push the demand for mineral resources upwards, Nevada emerges once again as a leader in innovative approaches to leverage the earth's crust's resources. In November 2022, the USGS announced US$1.45 million in funding to conduct geologic mapping, airborne geophysical surveying, and geochemical sampling in Northern Nevada to advance scientific innovation and map critical minerals.

Technological prowess that can sustain evidence of decreasing exploration risk will be one of the most important trends to watch for in the coming years. Mineral exploration is a high-risk business (commonly measured by three successes in a thousand projects), profiles in the short term, and is complicated to budget. As such, juniors are increasingly shifting their focus towards geology companies that have the expertise to leverage new technologies and decipher the millions of rows of historic data trapped in the archaic databases they will have gathered from acquiring a project.

Breakthrough technologies for mineral exploration

Nevada is no stranger to technological breakthroughs pioneering geological exploration. Almost a century ago, the Induced Polarization (IP) method began for the exploration of porphyry copper in the state and neighboring Arizona. This revolutionary geophysical method measures the chargeability of the subsurface by using voltage decay of a produced current and was in the 1950s a breakthrough in discriminating between low-grade and large-scale copper deposits.

Much of the new geophysical approaches are today focused on lithium discovery. One of the reasonings behind the foundation 2021 of Castillo Geophysical was applying seismic image tools developed by the oil and gas industry for a rapidly transforming lithium market. Consisting of a network of specialized PhDs, Castillo Geophysical focused on high-resolution data processing, while leveraging its connections to academia and scientific labs to access the latest technology. In November 2021, Ameriwest Lithium, an emerging junior, contracted the firm to reprocess seismic data at its Railroad Valley project using the latest techniques. Chris Castillo, CEO, explained his approach: "We interpreted seismic data, MT, and gravity in tandem to investigate complex groundwater interactions that are evidenced by geothermal springs in the valley."

> Digital transformation is reshaping the mining industry. As we have got deeper and the grades have declined, we have relied on innovation to sustain the industry.

Tom Meuzelaar,
Owner, Life Cycle Geo

The up-and-coming lithium capital of the US is forecast to continue resembling a testing ground for tens of geologists applying the latest innovations to upscale Nevada's unique lithium-rich basins that act as natural salt concentrators. The booming activity seen in 2021 and 2022 regarding seismic data interpretation is an indicator of the efforts ahead in 2023. Asked about geophysical innovations specific to the state, Christ Castillo shared: "A lot of it has to do with data processing. Globally, what sets apart the most productive lithium plays is the presence of subsurface hydrothermal input."

Innovation is also prevalent on the electromagnetic side, and this trend is unlikely to wane anytime soon. Controlled-source Audio frequency Magnetotellurics (CSAM), a method popularized in the 1990s, was leveraged by Lithium Corporation at their San Emidio lithium-in-brine prospect in Washoe County in November 2022.

Unlocking the means to leverage AI and computation

Visualizing the future of geological mineral exploration comes at a cost, often a significant one. Combining electromagnetic methods with multi-channel seismic approaches into a digitalized format to better picture the conductivity structure below the surface is a process in the early stages. The upstream investment in time, resources and capital is significant. Announced as the future new normal in geological surveys, machine learning, AI, and computation are slowly climbing out of the infancy stage, but the road remains long. As put by Chris Castillo: "Technologies require a large investment in computation, and the methods that will make this technology accessible are still in development."

Data science has the potential to unlock determining value throughout the life cycle of a project in its quest toward permitting. With a background in geochemistry, geology, and data science, Tom Meuzelaar founded Life Cycle Geo in 2019 to help mining firms characterize materials present in their deposits, along with interpreting large geologic datasets. This work is key for explorers to build the best version of their mineral resource estimation and guarantee NI 43-101 compliance, for instance. Mineral characterization through AI practices presents key advantages for explorers; fundamentally, misclassified materials result in time, resource and money loss.

Undoubtedly, machine learning algorithms able to predict the distance to mineralization are a game-changer. Operators that have historically struggled to recognize the complex sequence of mineral alteration are now presented with the power of data science to limit margins of errors that impact their margins. Explaining the challenges AI helps solve, Tom Meuzelaar explained: "The first data collected for a project is often surface geochemistry, followed by drill hole assay. This is a rich dataset, as operators are getting 30 to 50 elements from the periodic table. Assay data collection continues throughout the life cycle, so the primary thesis behind material classification is using machine learning to identify material types with all the assay data that has been collected." ■

> Nevada's unique extensional geology produces an array of small separated basins that act as natural salt concentrators. The exploration space will consolidate rapidly within these basins as hydrothermal inputs are discovered and then expand into other smaller basins in the region.

Chris Castillo,
CEO, Castillo Geophysical

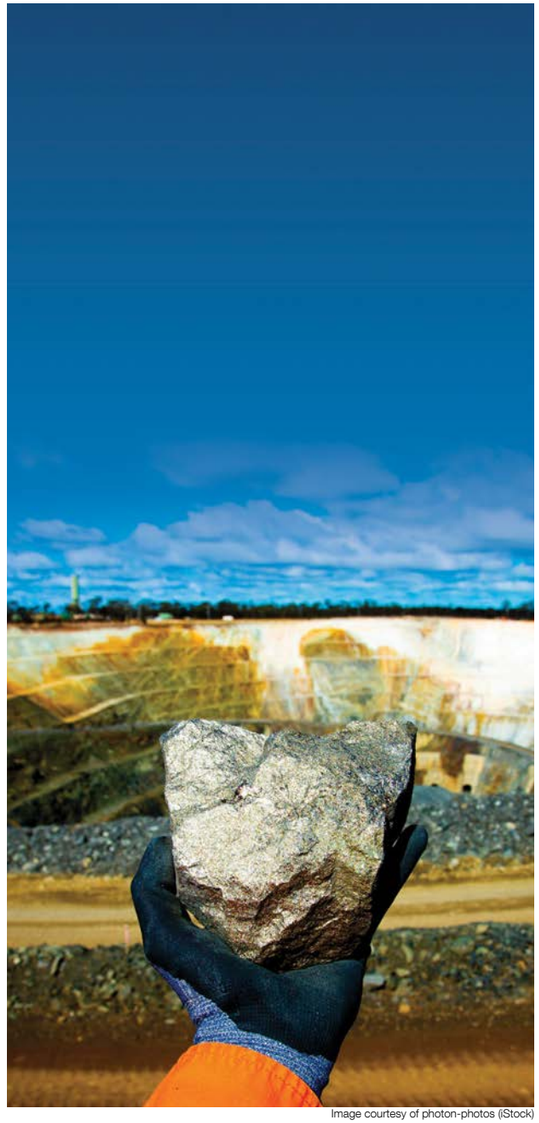


Image courtesy of photon-photos (iStock)

3D-P	Energy Fuels	Nevada Lithium Resources
ACME Lithium	Epiroc	Nevada Sunrise
American Exploration & Mining Assoc	Excelsior Mining	NevGold
Ameriwest Lithium	F&H Mine Supply	New Moly LLC
Ames Construction	Faraday Copper	Newmont (Ontario team)
AMIGOS	Florence Copper	NGM
Arizona Mining Association	Forsgren Associates	Northern Dynasty Minerals
Arizona Silver Exploration	Faraday Copper	NV Energy
Arizona Sonoran Copper	Florence Copper	NV Gold Corp
Ausenco	Forsgren Associates	NVMA
Barksdale	Freeport McMoran	OTC Markets Group
Barr Engineering	Getchell Gold	Pan American Energy Corp
Barrick Gold (Ontario team)	Global External Relations	Piteau associates
Bell Copper	Gold Springs Resources	Practical Mining
BLM	Gold79 Mines	Rema Tip Top
Boart Longyear	Governor's Office for Eco. Dev	Resolution Copper
Bradda Head Lithium	Haley & Aldrich	Respec
Bravada Gold	Heavy Metal Equipment	Ridgeline Minerals
Broadbent Associates	HeliosX	RK Equity
Business Council Nevada Canada	Hexagon	Robinson - KGHM
CAID Industries	Honeywell	Rockwell Automation
Cap Logistics	Hudbay	Sandvik
Cashman Equipment	Hycroft Mining	Silver Bullet
Cast Parts	I-80 Gold Corp	Silver One Resources
Castillo Geophysical	Infinitum Copper	Silver Range Resources
Civil & Environmental Consultants	InfoRight	Sitech Intermountain
Clearflow Group	Ioneer	Small Mine Development
Code Steel	KCA	SRK Consulting
Cœur Mining	Kinross Americas	Stantec
Comstock Inc	KP Exploration	Strayos
Copper Fox Metals	Liebherr	Summa Silver
Cyanco	Life Cycle Geo	SWCA Environment
Century Lithium	Lithium Americas	Tierra Group
Darling Geomatics	MacLean Engineering	Turner Mining
Dyno Nobel	Millcreek Engineering	Viva Gold
Eagle Mountain	Millenial Precious Metals	Western Cast Parts
Electra (Ontario team)	Mining Plus	Western Rare Earths
Element79 Gold	Minquest Ltd	Westward Gold
Elevation Gold Corp	MMR Constructors	WSP
Emergent Metals Corp	Nevada Division of Minerals	Zacapa Resources

Production and Management Team

Senior Project Director: Lucrezia Falcidia
Journalists: Alexander Stonor; Susana Isotupa
Executive Editor: Mungo Smith
Operations Director: Miguel Pérez-Solero
Graphic Design: Kaori Asato and Angel Vega (layout), Gonzalo Da Cunha (cover), Özgür Ergüney (ads and infographics), Andrea Suárez (infographics)
General Manager: Alfonso Tejerina


LF


AS

Your opinion is important to us,
please be in touch to share your comments on this report: on this report: info@gbreports.com
For updated industry news from our on-the-ground teams around the world,
please visit our website at gbreports.com, subscribe to our newsletter through our website,
and follow us on Twitter (@GBReports) and LinkedIn (gbreports)

Thank you

We would like to thank all the executives and authorities that took the time to meet with us.
Also, special thanks to:

NEVADA MINING ASSOCIATION
www.nevadamining.org

ARIZONA MINING ASSOCIATION
www.azmining.com

AEMA
www.miningamerica.org

AMIGOS
www.miningamigos.com

GLOBAL BUSINESS REPORTS