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This month, E&MJ explores some of the recent advancements with hydrometallurgy. On the cover, a Jetti Resources facility at Capstone's Pinto Valley mine in Arizona recovers copper from a rejuvenated, historic heap-leach system. (Photo: Jetti Resources)

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#### FROM THE EDITOR



Steve Fiscor Publisher & Editor-in-Chief

# Latest Bull Run or the Next Super Cycle?

With the exception of gold and silver, the prices for most metals rallied during February (See Markets, p. 80). Copper rose above \$4/lb. Cobalt prices also surged. What miners need to determine is whether this is the beginning of another super cycle or just another upswing of the boom-andbust cycles that commodities endure. If it is the beginning of another super cycle as some suspect, then now is the time to make the investment in new projects and production capacity. If they are wrong, then they will just be com-

mitting to a raw materials overhang when demand cycles downward. The fortunes of mining companies have been won and lost on these gambles.

From where it stands now at the beginning of 2021, the mining industry is facing a glass full or half-full future. Half-empty should be in the rearview mirror for a while. Economists and analysts are now coming to grips with the amount of metal the green revolution will require. The question is whether today's prices are sustainable, meaning they reflect this future demand, or are they the result of pent-up demand from the COVID recovery.

China's quick recovery has some economists forecasting the country's economy overtaking the U.S. Other forecasts are saying the \$1.9 trillion COVID relief package could spur as much as 6% GDP growth in the U.S. And, that is above and beyond the recovery the country would have experienced from herd immunity and increased vaccinations as a locked-down economy reopens. All of this bodes well for the companies that provide natural resources.

Then, there is the shift toward battery-electric vehicles. Former Xstrata CEO Sir Mick Davis recently created Vision Blue Resources to acquire a portfolio of strategically significant investments in battery mineral assets (See Leading Developments, p. 6). His vision for the future is remarkable. "The impact of rapidly growing demand for battery minerals is likely to lead to a surge in demand for specific commodities that will dwarf anything the mining industry has ever seen before, including the commodity impact of China's industrialization in the last 20 years," Davis said. "In combination with this surge in demand, a failure to develop new sources of supply highlights the need to ensure that critical mining assets are immediately financed and brought to production." Vision Blue said it is positioned to provide an alternative source of capital to rapidly advance projects using the experienced technical and financial team it has available and leveraging its credentials and industry relationships.

One thing is for certain. A major infrastructure investment is needed to support this transition. Whether the electricity is generated by fossil fuels or other sources, demand is already testing the limits of the grid. One has to look no further than what happened in Texas, the energy capital of the world, during February or the rolling blackouts in Europe and California last summer, to see an electrically powered future without an investment. The materials that will be required to improve and power the grid will come from mining.

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### **USFS Rescinds EIS for Resolution Copper Project**



The USDA directs the U.S. Forest Service to withdraw a notice of availability and rescind the final environmental impact statement and draft record of decision that was just issued on January 15 for the Resolution Copper project (above). (Photo: Resolution Copper)

On March 1, the U.S. Department of Agriculture (USDA) stopped the Resolution Copper Project in Arizona in its tracks. The USDA directed the U.S. Forest Service (SFS) to withdraw a notice of availability and rescind the final environmental impact statement (EIS) and draft record of decision that was just issued on January 15.

Since it released those documents, the agency said it has received "significant input" from collaborators, partners and the public. The pre-decisional objection period was also stopped.

The project, owned by Rio Tinto (55%) and BHP (45%), will reuse the historic Magma mine and is proposed on Oak Flat, a site sacred to numerous federally recognized tribes in the southwest. The department said it was taking this step to provide an opportunity for the agency to conduct a thorough review based on significant input received from collaborators, partners and the public since these documents.

The decision also comes on the heels of a presidential memorandum on tribal consultation and strengthening nation to nation relationships. The USDA said additional time was necessary to fully understand concerns raised by tribes and the public and the project's impacts to these resources and ensure the agency's compliance with federal law.

The publication of the final EIS triggered a 60-day window where 2,422 acres of Tonto National Forest, including 760 acres at Oak Flat, must be exchanged with land owned by Rio Tinto PLC and BHP Copper Inc. The land exchange mandate was included in a rider attached to the fiscal year 2015 National Defense Authorization Act. The Resolution Copper mine could not be built without the transfer of Oak Flat from public ownership where federal laws would prohibit its destruction into private ownership where these laws would not apply.

The USFS said it understood it has limited discretion related to protection of Oak Flat and long-term protection of the site will likely require an act of Congress.

The USFS did not give an anticipated timeline for the review, but said consultations like these typically take several months. In a company statement, Resolution Copper said it was evaluating the decision. "In the meantime, we will continue to engage in the process determined by the U.S. government and are committed to ongoing consultation with Native American tribes and local communities," it said.

Resolution Copper started the permitting process in 2013, with the Forest Service leading a comprehensive, independent review under the National Environmental Policy Act (NEPA), over seven years and multiple administrations.

### Newmont Reports 2020 Mineral Reserves of 94M Gold Oz

Newmont Corp. reported gold mineral reserves of 94.2 million attributable ounces (oz) for 2020 as compared to the company's adjusted 95.7 million oz at the end of 2019. Newmont exceeded its 2020 conversion target by replacing 80% of all depletion and maintaining its industry-leading position with the largest gold reserves.

"As the world's leading gold company, Newmont has an exceptional history of exploration success and a track record of consistently delivering on our commitments," President and CEO Tom Palmer said. "In 2020, we added 6 million oz of gold reserves overcoming the challenges of an unprecedented year. Newmont's ability to replace reserves is underpinned by our disciplined operating model and world-class portfolio, which will support stable production for decades to come."

Newmont said its reserve base has more than 90% of gold reserves located in top-tier jurisdictions, an operating reserve life of more than 10 years and average reserve grade of 1.03 grams per metric ton (g/mt).

In addition, Newmont has substantial exposure to other metals, with nearly 65 million gold equivalent oz from copper, silver, zinc, lead and molybdenum.

Depletion of 7.5 million oz was largely replaced by additions before revisions of 4.9 million oz and net revisions of 1.1 million oz primarily from mine plan improvements. Additions before revisions of 4.9 million oz through exploration met the company's target despite challenges created by the pandemic with travel restrictions and additional safety protocols. Ahafo added 800,000 oz from drilling at Subika Underground. Tanami added 600,000 oz from additional drilling at Auron and Federation. Merian added 600,000 equity oz primarily through drilling at the Merian No. 2 open pit. Nevada Gold Mines added 800,000 equity oz and Pueblo Viejo added 700,000 equity oz.

Favorable net revisions include 1.7 million oz at Boddington due to the conversion of a layback in the North Open Pit from resource to reserve, partially offset by net negative revision at NGM of 400,000 oz and revisions at Ahafo, Cripple Creek & Victor (CC&V), and Musselwhite from mine model and design updates.

#### Endeavour Completes Teranga Acquisition to Create New Gold Producer

Endeavour Mining announced the successful completion of the acquisition of Teranga Gold Corp. to create a new top 10 global gold producer. "We are delighted to successfully complete our acquisition of Teranga and would like to welcome the teams at the Sabodala-Massawa and Wahgnion mines to our organization," Endeavour President and CEO Sebastien de Montessus said. "We look forward to quickly integrating our new assets into our West African operating platform and delivering on the anticipated material synergies."

The company's production base is diversified across six core operating mines in three countries. It also has a development pipeline of six greenfield projects and the largest exploration portfolio in the region, according to de Montessus.

Pursuant to a court-approved plan of agreement, shareholders of Teranga received 0.47 of an Endeavour ordinary share for each Teranga common share held, resulting in the issuance of nearly 79 million Endeavour shares, with Endeavour now holding a total of more than 243 million Endeavour shares outstanding. As a result of the arrangement, Teranga has become a wholly-owned subsidiary of Endeavour.

Along with the completion of the Teranga acquisition, Endeavour has closed the previously announced \$800 million debt refinancing package. The refinancing consists of an amendment and extension of Endeavour's existing \$430 million revolving credit facility (RCF) and a \$370 million bridge facility. The refinancing proceeds have been used to retire Teranga's various higher cost debt facilities. Endeavour intends to downsize its Bridge and/or RCF facilities following the closing of the \$200 million La Mancha investment. The La Mancha investment, representing more than 8.9 million shares, is expected to close by the end of March. Following the investment, Endeavour will have approximately nearly 252 million shares outstanding with La Mancha holding an interest of approximately 19%.

### Fraser Institute Report: Nevada Most Attractive Mining Jurisdiction

Nevada ranks as the top jurisdiction in the world for mining investment based on the Fraser Institute's 2020 annual survey of mining and exploration companies. The least attractive mining jurisdiction was Venezuela.

The report is the result of a survey sent to individuals in the industry to assess how mineral endowments and public policy factors such as taxation and regulatory uncertainty affect exploration investment. Responses are tallied to rank provinces, states, and countries according to the extent that public policy factors encourage or discourage mining investment.

The top jurisdiction in the world for investment based on the Investment Attractiveness Index is Nevada, which moved up from its third-place ranking in 2019. Arizona followed in second, which ranked ninth in 2019. Saskatchewan climbed eight spots from 11th in 2019 to third in 2020. Western Australia ranked fourth this year after topping the ranking last year, and Alaska dropped a spot from fourth in 2019 to fifth in 2020. Rounding out the top 10 are Quebec, South Australia, Newfoundland and Labrador, Idaho, and Finland.

When considering both policy and mineral potential in the Investment Attractiveness Index, Venezuela ranks as the least attractive jurisdiction in the world for investment followed by Chubut, Argentina,



While geologic and economic considerations are important factors in mineral exploration, a region's policy climate is also an important investment consideration.

An overall Investment Attractiveness Index is constructed by combining the Best Practices Mineral Potential index, which rates regions based on their geologic attractiveness, and the Policy Perception Index, a composite index that measures the effects of government policy on attitudes toward exploration investment. The Policy Perception Index alone does not recognize the fact that investment decisions are often sizably based on the pure mineral potential of a jurisdiction. Respondents consistently indicate that approximately 40% of their investment decision is determined by policy factors, according to the report.

The companies that participated in the survey reported exploration spending of \$1.51 billion in 2020 and \$1.53 billion in 2019.

The report received a total of 276 responses out of 2,200, and it evaluated 77 jurisdictions. In 2019, 76 jurisdictions were evaluated, 83 in 2018, 91 in 2017, and 104 in 2016. This year's survey also includes an analysis of permit times.



### Antamina Will Invest \$180M in Copper Concentrator

Compania Mineria Antamina has submitted a Sustainable Technical Report to improve the operation of its copper processing plant at Yanacancha in Peru, for review and approval before the National Service of Environmental Certification for Sustainable Investments (SENACE), an office attached to the Ministry of the Environment of Peru.

The project seeks to optimize the efficiency of its production process at the Yanacancha facilities, in the Ancash region, by optimizing equipment and modifying auxiliary components in its concentrator plant, which consists of improving the pebble or crushing circuit of coarse ore and the selective flotation circuit. The investment involves an approximate outlay of \$180 million and there are no plans to disturb new areas or expand its current processing capacity of 175,000 metric tons per day.

In addition to the optimization of the concentrator, the main modifications also include the installation of a new belt for the transport and crushing system, as well as new workshops, warehouses and offices.

### Hecla Will Ramp Up Silver Production in 2021

Acknowledging modest disruptions in Quebec and Mexico, Hecla Mining Co. still managed to exceed the high end of its pre-COVID silver guidance by 1.4 million ounces (oz). In 2020, Hecla produced 13.5 million oz of silver, up 7% from 2019.

"As we look to 2021, we see three significant value drivers," President and CEO Phillips S. Baker Jr. said. "First, with Lucky Friday running at full production, positive results from the work at Casa Berardi, and the continued consistency of Greens Creek, we expect to grow silver production and generate significant free cash flow."

He added that silver production from the company's U.S. mines is expected to increase to almost 15 million oz by 2023. In 2018, those mines produced 8 million oz.

"Second, we start the year with the third highest reserves in our history despite disruptions to our planned exploration and definition drilling programs due to COVID 19, and we expect reserve growth in 2021 from a normal drilling program," Baker said. "Finally, Hecla's 2021 exploration program is following up on high-grade intercepts that have the potential to expand existing or develop new high-quality deposits in some of the world's best mining jurisdictions."

Examples include the Midas' Green Racer Sinter target where the company made a multi-ounce gold discovery in a never-before drilled target and at San Sebastian's El Bronco vein where there is high grade over significant widths, Baker said.

During the second half of 2020, all ore mined at Hecla's Nevada Operations



The Lucky Friday mine (above) is now running at full capacity.

was stockpiled, with no ore milled and no production reported during the period.

Mining of refractory ore at Fire Creek in areas with existing development was completed in the fourth quarter with most of the material shipped to a third-party processor by February. Metal prices have increased significantly since the tolling agreement was signed, and the company said it is no longer attractive for the third party to displace their feed to toll. Discussions are under way with another processor with surplus capacity. Fire Creek is, however, expected to be placed on care and maintenance in the second quarter of 2021.

### Vision Blue Raises Funds for Battery Mineral Development

Vision Blue Resources has raised an initial \$60 million and made its first investment of \$29.5 million in NextSource Materials, which is developing one of the largest and highest quality flake graphite deposits in the world, the Molo project in southern Madagascar. Studies conducted by Next-Source indicate that the Molo project has one of the lowest mine capital costs and will be a lowest-quartile producer due to its low-cost, open-pit operation with negligible stripping ratio.

The investment by Vision Blue, which was created by Sir Mick Davis in December to acquire a portfolio of strategically significant investments in battery mineral assets, of \$29.5 million will be used to fund the construction of Phase I of the Molo project, to fast track the completion of two technical studies in order to confirm the capital and operating costs for both Phase II mine expansion, and for a value-added graphite processing plant to produce spheronized, purified graphite for lithium-ion batteries in electric vehicles. The Phase I construction is expected to be completed within one year and will produce 17,000 metric tons per year (mt/y) of 98% purity graphite suitable for all end market applications.

"Vision Blue is uniquely positioned to take advantage of this emerging trend as we are nimble enough to access the opportunities currently present in battery minerals while having access to the financial firepower to undertake larger transactions when the timing is opportune," Davis said. "Today's announcement clearly shows our ability to raise and deploy capital on an accelerated basis." The former Xstrata CEO, Davis added that he is confident that production can begin within a year. Vision Blue said it has already identified a number of opportunities and expects to rapidly grow its portfolio.

### Premier Gold Approves Equinox Gold Acquisition

Premier Gold Mines Ltd. voted 99.9% to approve the acquisition by Equinox Gold of all of the issued and outstanding common shares of Premier. The arrangement was previously announced on December 16.

At the closing of the transaction, Premier shareholders will receive 0.1967 of an Equinox Gold share for each Premier share held. Equinox Gold and Premier shareholders will own approximately 84% and 16% of Equinox Gold, respectively. The transaction is expected to close in March. Equinox Gold will retain Premier's interest in the world-class Hardrock Project in Ontario, the Mercedes Mine in Mexico, and the Hasaga and Rahill-Bonanza properties in Red Lake, Ontario.

By approving the transaction, Premier security holders also approved the spinout of a newly created U.S.-focused gold production and development company to be called i-80 Gold Corp. that will own Premier's existing Nevada assets. Upon completion of the transaction, Equinox Gold and existing shareholders



The company to spin out of the transaction, i-80 Gold, will own the South Arturo and McCoy-Cove properties. (Photo: Premier Gold)

of Premier will own 30% and 70% of i-80 Gold, respectively.

i-80 Gold will own the South Arturo and McCoy-Cove properties and complete Premier's previously announced acquisition of the Getchell Project, all of which are located in Nevada.

i-80 Gold Corp. has entered into an agreement with a syndicate of underwriters led by CIBC Capital Markets (CIBC) where the i-80 proposes to issue and sell, on a private placement basis, 34 million subscription receipts at a price of C\$2.60 each for a total of of up to C\$88.4 million (\$70.3 million).

Each subscription receipt will be automatically exchanged for one share of i-80. In conjunction with the offering, Equinox Gold has agreed to subscribe for 30% of the subscription receipts, for a total of up to up to C\$28.3 million (\$22.5 million) and it is expected that management and affiliates will subscribe for up to approximately C\$5.8 million (\$4.6 million).

Proceeds are expected to be used by the company for working capital and general corporate purposes, to pay for exploration and development expenses related to the company's mining projects, and to fund the cash portion of the purchase price of the Getchell gold project from Waterton Global Resource Management Inc. and its affiliates.

The offering is expected to close on or about the week of March 15.

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### Minnesota Supreme Court Rules in Favor of Polymet Air Permit

On Wednesday, February 24, the Minnesota Supreme Court unanimously ruled in favor of the Clean Air Act permit issued to PolyMet Mining by the Minnesota Pollution Control Agency (MPCA) for its NorthMet project within the Mesabi Iron Range mining district. The decision overturned an order by the state Court of Appeals that had remanded the permit back to the agency.

The supreme court said the lower court had "relied on an erroneous interpretation of federal law" when it remanded the permit.

"This decision is another big win and a major step forward in the defense of our air permit," Chairman, President and CEO Jon Cherry said. "We believe strongly that the facts and the law are on our side, and we are pleased that the court agreed with us on the law. This is a victory for the company, our many stakeholders and for everyone that supports responsible mining in Minnesota."

The ruling endorses the MPCA's permitting process which involved a yearslong review of the project and its potential effects on air quality, Cherry said. "The decision provides additional clarity that will enable the company to move closer to mining the metals that are needed for improvement to U.S. infrastructure projects and production of electric vehicles and renewable energy technologies," he said.

Now that the Minnesota Supreme Court has ruled on the most significant legal issue, the case will return to the court of appeals for resolution of a few remaining items that the court did not specifically address in its original decision. "We are confident that the record in the court of appeals supports the MPCA's decision to issue the permit," Cherry said.

A federal judge dismissed a challenge to the U.S. Environmental Protection Agency's oversight of a water quality permit issued to PolyMet. The challenge was filed by the Fond du Lac Band of Lake Superior Chippewa back in September 2019.

PolyMet owns 100% of the North-Met project, the first large-scale project to be permitted within the Duluth Complex in northeastern Minnesota, one of the world's major, undeveloped mining regions. NorthMet has significant proven and probable reserves of copper, nickel and palladium in addition to marketable reserves of cobalt, platinum and gold.

### Biden Signs Order to Secure Critical Minerals Supply Chain

On February 24, U.S. President Joe Biden signed an executive order aimed at creating more resilient and securing supply chains for critical and essential goods. The order launches a comprehensive review of U.S. supply chains and directs federal departments and agencies to identify ways to secure U.S. supply chains against a wide range of risks and vulnerabilities.

"This is about making sure the United States can meet every challenge we face in this new era — pandemics, but also in defense, cybersecurity, climate change, and so much more," Biden said. "And the best way to do that is by protecting and sharpening America's competitive edge by investing here at home."

He added that it's about resilience, identifying vulnerabilities in the supply chain and making sure there are backups in place.

The order directs an immediate 100day review across federal agencies to address vulnerabilities in the supply chains of four key products, which included critical minerals and large capacity batteries for use in electric vehicles.

The review will identify near-term steps the administration can take, including with Congress, to address vulnerabilities in the supply chains for these critical goods.

The order also calls for a more indepth one-year review of a broader set of U.S. supply chains that focuses on six sectors, including public health, IT, energy, defense, transportation, and agricultural and food production.

Agencies and departments were directed to review a variety of risks to supply chains and industrial bases and make recommendations on how to improve resiliency.

Biden also directed his administration to work with U.S. partners and allies to ensure they have strong and resilient supply chains as well.

As the administration implements the executive order, it said it will identify opportunities to implement policies to secure supply chains that grow the American economy, increase wages, benefit small businesses and historically disadvantaged communities, strengthen pandemic and biopreparedness, support the fight against global climate change, and maintain America's technological leadership in key sectors.



In this file photo, U.S. President Joe Biden signs an executive order in the oval office. (Photo: Whitehouse)

Mining Association The National (NMA) applauded the order. "We can't import our way to economic and national security; we have to establish that security literally from the ground up by using American-mined materials produced by American workers under world-leading environmental standards," NMA President and CEO Rich Nolan said. "The president clearly recognizes the threat and is acting to protect against the exposure that exists in our energy, national security, manufacturing and medical supply chains given our overreliance on imports for the building blocks of these key industries."

According to the United States Geological Survey's Mineral Commodity Summaries 2021, U.S. import dependence for key mineral commodities has doubled over the past two decades with the U.S. now 100% import-reliant for 17 key minerals and more than 50% import-reliant for an additional 29 key mineral commodities. U.S. mineral import reliance continues to increase just as mineral demand from essential industries — such as energy and transportation — is expected to soar.

### New Gold Resumes Partial Operations at New Afton Mine

Partial underground operations as well as B3 and C-Zone development activities have resumed at New Gold's New Afton mine, located in Kamloops, British Columbia, following the tragic underground mudrush incident that occurred on February 2.

"The restarting of mining activities is a significant step for the New Afton mine as we continue our safe and sequential return to full operations," President and CEO Renaud Adams said. "As we move forward, our primary focus remains on the health, safety and wellbeing of our employees, contractors and their families and we will continue to provide counseling and support for them."

The extraction of ore has resumed on Lift No. 1 at limited capacity that includes a portion of the recovery level on a remote mucking basis.

B3 and C-Zone development activities have returned to normal levels. The area where the incident occurred will remain closed until further notice.

Milling, tailings operations and construction activities resumed. The mill is currently processing ore from the live pile and intermediate-grade surface stockpile, which is expected to supply sufficient vol-



The mud rush at the New Afton mine was located underneath the Lift 1 Cave in an isolated recovery area.

ume to feed the mill until full operations have resumed.

### Construction is Approved for Canadian Malartic Underground

Osisko Gold Royalties Ltd. announced that the Canadian Malartic Partnership, comprising Agnico Eagle Mines Ltd. and Yamana Gold Inc., have approved construction of the Odyssey underground project at the Canadian Malartic mine.

"The construction decision for the Odyssey underground project by Agnico and Yamana secures the Canadian Malartic mine as Osisko's flagship asset for decades," President and CEO Sandeep Singh said. "It is difficult to over emphasize the importance of this catalyst for Osisko as Canadian Malartic will continue to provide sustainable production until at least 2039, with significant upside beyond. We commend the partnership for the exploration and engineering efforts that have led to this announcement."

The Odyssey project hosts three main underground-mineralized zones: East Gouldie, East Malartic and Odyssey, the latter of which is subdivided into the Odyssey North, Odyssey South and Odyssey Internal zones. Osisko holds a 5% net smelter royalty (NSR) on East Gouldie, Odyssey South and the western half of East Malartic and a 3% NSR royalty on Odyssey North and the eastern half of East Malartic.

The East Gouldie deposit makes up 70% of the planned underground mining inventory. The Odyssey production forecast only considers about half of the total underground resources comprising inferred resources of 13.58 million oz (177.5 million metric tons of 2.38g/t gold), as well as indicated resources of 860,000 million oz (13.3 million mt of 2.01g/t gold) using a gold price assumption of US\$1,250 per ounce.

Exploration drilling at East Gouldie in 2020 totaled 97,000 meters (m) and increased the inferred mineral resource of the East Gouldie zone by 134%. The total exploration budget for 2021 has increased to 173,400 m (US\$30 million) focusing on further infill and expansion of East Gouldie and regional targets. East Gouldie alone will benefit from 141,400 m of drilling, which is approximately 80% of the total that has been drilled on East Gouldie to date.

A preliminary economic assessment technical report for the Canadian Malartic operation is expected to be filed in March.

Agnico will continue to evaluate optimization of the project and potential mining scenarios to further improve project economics.



Taseko will recover copper from a well field using injection and recovery wells. (Photo: Taseko Mines)

### Florence Copper Finds Financial Support

A bond refinancing and upsize allowed Taseko Mines Ltd. to significantly strengthen its financial position and lowered its cost of capital. The company now has a cash balance of \$200 million and no debt maturities until 2026, according to Taseko President Stuart McDonald. The majority of the required funding for the Florence Copper project in Arizona is now in hand and the company is moving forward with final design engineering of the commercial production facility.

The capital requirements for the commercial production facility are estimated at \$230 million and, while Taseko continues discussions with potential joint venture partners, the company believes it can obtain the additional funding, especially with copper prices currently north of \$3.70/lb.

"A commitment to capital discipline is a guiding principle for this organization," CEO Russell Hallbauer said. "We have demonstrated this in the past by completing more than \$800 million of capital programs at Gibraltar, on time and on budget. Florence is no different. [It] is one of the least capital-intensive copper production facilities in the world and when fully ramped up will produce 40,000 [metric tons] of high-quality cathode copper annually."

### E3 Opens Direct Lithium Extraction Facility

E3 Metals Corp. opened its direct lithium extraction (DLE) development and testing facility in Calgary, Alberta. This facility will be the site of the company's continued progression toward commercialization of its DLE technology. This includes the scale-up and lab prototype campaign in preparation for the field pilot plant.

All equipment within the facility is owned by E3 Metals and will be operated exclusively by E3 Metals' team. E3 Metals' DLE process test work will continue to extract lithium directly from oilfield brine sourced from the Leduc Reservoir within E3 Metals' resource area. In addition, the company said it will use the space to ramp up development of the full flowsheet, which is the production of lithium hydroxide from oilfield brine, throughout 2021.

"We are very excited to be consolidating our direct lithium extraction process development work into our new E3 Metals' testing facility right here in Calgary," President and CEO Chris Doornbos said.

E3 Metals has 7 million metric tons (mt) of lithium carbonate equivalent (LCE) inferred mineral resources in Alberta and its goal is to produce high purity, battery grade, lithium products.

### Liberty Gold Approves Plan for Black Pine Project

Liberty Gold Corp. received receipt of approval of an amendment to its plan of operations at the Black Pine project. Located in southern Idaho, Black Pine is a past-producing, run-of-mine, oxide heapleach gold mine that contains a large, shallow, district-scale, Carlin-style sedimentary rock-hosted gold system.

The plan includes a comprehensive access to an additional 4.6 square kilometers (km<sup>2</sup>) of an expansive gold system, bringing the total number of under the plan of operations to  $11.9 \text{ km}^2$ .

"This important milestone permits access to the largest undrilled target area in

the Black Pine gold system, covering several square kilometers of high-conviction ground," President and CEO Cal Everett, President and CEO of Liberty Gold. "It is nice have so much elbow room."

It also includes a total of up to 50.7 additional acres of disturbance, bringing the total to 224.8 acres, additional 15.3 miles of new roads, for a total of 56.7 miles, additional 154 drill pads, subject to a staged annual reclamation plan, bringing the total to 596 sites.

It also includes access to a water well that was used for the historic mine operation, which can now be used to support exploration efforts at Black Pine and access to areas between the Rangefront and M Zones to the east and the Discovery Focus Area, F and J zones to the west, linking the entire Black Pine Oxide Gold system together on a district scale.

"Throughout the many challenges presented by the year that was 2020, we worked with the U.S. Forest Service and Bureau of Land Management to produce the environmental assessment and met all of the timelines and milestones necessary to expand the footprint of this project," said Moira Smith, vice president of exploration and geoscience for Liberty Gold. "We appreciate their professionalism and thoroughness and look forward to working with them into the future as we advance the project toward the development stage."

The maiden mineral resource estimate is expected mid-Q2.

In February 2020, Liberty Gold submitted an application to the U.S. Forest Service Sawtooth National Forest-Minidoka Ranger District and U.S. Bureau of Land Management (BLM) Pocatello Field Office to amend the 2019 plan of operations, and worked diligently with these agencies, Stantec Consulting Services Inc. and Donahoe HydroGeo to complete wildlife, archaeological, hydrologic and other surveys to assist in producing a comprehensive Environmental Assessment. The plan of operations and draft environmental assessment were subject to rigorous inter-agency and public review. The BLM issued a Finding of No Significant Impact (FONSI) and approval of plan of operations for the portion of the permit on BLM land on December 23, 2020. The Forest Service issued a draft FONSI on December 21, 2020, and final approval of the amendment to plan of operations on February 17, 2021.



JENNMAR is proud to have been nominated for the Excellence in Hot-Dip Galvanizing Award presented by the American Galvanizers Association in recognition of our collaboration on the Park Ave Tunnel project.

11/17

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Simon Thompson





Rio Tinto Chairman Simon Thompson will not seek re-election as a nonex-

ecutive director for 2022. Senior independent directors, Sam Laidlaw and

Simon McKeon, will lead the search

for a successor. In addition, Michael

L'Estrange, a nonexecutive director,

will retire from the board at the con-

a significant sur-

Kirkland Lake Gold Ltd. announced a

number of management appoint-

ments.

Elisabeth Brinton

Lundin Mining Corp. appointed Karen Poniachik and Jack Lundin to the

board of directors. John Craig will be retiring and will not stand for re-elec-

tion as a director at the 2021 Annual

Meeting. Poniachik is currently the di-

rector of Columbia University's Global Centers, Santiago, an ESG lecturer for

Vaz

Natasha

has been

gery in February.

Natasha Vaz

Jennifer Wagner Jason Neal

promoted to the role of COO. Natasha joined the company in 2019 and, most recently served as senior vice president of technical services, technology and innovation. Jennifer Wagner has been promoted to executive vice president of corporate affairs and sustainability. Most recently, she served as senior vice president, corporate affairs, sustainability and legal counsel. Jason Neal will be joining as executive vice president. Most recently, he served as president and CEO of TMAC Resources.



Teck Resources Ltd. announced that Harry "Red" Conger, executive vice president and COO, has been awarded the Ben F. Dickerson III Award by the Society for Mining, Metallurgy and Exploration (SME) in recognition of his significant professionalism and contributions to the mining industry. "The Society for Mining, Metallurgy and Exploration is pleased to recognize Red Conger's outstanding contributions to the mining industry through the esteemed Ben F. Dickerson III Award," said Brad

Harry "Red" Conger

Dunn, chair of the SME Ben F. Dickerson Award Committee. "Red has clearly demonstrated the spirit of this award, through a career that has advanced our shared knowledge of best practices in mining, and his efforts set a higher standard for all of us to follow." Red Conger has spent more than 40 years in the mining industry and is recognized as a leader in safety, change management and production efficiency. As executive vice president and COO, he is responsible for Teck's mining and metallurgical operations,

projects and joint ventures, with a focus on execution of Teck's Quebrada Blanca Phase 2 copper project currently under construction in Chile.

Anglo American plc announced that Elisabeth Brinton will join the board as a nonexecutive director. Brinton is executive vice president of global renewables and energy solutions at Royal Dutch Shell plc.



Karen Poniachik

Thomson Reuters Latam and a member of the advisory boards of Microsoft #Transforma Chile and Chilemujeres. Lundin is currently the CEO and a director of Bluestone Resources Inc.



Fortescue advises of changes to its leadership and projects team. Greg Lilleyman, COO, has resigned from his position. Don Hyma, director of projects, and Manie McDonald, director of Iron Bridge, have also resigned from the business. Derek Brown, currently general manager of Solomon, has been appointed as acting director projects with the support of Fortescue's senior Projects team.

Piedmont Lithium Ltd. appointed Todd Hannigan as a nonexecutive director. He was formerly the CEO of Aston Resources Ltd.



Northern Vertex Mining Corp. announced that Kenneth Berry will step down as president and CEO. Berry will remain a director of the company. Berry's duties will be assumed by the chairman and director, Douglas J. Hurst along with Michael G. Allen who will be appointed president of Northern Vertex.

Michael G Allen Pan American Silver Corp. announced that Ross Beaty, founder and chair of the board of directors, has informed the board that he will retire as chair and director at the Annual General Meeting on May 12. The board will appoint Gillian Winckler as chair of the board, and to name Beaty as chair emeritus, both effective May 12. Beaty founded Pan American Silver in 1994 and has served as chair since then; he also was CEO of Gillian Winckler the company from its inception until 2004.





SSR Mining Inc. appointed Alison White as executive vice president and CFO. Prior to joining SSR Mining, White held various corporate and regional roles at Newmont Mining including serving as the regional CFO for North America. Prior to joining Newmont, White was the vice president of internal audit for a global water and natural resources engineering firm. White has leadership and financial experience across various industries holding roles at MWH Global (now Stantec), KPMG, ConAgra Foods, Sun Microsystems and Ernst and Young.



Nickel Institute has elected Tina Litzinger, vice president, marketing, Sherritt International Corp., as chairperson. Her appointment is for a one-year term, renewable for a second year. Litzinger succeeds Dan Chandler who has left the nickel industry.

Tina Litzinger

Turquoise Hill Resources Ltd. announced that Ulf Quellmann has resigned as the CEO. Steve Thibeault has been appointed interim CEO. He served as the CFO between June 2014 and April 2017 and led the negotiations of the funding agreements for Turquoise Hill that the company entered into with Rio Tinto in 2015.



Steve Thiheault

Copper Lake Resources Ltd. appointed Donald Hoy as vice president of exploration. Recently, he served as president of Wolfden Resources Corp. and prior to that, as vice president of exploration and development for Cliffs Natural Resources Inc.



Integra Resources Corp. appointed Carolyn Clark Loder to its board of directors. Most recently, she held the position of manager of mineral rights and public lands for Freeport-McMoRan Inc.

Gold Standard Ventures Corp. announced the resignation of Jonathan Awde from the board of directors of the company.

Atacama Resources International Inc. appointed Joe Dion CEO and chairman of the board of directors. Colin Keith will be transitioning to the position of vice president, legal affairs and corporate development, Wayne Holmstead will remain as the vice president of exploration.



Stéphane Goupil

Fordia, Epiroc's brand dedicated to exploration tooling, announced the arrival of Stéphane Goupil in the position of managing director of Fordia and vice president of exploration for Epiroc.

Strata Worldwide appointed Mike Rispin to lead the launch of Strata's new global division, Strata Tunneling. He will be joining the company as vice president of tunneling.





# China Coal & Mining Expo 2021

China's 19th International Technology Exchange & Equipment Exhibition on Coal & Mining

# Date: 26-29 October, 2021

Venue: New China International Exhibition Center (NCIEC) Beijing, China

Host: China National Coal Association

**Co-host:** China National Coal Group Corp.

Organizers: Together Expo Limited <u>China Coal Consultan</u>t International

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many

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# **Barrick Will Sell Lagunas Norte Mine**



Boroo will buy the Peruvian gold mine, which was idled in July 2019.

Barrick Gold Corp. reached an agreement to sell its 100% interest in the Lagunas Norte mine in Peru to Boroo Pte Ltd. (Singapore) for a total consideration of up to \$81 million, plus the assumption of Barrick's closure liability relating to Lagunas Norte of \$226 million backed by an existing \$173 million bonding obligation.

The total consideration consists of an up-front cash payment of \$20 million, additional cash consideration of \$10 million payable on the first anniversary of closing and \$20 million payable on the second anniversary of closing. It also includes a 2% net smelter return royalty (NSR) on gold and silver produced through the refractory sulphide ore project (PMR), which will terminate once 1 million ounces (oz) of gold has been produced and which may be purchased by Boroo for a limited period of time after closing for \$16 million, plus a contingent payment of up to \$15 million, which is based upon the average gold price per ounce for the two-year period immediately following closing. The contingent payment, which is payable two years following closing, is \$5 million if the average gold price is greater than \$1,600 and less than \$1,700; \$10 million if the average gold

price is greater than \$1,700 and less than \$1,800; and \$15 million if the average gold price exceeds \$1,800.

Boroo will also assume 100% of the \$173 million reclamation bond obligations for Lagunas Norte in two tranches: 50% on closing and 50% within one year of closing. The deferred payments, the contingent payments, and the obligation to replace the second tranche of the reclamation bond obligations will be secured.

Barrick President and Chief Executive Mark Bristow said the sale was in line with Barrick's decision to sell noncore interests in order to focus its portfolio on tier one assets. The proposed acquisition would benefit the mine's stakeholders in Peru by giving Boroo the opportunity to extend its life by accessing satellite resources and adapting the infrastructure, according to Barrick.

The transaction is subject to closing conditions.

Boroo, formerly known as OZD ASIA PTE Ltd., is a privately held investment holding company principally engaged in operating, developing and acquiring gold properties globally. Boroo owns and operates various production-stage and development-stage assets in Central Asia.

#### Josemaria Project Finishes Environmental Social Impact Assessment

An environmental social impact assessment (ESIA) has been completed for Josemaria Resources Inc.'s 100% owned copper gold project in the San Juan province of Argentina. The project has proven and probable mineral reserves of 6.7 billion Ib copper, 7 million ounces (oz) of gold, and 30.7 million oz of silver. A ceremony was held, led by Gov. Sergio Uñac, to demonstrate the support from the government and to mark the important milestone, the company said.

"The ESIA brings us a step closer to achieving our goal of developing Josemaria into a large-scale copper pro-



A ceremony, led by Gov. Sergio Uñac, demonstrates Argentina's support for the project. (Photo: Josemaria)

ducer in time to meet rising worldwide demand and ensuring the surrounding communities and stakeholders receive direct and indirect benefits from the project," CEO Adam Lundin said.

The Josemaria project, optimally located in the San Juan province of Argentina, is on track to become one of the next major copper-gold project developments globally. Project construction is expected to create more than 4,000 jobs and more than 1,000 operations jobs once in production.

Uñac said there were many benefits to working with Josemaria. "They have demonstrated reliability and their positive goals with regards to the environment and the community are in alignment with ours in San Juan," he said. "Their planned investment of \$3 billion in our San Juan province, would be the engine for improving the livelihoods of the stakeholders and the local communities."

Josemaria will double provincial exports and increase mining employment by more than 30%, he added.

Josemaria is a Lundin Group company and works in partnership with the Lundin

Foundation to execute best practices in responsible mineral development in Argentina where the Lundin's have a 30year track record of value creation.

### Mexus Continues Operations at Santa Elena Mine

Mexus Gold US will continue to mine the Mexus III pit area at its Santa Elena mine located 54 kilometers from Caborca, Mexico. The increase in mining efforts comes after a 20-day slowdown due to a COVID outbreak of some of its mine employees. The crew is now COVID free with the company taking extra measures to ensure the safety of all involved. Mexus CEO Paul Thompson recently received a vaccination shot adding confidence when traveling to the mine and interacting with employees and representatives of other mining companies.

The Mexus III area continues to show a potent detachment alteration zone with values ranging from 0.7-1.2 grams per metric ton (g/mt) of gold and 0.3-0.5 g/ mt of silver. The heap-leach pad is currently leaching at 60 gpm. The carbon filters have been filled with a new load of activated carbon collecting 100% of values at 0.25-0.27 ppm gold. Mexus expects the values to increase to 0.35 ppm within a week of additional material being placed on the heap leach pad.

The Vein II area, with 300 drilled holes, is now ready for blasting. A recent military inspection by a group of army personnel occurred as part of the permitting process. The company believs the issuance of the permit should occur any day. The first blast will produce more than 10,000 tons of highgrade quartz vein mineralized material averaging 2.3 g/mt of gold.

"In addition to the positive results at the Santa Elena mine, we continue to meet with potential partners," Mexus CEO Paul Thompson said. "[Several companies have expressed] their interest in both the Santa Elena mine and our Mabel property. In addition, there are ongoing discussions with companies concerning Mexus' copper property in the Sonora State of Mexico. I'm very pleased with the progress at the Santa Elena mine and by the interest that Mexus is garnering,"



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### Fortescue Postpones Iron Bridge Magnetite Project



Cost overruns for a major iron ore project in Western Australia caused FMG to re-evaluate the project. It also forced several executives to tender their resignations.

Fortescue Metals Group Ltd. performed a detailed review of the Iron Bridge magnetite project in the Pilbara region in Western Australia and decided to defer construction until the second-half of 2022. The review considered the forecast capital estimate and schedule for the project, taking into account the strength of the Australian dollar, access to resources and specialist skills, as well as other market factors.

The revised preliminary capital estimate is \$3 billion, up from the previous estimate of \$2.6 billion. The technical and commercial assessment is under way and is scheduled to be completed in 12 weeks. The Iron Bridge project is a joint venture between FMG Iron Bridge Ltd., via subsidiary FMG Magnetite Pty Ltd. (69%) and Formosa IB Pty Ltd. (31%). FMG Iron Bridge is jointly owned by Fortescue (88%) and Baosteel Resources International Co. Ltd. (12%)

Key areas of focus included assessment of the magnetite concentrate transportation solution and return water pipelines to Port Hedland; enhanced utilization of Fortescue's port and rail infrastructure; contractor strategy and selection; and logistics infrastructure to maintain the schedule for the delivery of large modular components through Port Hedland. Limited project works on critical path items will continue during the next 12 weeks, including engineering, off-site fabrication, procurement activities and site-based civil works.

As of January 31, the joint venture has incurred capital expenditure of approximately \$1.1 billion since the stage 2 investment decision in April 2019. Fortescue's share of stage 2 investment is approximately \$750 million. Fortescue has also contributed \$274 million of deferred joint venture contributions relating to stage 1 of the project.

Prior to the review being released, the company announced COO Greg Lilleyman, Don Hyma, director of projects, and Manie McDonald, director of iron bridge, have resigned from the company.

Commenting on the leadership changes, Fortescue CEO Elizabeth Gaines said, "At Fortescue, our commitment to our values and culture is our highest priority. What we've learned through our review of the Iron Bridge project to date is that we have lost sight of that critical focus. Since Fortescue was established, our values, above all else, have driven our behaviors and our decisions. These values were allowed to slip inside the Iron Bridge team."

Derek Brown, currently general manager of Solomon, has been appointed as acting director projects with the support of Fortescue's senior projects team. The project team comprises Andrew Hamilton, project director, Iron Bridge; Corey Dennis, project director port, rail, pipelines and power; and Warren Harris, project director, Iron Bridge and operational projects.

Gaines added that she and CFO Ian Wells will forego all incentive payments this financial year.

"We take this opportunity to reset the company's focus on our culture and values, which defines us and makes Fortescue a truly great company," she added.

#### Oceanagold Produces First Gold at Martha Underground at Waihi

OceanaGold Corp. has produced first gold at Martha Underground (MUG).

The company said it achieved first gold production from MUG after pro-

gressing development by nearly 7.5 kilometers (km) in 2020. Mining of MUG continues to ramp-up with additional production expected in the first quarter ahead of the installation of a new SAG mill shell, which is scheduled to be completed in the second quarter. The company continues to expect Waihi to produce between 35,000 ounces (oz) and 45,000 oz of gold in 2021.

Mining from MUG will continue to ramp up with ore stockpiled ahead of continuous milling recommencing late in the second quarter of 2021. The company expects to complete the first full stope at the end of the first quarter before increasing average mining rates to between 30,000 metric tons (mt) and 35,000 mt per month in the second half of the year. Development continues at MUG as the company targets a steady-state annual gold production rate of 90,000 oz to 100,000 oz gold plus silver. The MUG feasibility study, including the initial mineral reserve, is due for completion late in the first quarter.

"We are very pleased with the progress we have made at Martha Underground where we have achieved first gold production and expect steady-state in the second half of the year," President and CEO Michael Holmes said. "We will continue to batch process MUG ore this month ahead of the planned mill shutdown to install a new SAG mill shell, which remains on schedule for completion in late second quarter. Once completed, we expect underground production to sustain continuous milling."

The company announced an increase in the indicated resource to 1 million oz of gold grading 5.2 grams/t; an increase of 36% representing the addition of approximately 260,000 oz of gold. The increase in indicated resource underpins the minimum 10-year mine life targeted for MUG.

### Macmahon Secures 4 Year \$220M Contract at Deflector Underground Mine

Macmahon Holdings Ltd. was awarded a four-year contract with Silver Lake Resources to perform the mining works at the Deflector gold and copper mine in Western Australia.

A Macmahon subsidiary, GBF, has been providing underground mining ser-

vices at the Deflector mine since mining commenced in early 2016. Macmahon acquired 100% of GBF in 2019, and this business is now an important part of the company's strategy to expand in the underground mining services market.

The new contract with Silver Lake will run until April 2025 and is expected to generate approximately \$220 million in revenue. The contract is a full-service mining contract and therefore incorporates all underground development, ground support and production activities, including the provision of all labor and mobile mining equipment.

"This new contract is an important milestone in our strategy to expand our underground business, and is a clear demonstration of the benefits we are now realizing from the GBF acquisition," Macmahon CEO and MD Michael Finnegan said. "Importantly, the Deflector mine is a high-grade gold and copper asset in Western Australia, so is an attractive project in the current macroenvironment. We look forward to continuing to support the development of Deflector, and to achieving further scale in the underground market."



# **Orion to Acquire Okiep Copper Complex**



The OCC project includes several un-mined, drilled copper deposits — many with mine access declines and shafts in place, like the Flat mine (above).

At the beginning of February, Orion Minerals Ltd. entered into an agreement giving it exclusive rights and a clear pathway to acquire and consolidate a significant interest in the Okiep Copper Complex (OCC), located in South Africa's Northern Cape Province. The OCC holds the mineral rights for several large historical mines, which produced more than 2 million metric tons (mt) of copper. This represents a significant growth opportunity for Orion, which could become a future second base metal production hub, alongside its flagship Prieska copper-zinc project, located 450 kilometers (km) east of OCC.

Under the agreement, Orion has an exclusive option to undertake due diligence and acquire a 56.25% interest in Southern African Tantalum Mining (Pty) Ltd. (SAFTA) — alongside Industrial Development Corp. of South Africa Ltd. (IDC) with 43.75%, 100% of Nababeep Copper Co. Pty Ltd. (NCC) and 100% of Bulletrap Copper Co. Pty Ltd. (BCC). These assets are collectively known as the OCC.

The OCC project includes several unmined, drilled copper deposits — many with mine access declines and shafts in place. The current owners have completed resource estimates and a scoping-level feasibility study that Orion will subject to due-diligence scrutiny in coming weeks. Based on in its initial investigations, Orion believes there is an opportunity to restore mining at OCC to historical production levels when it was operated by Newmont in the 1980s.

"This is a unique opportunity to acquire a dominant position in a historic world-class copper mining district — an exceptional growth and diversification opportunity," said Orion's managing director and CEO, Errol Smart. "We believe that the complementary combination of the advanced OCC with our [Prieska] will transform Orion into a significant base metals mining house, accelerating our journey to become a major producer in the Northern cape region."

Orion intends to apply its proven expertise in permitting and developing large-scale base metal projects to the OCC opportunity, with work to commence immediately on resource modelling to upgrade estimates using good quality drill data. The company said it plans to review the 2019 scoping-level feasibility study will also be reviewed before reporting and, if appropriate, advancing to a bankable feasibility study.

The total acquisition cost assuming the option is exercised, payable in stages at various milestones through a combination of cash and Orion shares, amounts to an aggregate total of ~A\$7.5 million of initial purchase consideration, with possible deferred consideration of an additional ~A\$8.5 million. The deferred consideration is payable on successful definition of JORC compliant Mineral Resources above cut-off grades ranging from 1%-1.2% copper in addition to a baseline of 8.9 million mt.

"Given the shallow nature of many of the deposits — many of which have been drilled extensively — we see an outstanding opportunity to fast-track resource delineation and feasibility studies to underpin near-term production," Smart said. "Our immediate focus will be to upgrade the existing SAFTA resources and feasibility study to JORC status, which we anticipate will be a relatively quick and cost-effective process.

Should this work be successful, Smart believes production from OCC would supplement Prieska's forecast production of 22,000 mt/y of copper and 70,000 mt/y of zinc. This would transform Orion into a substantial base metal mining house with two operating hubs in Tier-1 mining districts in the Northern Cape.

Roughly two weeks after making the OCC announcement, Orion secured an option to purchase mining and exploration records and extensive data of the O'Okiep Copper Co. giving it access to data covering more than 60 years of mining history for ZAR25 million (\$1.77 million), payable in cash and Orion shares.

This transaction includes all historical mining and exploration records over areas included in the OCC Option. Data includes exploration records and historical due diligence reviews over much of the Northern Cape Province, including Orion's own Prieska copper-zinc mine and the Areachap Belt, undertaken by Newmont and Goldfields through the O'Okiep Copper Co.

Consolidating important datasets and records with current prospecting rights and mining rights that are subject to the OCC option agreement unlocks enormous value and positions Orion to fast-track exploration and feasibility studies on a number of high-priority targets. A large proportion of the hard copy records have been converted into high-resolution digital format and have been used to capture a large digital database of drilling data. This will allow resource modelling and target generation to proceed rapidly.

Access to the datasets will allow Orion to fast-track its evaluation of this copper district. "The acquisition of this incredible dataset comprising more than 150,000 hard copy records and including drilling and sampling of more than 26,000 drill holes is a remarkable coup for the company," Smart said. "With a replacement value of hundreds of millions of Rand and encompassing more than 60 years of intensive work by top explorationists and geologists of the time, this acquisition is a tremendous step forward for Orion."

### Energy Regulator Approves South Deep Solar Plant

Gold Fields said its electricity generation license has been approved by the National Energy Regulator of South Africa (NER-SA) for the construction of a 40-MW solar power plant at its South Deep mine. The acting CEO of NERSA now has to authorize the license and Gold Fields expects a decision soon. All the regulatory approvals to proceed with the project are then in place. Stating that the solar plant has the potential to provide around 20% of South Deep's average electricity consumption, Gold Fields will update its definitive costings and finalize all the required internal processes to commence the project as soon as possible.

"The solar power plant will increase the reliability and affordability of power supply to South Deep, ultimately enhancing the long-term sustainability of the mine," said Nick Holland, CEO, Gold Fields. "The approval of this license sends a strong, positive message to mining companies and their investors, potentially leading to decisions being taken to sustain and grow mining operations in the country, especially in deep-level, underground, marginal mines. Enabling companies to generate their own power also gives Eskom room to address operational issues at its power plants."

Gold Fields' energy objectives are based on four pillars — energy must b reliable, available, cost-effective and clean — which promote a shift to self-generation using renewable energy sources. "We are fully committed to making our contribution toward net-zero emissions," Holland said. During 2020, Gold Fields successfully implemented solar and wind power plants, backed by battery storage, at two of its Australian mines, Agnew and Granny Smith, and committed to renewables at its other Australian mines, Gruyere and St. Ives, as well as the Salares Norte project in Chile when it starts operations in 2023. All its other mines are also reviewing renewable energy options.

Since full commissioning of the Agnew microgrid, renewable electricity averages over 55% of total supply at the mine. During 2020, renewable electricity averaged 8% for the Australia region and 3% of total Group electricity. Once the South Deep project is commissioned, renewable's contribution to the group total will rise to approximately 11%.

"We expect our investment in renewable and low-carbon energy sources to contribute significantly to our carbon emission reductions over the next few years," Holland said. "Power from the South Deep solar plant will partially replace coal-fired electricity from Eskom, enabling us to significantly reduce our Scope 2 carbon emissions."

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### **Problems Mount for Nornickel**



Nornickel CEO Vladimir Potanin (center) visits the Oktyabrsky mine to survey the measures being implemented in response to a recent water inflow, measures that will be replicated at the Taymyrsky mine.

Russian palladium and high-grade nickel producer Nornickel recently suspended production at its Oktyabrsky and Taimyrsky mines. On February 12, during drifting operations, a natural groundwater inflow was detected at the 350-meter level in the Oktyabrsky mine's hanging wall. The company partially shut down operations at the mine until the flooding ceases. Operations at the Taimyrsky mine have also been partially suspended, since the two mines are connected.

"We are currently installing a cofferdam to stop further water inflow," Nornickel First Vice President and COO Sergey Dyachenko said. "Once [it] is in place, we will be able to estimate the amount of accumulated [water] and enhance response efforts to drain the workings as quickly as possible."

Last week, a building at an ore reloading facility and an adjoining walkway collapsed at the Norilsk Concentrator during repairs to reinforce the structure. Six contractors were buried. Four people were pulled out from under the rubble. One of them sustained serious injuries and died in the hospital. The search for the other two continues.

Nornickel said it is investigating the causes of the incident.

In related news, Nornickel said it will not appeal and will comply with a judgment issued February 12 by the Arbitrazh Court of the Krasnoyarsk region in relation to the May 2020 massive diesel spill that fouled waterways. The company was fined more than \$1.9 billion for its role in the spill at the Norilsk plant. According to local media reports, more 21,000 metric tons of diesel leaked into the rivers and soil.

"We welcome this decision as this will enable Nornickel to move on and concentrate its efforts on the execution of its ambitious sustainable development strategy, which was presented to the investment community last December," said Gareth Penny, chairman of the Nornickel Board of Directors. "On behalf of the board, I can confirm that the management has our full support in these efforts and that we appreciate the commitment of all to achieve these goals."

### Power Agreement Makes ISAL More Competitive

Rio Tinto has reached agreement on an amended power contract that will allow the ISAL aluminum smelter in Iceland to continue operating with an improved competitive position. The agreement with power supplier, Landsvirkjun, will deliver a more competitive power price and energy flexibility that is mutually beneficial for both ISAL and Landsvirkjun, according to Rio Tinto.

"This provides a stronger footing to continue operations at the smelter and gives increased security for the team at ISAL, who have been doing an outstanding job in challenging conditions," Rio Tinto Aluminum Chief Executive Alf Barrios said. "We will continue to work to strengthen ISAL's future in order to keep supplying low carbon aluminum to customers in Europe and North America and making a significant contribution to Iceland's economy."

In parallel to the new agreement, Rio Tinto has decided to withdraw a complaint filed with the Icelandic Competition Authority in July 2020 regarding the energy supply for ISAL.

ISAL is wholly owned by Rio Tinto and employs around 500 workers on site.



The aurora borealis dances above the ISAL smelter in Iceland.

### Polyus Will Offer Vaccinations to Miners

Russian gold mining company PJSC Polyus has launched a COVID-19 vaccination program for its production assets. The company aims to make the vaccine available to all employees as well as contractors. Vaccinations will take place at firstaid posts at the Olimpiada, Blagodatnoye and Verninskoye mines. Miners working at the Kuranakh, Alluvial and Natalka mines will be vaccinated at local medical centers.

The first delivery of 1,100 vaccine doses arrived at Olimpiada and Blagodatnoye on February 5. More batches will be delivered as required.

Polyus is the fourth-largest gold mining company by production volume. Its principal operations are located in Siberia and the Russian Far East: Krasnoyarsk, Irkutsk and Magadan regions and the Republic of Sakha (Yakutia).

#### Rio Tinto, Hydro Will Close Aluchemie Anode Plant

A strategic review by Aluchemie owners Rio Tinto and Hydro has determined it is not viable to make the ongoing investments needed to continue operating the stand-alone anode production facility in Rotterdam, Netherlands, due to its weak competitive position and challenging market conditions.

As a result, production at Aluchemie is expected to finish at the end of 2021. A consultation process with the relevant European works councils and union representatives will now begin on the planned closure.

Rio Tinto Aluminum Chief Executive Alf Barrios said, "We have carefully considered options to make Aluchemie competitive, however, the investments required to continue operations are not viable. We recognize this will impact employees and the community, and our focus now will turn to supporting the team at Aluchemie as they work with stakeholders to plan a safe and responsible closure."

Aluchemie was started in the mid 1960s and is jointly owned by global mining and metals company Rio Tinto and global aluminum company Hydro. The plant employs 220 employees and produces 216,000 metric tons (mt) of anodes per year.

#### **NEWS - CALENDAR OF EVENTS**

MAY 4-6, 2021: Canadian Institute for Mining (CIM), Montreal, Quebec, Canada. Contact: Web: convention.cim.org.

MAY 25-27, 2021: Austmine 2021 Exhibition and Conference, Perth, Western Australia. Contact: Web: https://austmineconference.com.au/.

JUNE 1-3, 2021: Euro Mine Expo (virtual), Kraft Center, Skelleftea, Sweden. Contact: Web: www.eurominexpo.com.

JUNE 7-11, 2021: Elko Mining, Elko, Nevada, USA. Contact: Web: www.ExploreElko.com.

SEPTEMBER 13-15, 2021: MINExpo INTERNATIONAL, Las Vegas, Nevada, USA. Contact: Web: www.minexpo.com.



### Anglo American Idles Moranbah North Mine in Queensland

Anglo American suspended operations at its Moranbah North longwall mine in Queensland as a safety precaution after elevated levels of gases were detected on February 20. Miners were withdrawn and operations remain idled.

"Conditions underground are normalizing in response to the measures being taken," a spokesperson for Anglo American said. "The trigger for the underground withdrawal was elevated levels of some gases in the goaf (gob), which would indicate a coal heating issue and an overpressure event. We have internal and external experts assessing various information sources in order to more accurately determine the cause of the event."

At the time of the incident, the longwall had been mining through some particularly challenging geology, the company said.

While overpressure is a term used in blasting, the company said there is no evidence that an explosion occurred and methane levels on the longwall were well within the regulatory levels.

### Ramaco Will Open 2 New Coal Mines

Ramaco Resources plans to open two new metallurgical coal mines. At full production, they are expected to add almost 1 million new tons per year (tpy) of additional low-vol and mid-vol production, with initial production beginning in 2021. Together, they will increase Ramaco's overall capacity by roughly 50%, to approximately 3 million tpy.

The current Berwind slope on the border of West Virginia and Virginia, which had been halted last year, will be brought into production as well as a new surface mine at the Knox Creek complex called the Big Creek mine, Chairman and CEO Randall Atkins said. "We look forward to resuming Ramaco's originally projected growth trajectory to more than 4 million tpy in this current strong market and plan to spend approximately \$18 million on these properties over the next two years," Atkins said.

The Berwind slope is the larger of the two projects, Atkins explained. "We view Berwind as the second flagship complex for Ramaco," he said. "We are excited not just about the economics, and the fact that this will make us a presence in the low-vol markets, but also about the long-term job creation that this operation will bring to West Virginia and southwest Virginia."

Ramaco has invested \$50 million over the past four years at Berwind. The company anticipated spending another \$10 million to 12 million in development capital over the year, with about a third of that outlay spilling over into the early part of 2022. At full production, Berwind will produce approximately 750,000 tpy of high-quality low-vol coal, with cash costs in the low to mid \$70s per ton range. "We expect initial production later this year, which will ramp up to full production levels by the second quarter of 2022," Atkins said. "We anticipate being able to produce at these levels in this reserve for more than 20 years."

The new Big Creek project is a surface mine near Ramaco's Knox Creek prep plant, where it can ramp up to initial production within roughly four to six months of breaking ground. In total, the company expects to spend roughly \$5 million to \$7 million at this mine over the next two quarters. "We anticipate full production of around 150,000 tpy to 200,000 tpy by the fourth quarter of 2021," Atkins said. "Big Creek will be primarily high-quality mid-vol coal, with cash costs in the upper \$50s per ton range."

Ramaco expects to be able to produce at these levels for more than three years.

### Allegiance Coal Comppletes \$15M Private Plaement

Allegiance Coal Ltd. has completed a \$15 million placement at \$0.08 per share with investors. The company also intends to offer a share purchase plan (SPP) to shareholders at \$0.08 per share, the same price as the placement, capped at \$2 million. The funds will be applied toward development at New Elk, the Tenas environmental assessment application, debt repayment and working capital.

Following the placement, the company said it is strongly positioned to advance the New Elk mine into production by mid-2021 while continuing to advance approvals for the Tenas project with its joint venture partner Itochu.

Chairman and Managing Director Mark Gray said, "The placement was well received with interest from offshore and Australian institutional and wholesale investors."

The SPP opened on February 24 and will close at 5 p.m. (Sydney time) on March 27.



Ramaco is reactivating its Berwind mine (above), which sits on the border of Virginia and West Virginia.

### NACCO's Fourth Quarter Coal Deliveries Decline

North American Coal Co. (NACCO) delivered disappointing fourth quarter earnings, saying its revenues decreased substantially compared with the fourth quarter of 2019. The company attributed the results to a reduction in tons delivered by Mississippi Lignite Mining Co. due to a substantial decline in the number of days the customer's power plant operated in 2020 compared with 2019. During 2020, the company also closed two mines in Texas, the Eagle Pass mine operated by Camino Real and the Marshall mine operated by the Caddo Creek Resources. Total coal deliveries for Q4 2020 were 7.5 million tons compared to 8.2 million tons in Q4 2019.

For 2021, NACCO said it expects coal deliveries to be comparable to 2020. "We continue to believe that coal will play an important role in electricity generation capacity in the U.S.," said J.C. Butler, president and CEO, NACCO. "The recent events in Texas show us the importance of an electrical source that's readily dispatchable. We are actively engaged in

keeping our coal customers competitive and we will continue to do so."

Prior to the recent power outages in Texas, the owner of the power plant served by the company's Sabine mine, Southwestern Electric Power Co., was planning to retire it in 2023.

In May 2020, Great River Energy (GRE) in North Dakota, the Falkirk mine's customer and the company's second largest customer, announced its intent to retire



A dragline moves overburden at the Sabine mine in Texas.

the Coal Creek Station power plant in the second half of 2022. GRE is willing to consider opportunities to sell Coal Creek Station, and NACCO is actively engaged in the exploration of options that could, if successful, allow for transfer of ownership of the power plant to one or more third parties, which would preserve jobs at both Coal Creek Station and the Falkirk mine.



# **GET-ing to the Point**

Ground engaging tools protect earthmover bucket and blade edges, and anti-wear plates and panels serve as sacrificial barriers against premature wear damage in a wide range of mine and plant applications. New materials and designs mean they'll be around for longer tours of duty.

By Russell A. Carter, Contributing Editor



Weir ESCO's Nemisys GET system offers users the option of mechanically attached adapters — useful in tough applications where the risk of adapter breakage is greater. Mechanical adapters eliminate the need to conduct hot work associated with adapter removal and reinstallation. (Photo: Weir ESCO)

There aren't many constants in mining. Ore grades vary from site to site and year to year, demand for commodities rises and falls and companies come and go. One thing that can be counted on to endure throughout time and place, however, is wear — the grinding, scratching and cracking of surfaces that occurs whenever and wherever abrasive material is moved from point A to point B.

Even so, omnipresence is perhaps the only constant characteristic actually associated with wear. There are no universal remedies that solve all wear problems, and even the same anti-wear product used in identical equipment setups might not be appropriate at different locations because of variances in environment, rock properties or installation practices. This makes it hard for both vendors and users to accurately predict what product will work best without thorough, time-consuming field testing, which can lead to even more questions, such as how long it should take to collect meaningful data or whether the right metrics are being measured.

Variability also comes into play from the wide array of designs, material choices and price-versus-cost options that a potential customer encounters when shopping for wear-resistant products. Yet, whether the search is for longer-lasting GET (ground engaging tools) to protect an earthmover's bucket or blade, hardened steel plate to armor a haul-truck body or sturdy synthetic lining to guard chute walls against impact, the process can be condensed down to a simple concept: it's a battle to control critical surfaces.

### On the Edge

As the first earthmover components to contact ore in the mining process, GET are literally the tip of the spear in this fight. Tasked with protecting structural surfaces of the bucket or blade from damage or premature failure due to wear, GET generally must be tough yet hard, substantial yet not exceptionally heavy, and fastened securely without being overly difficult to remove and replace. They can be forged, cast or fabricated from a variety of alloy steels with prices that reflect their materials and manufacturing cost, and they often play a significant role in the opex and service life of the machine they're attached to by helping the operator dig more efficiently, avoiding unnecessary stress on bucket, blade, boom, linkage or hydraulic systems.

Choosing an optimal GET system for a particular type of machine and location can involve selecting from a large universe of GET products with similar specs, common or unique fastening systems and prices ranging from dirt cheap to thousands of dollars per item. But what's the best first step toward realizing maximum value from GET products? It could be just properly managing the system you currently have, according to most GET experts.

"Proactive GET inspection and maintenance is critical to reduce the risk of component loss or breakage and minimize the risk of loss or over-wear contributing to damage to permanent or semi-permanent structural components on the bucket," said Casey Springer, global product manager, mining expendables, Weir ESCO. "For instance, failure to inspect teeth or intentionally running GET beyond its useful life could lead to wear-through to the adapter nose or lip itself. Damage to these structural elements can create fit and reliability concerns, which can in turn drive a need for unplanned maintenance and equipment downtime to execute a repair or replacement. The cost of lost production and increased maintenance typically exceeds the minimal savings in GET spend that come from running components beyond the end of their useful life."

It's impossible to know the number of times a broken GET component has caused a crusher shutdown at mines around the world, or to estimate the productivity losses arising from associated problems resulting from lapses in GET management and inspection. However, there are systems available that are capable of warning operators of broken or missing GET in time to prevent crusher mishaps. The newest of these are also designed to tap into IIoT and other digital technologies to provide up-to-date productivity information based on real-time analysis and reporting.

For example, Springer pointed out that ESCO's GET Detect system can serve as an added layer of protection for the mine site by quickly detecting loss events. This not only helps reduce damage to any structural components that may be exposed following a loss, but it also provides information needed to quickly isolate a lost component and prevent it from causing significant damage downstream. GET Detect provides real-time feedback of a loss event so the mine can take immediate action. It also helps collect utilization and performance data at the bucket and tooth position level that can be used to better optimize maintenance programs and even develop predictive maintenance models.

Sensors are integrated into each Nemisys point and shroud to eliminate additional handling or installation requirements. Sensors are powered by a self-contained battery that will last the life of each component. These sensors can be removed at the end of the tooth or shroud life for recycling.

ESCO also offers a dedicated customer portal that provides a consolidated view of all operating GET Detect systems installed at the mine site. The portal can be accessed from any web browser by registered and authorized users at multiple locations. The GET Detect portal also provides weekly summary and GET performance reports that are a valuable resource to help with planning maintenance, improve productivity and manage total cost of ownership.

- Overall bucket utilization for a given week;
- Detect system performance and health;
- Bucket performance for each day;
- GET performance by location;
- GET utilization hours.

CR Mining (formerly CQMS Razer), an Australian company that acquired the underground GET business assets of Keech Castings, another Australian company, in mid-2020 as a move to broaden its GET technology portfolio, also bought GET Trakka, an Australian business that developed a sensor-based GET loss detection system. The GET Trakka system, according to CR, integrates RFID with advanced sensing technologies to track the real-time status of GET components for immediate breakage detection, and when a breakage incident is detected is capable of generating an alarm within a single scoopand-dump cycle. This, according to the company, ensures that broken GET can be rapidly located at the pit face or in a truckload and removed to prevent downstream damage and production loss.

The system employs rugged, compact RFID tags that are embedded in a small recess inside GET. These collect real-time digging activity information and wirelessly transmit it to a receiver onboard the excavator. Upon getting a breakage indication, the receiver immediately triggers an alarm module in the cab or operations control center, or both. Broken components continue to transmit a unique signal, enabling rapid location with portable readers.

The sensor network also captures digging and haulage data, which can be used by the company's Productivity Plus program to convert data into actionable information for reporting mine performance metrics.

#### Expanding the Range

With more than 700 machine installations worldwide, Weir ESCO's Nemisys GET system is one of the most popular product lines of its type among mining customers, and the company said it spent the last few years expanding the line to address all mining machine classes. The initial Nemisys offering targeted large mining excavators and draglines, and the system is now available for cable shovels, wheel loaders and less than 250-ton plate lip excavators.

ESCO's Springer explained that each machine class-specific system features unique elements to maximize its effectiveness and to address pain points found in competitor systems. For example, in the case of the Nemisys system for plate lip hydraulic excavators, advanced metallurgy and tooth design are combined with a unique adapter wear cap design that significantly reduces adapter leg wear, which, in turn, extends the life of these weld-on adapters and minimizes maintenance costs and equipment downtime.

The Nemisys system for wheel loaders, according to Springer, delivers significantly longer lasting teeth — in some applications, more than a threefold increase in wear life vs. OEM systems - and supplements that with optimized shroud designs that address retention, ease of removal and safety concerns that plagued OEM systems. The system also retains the option for mechanically attached adapters, which can be a significant benefit in certain applications where the risk of adapter breakage is greater. The mechanical adapters eliminate the need to perform any hot work associated with adapter removal and reinstallation, significantly reducing maintenance costs, equipment downtime and potential employee exposure.

Two Komatsu-owned companies — Norway-based KVX and Hensley Industries in Dallas, Texas — recently highlighted additions to their GET lines. Hensley's GET offerings range from the budget-priced Dura DRP line up to its XS<sup>2</sup>



KVX's bolted GET system protects the lip and bucket floor while leaving the interior smooth for optimal material flow.

extreme-strength tooth system for 75-ton loaders and 80-ton-class and above excavators. KVX introduced the E2 tooth system, a line designed for up to midrange excavators that carries over much of the same technology used by KVX in its popular bolt-on adapterless tooth system.

KVX said its specialized bolting technology enables secure attachment of E2 components without welding, thus saving the bucket lip from potential heat-induced cracking over its service life, and eliminating downtime associated with welding and welding-related problems. Additional advantages of the E2 system come from use of a high toughness-rated adapter. The nose of the adapter is now better matched to the hardness of the replaceable tips and is more resistant to wear and deformation from the tooth tips and contamination between adapter and tips, according to the company. Adapters are bolted to the outside of the bucket, providing protection to the lip and bucket floor while leaving the bucket interior smooth and unobstructed to enhance optimal material flow.

Hensley's GETPro tooth system, displayed at the CONEXPO 2020 trade show, features what is described as an intuitive, foolproof locking design that can be performed by a single worker with a wrench. The system is claimed to offer better adapter nose to tooth fit, and the strength of the adapter nose has been increased by up to 10%. Overall, the GET-Pro design features 15% more tooth wear material, and wear indicators have been added to assist in GET management.

Weight is often a concern in GET applications, both from payload-reduction and worker-safety perspectives (see sidebar), and for that reason, Hensley and other major GET suppliers stamp item weight on larger GET components. It's viewed by some customers as an indication of value and wear life, but as ESCO's Springer explained, component weight by itself is not the supreme criteria for achieving good GET life. "The over-simplification of GET selection can adversely affect system performance and machine productivity. Focusing on point weight, for instance, as a proxy for wear life can not only fail to deliver the expected wear-life improvement as not all wear material is created equal, but the unoptimized addition of wear material can also lead to blunt tooth wear profiles that inhibit penetration and can adversely affect dig cycle times and machine productivity.

"Additionally," Springer continued, "evaluations of GET systems based on unit price seldom deliver the desired results as any unit price-driven savings will almost always be offset by increased consumption of inferior GET and/or the lost productivity that comes from more frequent maintenance events and unplanned equipment downtime."

### Buckets Underground: Bolting vs. Welding?

Replacing buckets and GET is a normal part of any operation but, as Caterpillar pointed out, underground mines with limited access points and long travel distances from the portal to maintenance areas often find it hard or impossible to bring in assembled, ready-to-install buckets. Instead, mines often have buckets delivered in pieces, which are then welded together underground. While this method solves the problem of getting the bucket where it's needed, it comes with drawbacks. Welding takes time, skilled labor, and specialized equipment and consumables.

According to Ron de Haan, Caterpillar product support/life cycle manager, using bolt-together buckets and bolt-on GET instead of welding pieces together can significantly reduce downtime and costs for maintenance. "Using bolts instead of welds can cut your replacement times by up to 75%," said de Haan, "and you can replace them using simpler, less expensive tools."

When Caterpillar introduced its R1700 LHD for underground mining, it called at-

### Getting a Grip on GET

CR Mining recently launched the GRIPAssist Handling device, a safety, maintenance and productivity solution designed to remove and reposition GET with a minimal requirement for human interaction. The GRIPAssist unit is designed to fit on a tracked skid-steer or similar small in-pit mobile loader and has a hydraulic arm that grips GET products to enable safe, quick and easy maintenance changeouts. It's the flagship product of CR's MINEAssist product line.

Quintin Nienaber, general manager of product management at CR, said the GRIPAssist could disrupt standard GET-related maintenance practices. "We have seen changeout times halved in our initial field tests, which is an incredible outcome while at the same time improving safety. While the aim of the GRIPAssist is to remove human interactions during GET changeouts, the fact that it can enhance productivity by reducing downtime is a significant associated benefit and is a game-changer in how GET maintenance will be managed and scheduled in the future."

Weir ESCO has developed the ToolTek system, which features a remotely operated, hydraulic crane-mounted tool that is designed to remove and replace worn Nemisys GET parts without direct human interaction. New parts are pre-staged on racks positioned on the flatbed truck outfitted with the crane, and the truck also has a recycle bin for disposal of worn parts.



CR Mining's GRIPAssist (left) and Weir ESCO's ToolTek system (right) are designed to remove, handle and replace heavy GET components without direct human interaction.

tention to a new BOHA (bolt-on, half-arrow) GET design for the machine, noting that its main benefit to underground operations was elimination of the need to weld cutting-edge replacements into place. An average weld-on set of cutting edges can take 20-40 hours to replace. BOHA takes approximately 1 to 2 hours to replace and requires no welding. Plus, during extensive field trials prior to introduction, Cat matched BOHA GET against weld-on systems and found that in some cases, BOHA provided twice the life of weld-on options.

Cat announced last year it also had developed a new Durilock Lip Shroud System for underground loader buckets. The integrated bucket system features hammerless installation and maintenance-free GET retention with elastomer compression retainers. According to the company, the Durilock system delivers 50% faster installation and removal of GET compared to legacy, mechanically attached systems, and, because there is no need to re-torque bolts periodically, maintenance time for GET is reduced by more than 50%. Additionally, integral corner guards extend bucket in-service time by about 30%.

The Durilock system has three shroud styles: The D50S Standard is a traditional wedge shape used in most production and development applications. The D50A Abrasion has a contoured design and repositions more material on the shroud base, and the D50P Penetration has less leading-edge material to deliver easier penetration in dense material.

The lip assembly provides the mounting surfaces for the shrouds and corner protectors, which balance corner and center station wear rates. Cast corners are welded to the base edge assembly to create the lip assembly. The corners incorporate a stepped design that eliminates corner shroud torsional loads. According to Cat, the integral corner design boosts corner life by 15% and improves penetration compared to systems that experience corner erosion and shortened bucket life due to corner rounding.

### A Quicker Route to Advanced Alloys

Many mines choose to have GET components reinforced with hardfacing material. Some order hardened GETs directly from the OEM and others send components out to hardfacing services. Either approach involves increased costs — for purchase expense or logistical arrangements. This is an area in which the use of "big data" analysis methods has the potential to offer benefits for both vendors and customers. As an example, hardfacing materials recently developed by surface solutions provider Oerlikon Metco using its Scoperta Computational Rapid Alloy Design Process are claimed to have comparable abrasion resistance to tungsten carbide with the impact strength of manganese steel, while eliminating the need for specialized welding capabilities for proper application.

In a recent webinar, Oerlikon Metco's mining-applications manager explained how the Scoperta process provides advantages in the design of new industrial materials such as its 8247 hardfacing wire. Benefits include: 1) a rapid process that allows the company to formulate new solutions in months instead of years; 2) development of innovative material compositions with unique service characteristics to solve application issues that conventional allov development process cannot: and 3) formulations designed specifically for surface applications -avoiding a common problem in that while a bulk alloy may have the desired wear, corrosion or other characteristics, those properties often don't carry over completely when the same alloy is used as a surface solution.

"These new material technologies provide significant improvement in component operational performance and are the future of maintaining plant sustainability," said Adolfo Castells, global product portfolio manager for hardfacing products at Oerlikon Metco.

"Metco 8247 is an iron-based composite wire for use as a non-cracking hardfacing material applied to bucket teeth. We discovered that components hardfaced with Metco 8247 showed an increased component life of 200% to 400%. Teeth lasted approximately 1.5 to 2 times longer than unhardfaced teeth, leading to less frequent change-outs of components, reducing machine downtime and lowering labor costs. The use of a wear-resistant, non-cracking hardface materials such as Metco 8247 can eliminate GET failure while maintaining the designed geometry of the GET."

Scoperta allowed Oerlikon Metco's teams to develop a new family of materials including the 8247 composition with the aim of providing the highest possible level of GET hardface protection at the lowest cost. Consequently, the newer alloys don't require highly technical welding



Oerlikon Metco develops its 8247 hardfacing alloy wire by employing a new rapid product-design process that leads to results in months, not years.

methods for application and are resistant to the four common types of GET failure — abrasion, impact, gouging and, in the case of bucket teeth, tooth fracture.

According to the company, 8247 wire only requires conventional welding (GMAW or MIG) on Q & T steels and can be applied in much thinner overlays that provide significantly longer service life when compared with tungsten carbide hardfacing. The company also offers another Fe-based hardfacing material, 8223, for use on GET components made from manganese steel.

#### Making a Trade

When the word "tradeoff" appears in a product evaluation, it usually means giving up something to gain something else — possibly cost vs. reliability, weight vs. strength or convenience vs. functionality, to name a few. When it comes to the choice of abrasion-resistant steel products for mining applications, Swedish steelmaker SSAB believes it can offer a win-win tradeoff proposition involving its Hardox wear steel plate that enables customers to choose a desired advantage without incurring a corresponding penalty.

Hardox 500 Tuf is a fairly recent addition to the family of Hardox wear plate products originally introduced by SSAB in the 1970s. SSAB's technical development manager, Maurice Picard, outlined the technical and practical advantages.

"Hardox 500 Tuf enables users to replace thicker and lower hardness steels that are often harder-to-handle in the workshop," Picard explained. "It can be installed in thinner sheets when compared with Hardox 450 for example, and Hardox 500 Tuf offers a Charpy impact toughness of 33 ft-lb at -40° F, comparable to that of Hardox 450 (37ft-lb). This rating, he noted, provides very good cracking resistance in extremely cold environments."

Picard also noted that Hardox 500 Tuf offers advantages to OEMs and service fa-

cilities. Because it can be substituted for thicker steel plating, a shop won't need the high press brake machine capacity required to work on thicker sheets, and 500 Tuf requires a much lower welding preheat temperature (167°F for 5/8-in. plate) than either Hardox 450 (257°F for 1-in. plate) or Hardox 500 (347°F for ½-in.). For plates less than 5/8 in. thick, Hardox 500 Tuf requires no preheating at all.

As an example, a team from Car-Wil, a Hardox Wearparts center in Nevada, worked with engineers at SSAB's Knowledge Service Center to develop a haul-truck body liner design that significantly reduced liner-package weight and increased overall wear life. Upgrading from standard thickness abrasion-resistant steel to thinner liners of Hardox wear plate allowed CarWil to design a weight-efficient package that offers the highest wear resistance in the right places.

CarWil used ½-in.-thick Hardox 500 Tuf in the body liner's main flooring sections, replacing a 5/8-in.-thick liner of standard AR. For the tail section, where the most damaging sliding wear occurs, they specified ½-in.-thick Hardox 550. These changes more than doubled the liner's wear life and reduced the weight by 20%, according to the company, which translates into a higher capacity potential and lower fuel costs per trip.

"That means one less liner replacement over the lifespan of a heavy hauler



SSAB says the exceptional strength, hardness and toughness of Hardox 500 Tuf steel wear plate, combined with its bendability and weldability features, can improve excavator and loader bucket payload and performance.

in an aggressive mining operation or a \$75K cycle savings," said Shane Havens, CarWil general manager.

Austin Engineering, which engineers and manufactures various types of mining equipment including surface and underground haul truck bodies, began using Hardox plate in its body designs in the 1980s, employing Hardox 400 and 450 as a means to cut dead weight and increase payload capacity. Austin has turned to Hardox 500 Tuf as the next step in weight-saving design.

Austin formerly used 1-in. thick Hardox 450 to create custom body designs, but when it switched to 3/4-in. Hardox 500 Tuf, it was able to reduce component weight by 25%, according to SSAB.

"With these type of projects, it is a matter of going through every little detail to make sure that the result is as expected. We offer many tools and expertise to assist our customers. It is not only looking at increased service life or reduced weight, but also examining all steps when it comes to welding, supply of test material or stress calculations that needs to be carefully investigated before starting serial production," said Jonas Allebert, wear specialist at SSAB.

### Saving Time, Trouble and Money

The expansion of market-ready wear material choices and component design has opened the door to a wider possibility of savings for mining customers. SSAB's Picard noted that the possible weight-saving benefits of Hardox 500 Tuf isn't limited to truck bodies. It can be used in excavator and loader buckets to reduce overall bucket weight and increase payload while reducing the need to bolt or weld additional wear components to the bucket. This can provide easier digging and tangible opex savings in fuel and maintenance. SSAB pointed to a real-life example of a 5.2-vd<sup>3</sup> bucket mounted on a 60-ton excavator: the use of Hardox 500 Tuf resulted in a 14% weight reduction overall when compared with conventional steel construction, a 10% increase in steel plate service life and an approximate 3% savings in fuel amounting to 634 gal/year.

Weir ESCO's Springer said the company had seen a high level of interest in its Nemisys cable shovel system by North American iron ore producers. Multiple customers in that area have opted to convert their entire cable shovel fleets over to Nemisys thanks in part, said Springer, to the system's ability to deliver a cost-perton that was as much as 15% lower than the system they'd run previously.

"Nemisys systems for cable shovels have proven to be successful outside of iron ore as well, having delivered comparable wear life and cost-per-ton results in copper mines in Peru, a gold mine in Australia and coal mines in Western Canada, to name a few," he continued.

"Similarly, Nemisys for wheel loaders has also delivered favorable results in hard rock applications. A gold mine in North America recently trialed Nemisys loader points and saw wear life extended by more than three times vs. OEM GET (185 hours per tooth increased to 685 hours per tooth). This extended wear life helped the mine reduce its annual GET spend and improve site safety by significantly reducing employee exposure through fewer GET changes and maintenance events. Additionally, the extended wear life vielded sustainability improvements for the mine as the reduced tooth consumption translated to a savings of more than 39 tons of steel produced and 16 tons of material that must be recycled at end-of-life on an annualized basis."

### Ceramic Panels Extend Service Life

FLSmidth introduced its FerroCer ceramic wear panel line in 2017, offering it as a 44-mm-thick but lighter, easier-to-handle yet durable alternative to conventional metallic anti-wear liners. They followed up with FerroCer 22 two years later — a thinner panel by half, designed for use in applications that need or can benefit from weight savings. The company recently reported a success story involving FerroCer 22 at a major iron ore producer in Western Australia.

According to Alex Bozward, regional product line manager-material handling, the customer wanted to extend the wear life of its reclaimer buckets by one shutdown cycle, from 48 weeks to 60 weeks. This would bring a range of benefits including improved safety (fewer man-machine interactions) and sustainability (less waste generated), and lower maintenance costs. It would also allow shutdown time to be spent on other maintenance activities around the bucket wheel.

"Thanks to our close working relationship with the mining company, encompassing an installed base of more than 50 stockyard machines, we were invited to inspect the worn buckets and propose a solution. After visiting various sites, we suggested adding FerroCer wear panels to the areas of high wear," Bozward said.

Each FerroCer panel comprises a set of abrasion-resistant ceramic inserts enclosed in a matrix of malleable steel. The matrix ensures only the top surface of the inserts is exposed to material impact. The sides of the inserts are tapered within the matrix, keeping the inserts in place and preventing material particles and fluids from damaging the panels.

To test the ability of FerroCer to meet the mining company's objectives, FLS supplied three buckets — two with the FerroCer panels and one with the existing design as a control. The upgraded panels also included WearMax epoxy ceramic coating, applied inside the bucket around the FerroCer panels, as well as to the outside of the bucket to protect the FerroCer panel hold-down fixings.

"We monitored and documented bucket wear at each shutdown interval. Although in the end, two inspections were missed: one due to disruption caused by a cyclone, and one due to COVID-19 travel restrictions,"



FLSmidth's FerroCer panels consist of an array of abrasion-resistant ceramic inserts enclosed in a matrix of malleable steel. Shown here are FerroCer 22 panels being installed on a reclaimer bucket.

Bozward said. "In doing so, we had to work closely with the site team to coordinate our inspections during the shutdowns to ensure we could gain access to the buckets.

The upgraded buckets were still in service after 48 weeks — the service life of the existing solution; at 60 weeks, the target set by the mining company; and

remained in operation as the mine approached a scheduled shutdown at 94 weeks. This performance, Bozward reported, almost doubled the service life of the existing buckets, extending it by four shutdown cycles, and discussions were ongoing to push the buckets past 94 weeks to the 106-week service point and beyond.



# **Evolving Haulage for Open-pit Mines**

E&MJ speaks to Trevor Kelly about the Canada Mining Innovation Council's Alternative Haulage Project

### By Carly Leonida, European Editor

In May 2018, the Canada Mining Innovation Council (CMIC) together with its mining company members, held a workshop at the CIM convention in Vancouver to discuss its roadmaps for the future of both surface and underground mining.

"The two are very similar and we may eventually combine them to create a single mining roadmap," said Trevor Kelly, innovation manager for mining at CMIC. "Our member companies operate across a variety of commodities including oil sands, base metals and gold, but there are common threads and there are lots of opportunities for these companies to learn from one another.

"We use our strategic planning workshops to help mining companies communicate the work that they are doing and thinking of doing around innovation, and identify potential areas for collaboration. We then narrow those down to the greatest synergistic opportunities for improvement and that informs our projects going forward."

In surface mining, the five projects selected are based around alternative haulage; sensor-based ore sorting; fully autonomous mining; fully electric mining; and predictive analytics.

"The mining companies identified haulage as being one of their biggest cost drivers and also once of the biggest opportunities to potentially do better regardless of the commodities they operated in," Kelly said. "So, that's where we started."

### Identify, Assess, Model

The Alternative Haulage Project kicked off in 2018, and the first step was a technology scan with support from an engineering consulting firm.

"We identified, both inside and outside of the industry, around 30 alternative haulage technologies and groups of technologies that we were interested in learning more about," Kelly explained. "The focus is on building a transportation system for ore or waste that is optimal for different terrain/slope and haulage distances and different haulage segments.



The team is evaluating combinations of technologies for different haulage segments to give mines the best possible integrated solution. (Photo: CMIC)

"Trucks may very well be a piece of that, but right now we use trucks for everything. So, what we want to do is evaluate different combinations of technologies to give mines the best possible integrated haulage solution from an economic and environmental perspective."

Phase one completed in early 2019, and the project is currently in the second phase. Kelly refers to this as the "socialization and alignment phase."

"We are developing a process to model and evaluate the technologies," he said. "At this stage, it's more about the methodology than it is about selecting the right ones. We're working through modelling of both the mine planning and technology elements.

"It's a little bit different to the way the mining industry currently does technology adoption. Usually, we'll do analysis and a trade-off on a spreadsheet, but modelling on a spreadsheet will only take you so far. With today's technologies for modeling and simulation, a more integrated approach can be taken with multiple scenarios run in much shorter times.

"This new methodology we're working on with Deloitte is designed to utilize the software and computing power that's available today. It will cost significantly less money than a full-blown trial and will help to narrow down three or four technologies that we want to investigate per base case mine.

"After that, we can move to phase three, which is dynamic simulation and make a recommendation. And then phase four is about piloting. Phase five would be looking at doing a full-on demonstration."

As Kelly mentioned, the project is currently in phase two and, as part of that, the team has identified three mines from consortium member portfolios to model: a large, shallow, high-volume mine; a deep high-volume mine; and one that falls somewhere in the middle.

"This modelling is a change from the usual processes, and there is a great deal

of work under way to make sure there is a clear picture of the mining companies' requirements for information and data, sitebased mining expertise and the benefits from undertaking the next phase of the project," he said. "There are both technical and cultural elements that must be addressed for the next phases of the project to be successful.

"What we're looking for are not necessarily incremental changes or improvements to trucks. We're looking for large opportunities to make it interesting enough for people to commit to a new way of evaluating technology and, ultimately, transforming haulage.

"Eventually, we'd like to build models of various different technologies, like Lego blocks, in collaboration with the OEMs and mine planning people. The assumptions will be validated and scrutinized, so that each of the mining companies can then take that process that we've built and use those Lego blocks and the modelling approach that we've worked through to optimize their mines, both from a greenfield and brownfield perspective."

#### Moving in the Right Direction

So far, progress is slow but positive.

"There's a lot of discussion and we're walking a bit of a journey with the mining companies," Kelly said. "The process is a little confrontational in that it challenges how we've done things for a long time. It's not so much the technology piece, it's the cultural piece that's the sticking point. So, we're really putting emphasis on the methodology, and using the technology of the day to show senior management and other people in the industry that this is likely to work."

Currently, the project is focusing only on the haulage piece of the puzzle. Kelly added that if, in time, the project is a success, then it might be possible to create a more holistic model that incorporates front-end and back-end processes as well. But, for now, the focus is haulage.

"This is not about seeing the impact of haulage on your cut-off grade," he said. "This is purely a capital and operating discussion around haulage processes and systems.

What sort of concepts or technologies are we talking about?

"One of the members said, 'we want to do a relatively wide and deep look at what technologies are out there,'" Kelly said. "That doesn't mean that we're going to utilize them all or that they're a possibility, but that's exactly what we did.

"The technology scan looked at everything from airships to rail haulage, battery electric vehicles to trolley assist, rope conveyors, modular trucks, rail-based haulage... Some could potentially be supplied by three or four different OEMs, while others are unique. When we get to the actual modelling, we're going to go through a triage approach on how these technologies will or will not fit.

"We're working through that now. When people ask, 'why didn't you use this or why didn't you use that?' we need to have a rationale for each technology that we park, criteria that it didn't meet to move forward."

### Why Do We Need Alternatives to Trucks?

Kelly was very clear that this is not an exercise in replacing trucks; it's about finding haulage methods that complement trucks to build the best possible haulage model for each mine and allow operations to address whatever cost/operational/environmental concerns they might be facing in the future.

"Culturally, trucks are very flexible," he said. "They allow us significant freedom with regards to mine planning and they provide the ability to make changes quickly and easily if we need to. That flexibility is fantastic, but with flexibility comes some inefficiencies.

"There are obvious concerns around diesel emissions and most mining companies have greenhouse gas (GHG) reduction targets so naturally, there is a lot of interest in moving to electric or autonomous mines. These kinds of discussions are evolutionary with regards to why we're having them. It's not that trucks are bad, it's just a matter of understanding the best method for different haulage segments.

"We all know that conveyor belts are more efficient than trucks for moving material in a straight line. However, there are challenges associated with those, too. In certain elements, you're probably not going to beat trucks. Now, is that truck going to be diesel or battery-electric? Will it be battery on the bench and trolley-assisted to get out of the pit? This discussion is currently taking place.

"And we haven't even taken on the discussion yet about mining methods, se-

quencing and the impact of the haulage system on the wider mining operation that will come later in phase three. We haven't looked at how we might be able to do mining differently using different technologies to make things easier on ourselves yet. It's like peeling back the layers of an onion.

"The main considerations for all of the companies that we're working with are reducing GHG emissions and diesel usage to meet and exceed their targets."

### The Next Steps

Originally, phase two of the Alternative Mine Haulage Project was only set to last a few months. However, when *E&MJ* spoke to Kelly in February, the team was six months into it, with another three or four months to go.

"The socialization piece has been a little more confronting for the people than expected, but we appreciate the importance of this process and are willing to take the time needed," Kelly said. "So, we've been allowing people to hear things and sleep on it. The goal is to start the physical modelling by the end of this year but, at this point, it's still hard to say for sure because we're not sure what the overall cost is. We're still working on some estimates.

"I would think that the modelling phase, phase three, will probably start in 2022 and that will take six months or more."

The team is aiming to have a pilot ready for 2024 to trial certain system components, or material transfer from one technology to another. Although there may be some design work involved.

"At the moment, it's hard to say because we don't know which technologies will be combined together," Kelly said. "It's hard to predesign any of these things or get work going in advance because we're curating as we go."

Funding is the other piece of the puzzle... "CMIC is industry funded," Kelly said. "We are always open to having more companies participate in this and other projects and we continue to investigate government funding and other opportunities to supplement this.

"We're looking for funding to help offset the requirements of mining companies to pay the full price and see what we can do to help them share some of the cost burden and risk. That's an ongoing challenge...."

# **ESG Diversifies Haulage Underground**

E&MJ explores the growing opportunity for new haulage technologies and concepts underground

By Carly Leonida, European Editor



Automation is changing the face and pace of haulage, making mines safer, more efficient and profitable. (Photo: Sandvik)

As the old saying goes, if you always do what you've always done, you will always get what you've always gotten. In the past, what we've always gotten from mine haulage has been good enough, and there has been little incentive to break away from tried and tested methods (truck, conveyor, skip or rail) for material handling underground.

While there has always been more variation in underground haulage methods than those used in surface mines, as operations delve deeper and pressures surrounding cost, safety and environmental performance mount, there is a growing business case for new technologies like automation, battery electric and ultra-clean diesel engines, and also for more innovative haulage concepts.

"Sustainability with all of its different aspects has started to play an ever-increasing role in mining companies' investment decisions during the past 10 years," said Pia Sundberg, product line manager for trucks at Sandvik Mining and Rock Solutions.

"Generally, we see a shift toward larger equipment in underground operations, and also haulage equipment is expected to support mines to reach their more demanding productivity goals. That requires productivity, reliability and low total cost of ownership from the loaders and trucks. "Practically all of our customers are talking about, and requesting, cleaner technologies now. Local legislation is a key driver, as well as the general proactive approach toward environmental issues."

Jim Fisk, executive chair of Rail-Veyor Technologies Global, reported similar findings. "Today, mine executives are more concerned than ever with the environmental factors of a haulage system whether it is for a brownfield or greenfield operation," he said. "I think that's the biggest change I've seen in the last few years.

"There was always a consideration to make mines, and thus haulage systems, safer and more economical. However, the familiarity of what was done in the past always holds a big emotional sway in the discussion."

Lisa Youngblood, executive director of marketing and communications at Rail-Veyor, agreed: "With investors becoming more and more interested in the environmental, social governance (ESG) of a company and its supply chain, how a supplier sits within that ecosystem is very important. When you can marry safety, environmental consciousness and economy, it gets attention. And, I'd add that, since the pandemic, automated systems are also being looked at as a serious need.

"In mining, there are so many perceived risks when it comes to adopting 'new' technology. It's not generally something that mine operators want to do. The push typically comes from the top management as they hear concerns of the communities where the mines are located or from investors."

### Optimizing Traditional Haulage Methods

Flexibility and low investment costs are among the principal benefits of truckbased haulage. Units can be easily moved from location to location, without permanent infrastructure that, for example, skip or rail-based solutions require. They also offer redundancy in the case of breakdowns. However, all mines are different, and the size and shape of the orebody as well as the mining technique and mine plan over the life of an operation will greatly influence the haulage method selected.

Aside from the obvious environmental benefits offered by battery-electric and advanced diesel-engine technologies, automation probably has the greatest potential to affect change in truck fleet performance.

Jouni Koppanen, product line manager for underground automation at Sandvik Mining and Rock Solutions, joined the conversation. "With the huge developments in digitalization and connectivity, the potential to increase safety, productivity and overall efficiency with less equipment breakdowns is being proven very successful at more and more sites," he said. "This also convinces other mining operations that automating fleets provides a high return on investment.

"In addition, there is a shift in the appetite of the mining industry. We are seeing more planning for automation from the prefeasibility phase, and more implementation of automation. Mining deeper and in more challenging conditions underground requires a high degree of operational flexibility, mobility and adaptivity, which are the main focus of Sandvik's AutoMine and OptiMine offering with mobile equipment fleets." Sandvik's AutoMine product group for autonomous and remotely operated mobile equipment includes AutoMine Underground and AutoMine Surface Drilling.

AutoMine is integrated with OptiMine — Sandvik's digital analytics and optimization suite — for production planning and automatic dispatching of tasks to AutoMine for production execution.

"Network technology is constantly evolving, which provides different types of technical solutions for different mining environments," Koppanen said. "For example, Sandvik surface navigation now enables autonomous underground machines to also work on the surface with seamless transition from underground to the surface."

Sandvik is also utilizing developed network technology to provide mines with the ability to operate automated machines from several locations and over short or long distances, which gives more flexibility for planning at large-scale operations.

Besides trucks, shaft hoisting remains one of the most cost-effective and enduring methods for material handling, particularly when mining a large orebody deeper underground.

From a sustainability point of view, hoists can be run using renewable or sustainably sourced electricity to eliminate fossil fuels. However, they require a significant capital investment compared to trucks, and they lack the flexibility of mobile haulage. Then again, truck operating costs are greater than those associated with hoists.

### **Doing Haulage Differently**

Ventilation is another huge cost consideration. At underground operations, air laden with dust and diesel particulates must be removed and fresh air brought to the face in order to sustain working conditions. However, ventilation shafts are a huge expense. If the haulage method selected does not contribute to air contamination, how much could a mine operator save through ventilation? And, if the haulage method can be situated in a contaminated air drift, there is an added benefit.

"Obviously every mine operator wants more for less," Fisk said. "That is how they make a profit. If alternative haulage methods don't require more ventilation and/or have reduced energy consumption, then the mine can make money with a lower cut-off grade of ore. That in turns gives more life to existing mines." While Rail-Veyor's technology is not new (the concept can trace its roots back to the 1960s), it is still yet to be considered mainstream. However, the company has experienced a surge in interest recently and high-profile success stories like the haulage system at Agnico Eagle's Goldex operation in Canada (detailed in *E&MJ* February 2021), provide an example of what can be achieved if mining companies are willing to look and think outside of the box.

The Rail-Veyor system consists of a very low-profile train running on a 40-lb rail. It is fully electric, so the environmental benefits include reduced ventilation requirements for underground operations and, for surface applications, there is no water usage required as the system doesn't produce dust.

Rail-Veyor described its technology as "TrulyAutonomous." In practice, what this means is the system is programmed from loading to unloading and monitors itself; no operators are required.

"We optimize the system for the tonnage requirements the project needs to meet," Youngblood explained. "Because it can navigate difficult terrain, around tight corners and up steep grades, we can fit inside an existing mine route with little to no additional development needed.

"And, if the mine is new, and we get in on the ground floor of mine planning, we can change the way mine haulage is done to take advantage of all our benefits. This includes not needing to mine on a horizon or flat drift and then skip to other levels as with traditional rail solutions.

If operated according to the design specifications, Rail-Veyor systems are expected to last 20 years with no need for midlife overhauls. If the life of mine isn't that long, then the system can easily be relocated or extended. Planned maintenance is mostly inspection-based.

"Traditional diesel haul trucks might be cheaper, but they won't last as long without a midlife overhaul or needed to be completely replaced," Fisk said. "And when you take into consideration the cost of construction and maintenance ventilation shafts and skips, the CAPEX is greatly offset.

"Our OPEX costs are far lower than any other method. We are 92% cheaper at one installation than the previous haulage method they had. It's also cheaper to install than a conveyor because the light rail component of the Rail-Veyor system does not need the infrastructure that a conveyor does."

### Changing the Way We View Haulage

Have you seen a shift in miner's attitude toward alternative haulage methods over the past 10 years?

"I'd say miners are more aware and more accepting of viable alternatives," replied Youngblood. "It has really changed in the last two years with the increased demand for ESG requirements by stakeholders. Environmentally minded investors are pushing the agenda.

"Additionally, there has been a huge shift in attitudes to the acceptance of automated systems because of the pandemic. Mine operations want to reduce the number of people that are in harm's way, whether from rubber-tire vehicle collisions, fire or now microscopic invaders. As more technology is adopted in all areas of mine production, more operators are exposed to alternative methods and gain the familiarity, which is needed for widespread adoption."

"I think over the next 10 years, we will see more diversification in mine haulage globally," Fisk said. "I've heard experts say that material transport is 70% of mine costs. If that could be reduced in half, then mines would be able to go after lower grades of ore and still make money. That greatly evens the playing field for the juniors."

Sandvik's Sundberg was diplomatic in her outlook: "What we know is that developing new technology takes time, and to be able call new technology proven will also take time," she said. "Simultaneously, innovations are needed because of the social responsibilities and also commitments to shareholders.

"This leads to an interesting situation where we need to be able to guarantee productivity, which, of course, requires proven equipment, but also at the same time to have courage to try something new. It's very seldom possible for a mine to make a complete change in its operations, i.e., to change from truck haulage to something totally different. But, when it comes to entirely new operations, there is more room for new technologies."

Sundberg added: "Having the ability to innovate and improve, and the courage to try new technologies will help us to reach end results which are successful for all. There are no shortcuts to success, we need to work for it, all of us."

### **Disruptive Metallurgy for Cleaner, Greener Battery Metals**

*How novel hydrometallurgical processes are enabling more efficient and sustainable extraction of battery metals* 

By Carly Leonida, European Editor



Copper is, by volume, the one metal upon which electrification depends. (Photo: Matthew Henry, Unsplash)

The global shift toward electrification will balance the use of fossil fuels and transition individuals, groups and businesses to using more sustainable energy sources.

But can the green energy revolution truly be called "green" if the metallurgical processes that underpin critical metals production carry a high level of inefficiency? And, just as importantly, can demand for metals like copper, nickel, lithium and cobalt be met with current production methods?

According to the World Bank Group report, "Minerals for Climate Action: The Mineral Intensity of the Clean Energy Transition," the production of minerals such as graphite, lithium and cobalt, could increase by nearly 500% by 2050, to meet the growing demand for clean energy technologies.

The group estimates that more than 3 billion tons of minerals and metals will be needed to deploy the wind, solar and geothermal power required for achieving a below 2°C future, as well as energy storage.

That's a colossal figure. One that doesn't consider the amount of waste

material produced using traditional hydrometallurgical and pyrometallurgical extraction methods, nor the emissions generated — carbon, water, heat or otherwise.

While current extraction methods have enabled mining companies to keep pace with demand for metals thus far (hence, their longevity), the step-change required in production as well as environmental performance going forward will require new, more efficient technologies. In turn, those could create opportunities for new business models and streams of revenue.

### Jetti Resources: Catalytic Change in Copper

Hydrometallurgy is typically used for extracting gold and battery metals like lithium and cobalt, as well as other minerals. It is also used predominantly for copper extraction, where pyrometallurgical methods are challenged by lower grades, high energy use and high capital investment requirements.

Copper, although less exotic than other metals used in electrification, is by volume the one metal upon which electrification depends, due to its conductive properties and lack of potential substitutes.

Colorado-headquartered technology company, Jetti Resources, estimates that 70% of the world's copper resources — worth more than \$20 trillion — are tied up in primary sulphide ores, which are uneconomic to extract using traditional solvent extraction-electrowinning (SX-EW) methods.

The company has developed an innovative leach catalyst to address this. The technology is already in use commercially at Capstone Mining's Pinto Valley copper operation in Arizona (See *E&MJ*, January 2021), and Jetti is currently in advanced testing with some of the largest copper mines in the world, including 20 in the Americas.

*E&MJ* spoke to chief technology officer, Dr. Nelson Mora, for a more in-depth look at the technology.

"Enabling electrification is a key requirement to transitioning to a low-carbon economy, and the mining industry will have to play a huge role in supporting the transition by supplying the growing volume of battery minerals required," Dr. Mora said.

For copper in particular, the industry faces significant challenges in supplying these minerals in sufficient quantities and in a sustainable manner. Issues such as declining ore grades, mine footprint, emissions and water usage are becoming increasingly acute.

"Hydrometallurgy can be instrumental in solving these challenges," Mora said. "According to Wood Mackenzie, leaching uses three to four times less water and around four times less electricity than pyrometallurgy. The use of leaching technologies also reduces the amount of transport required to move large volumes of concentrate to smelters, which are often in China, and the greenhouse gas (GHG) emissions related to the smelting process.
"Furthermore, when technologies such as Jetti's are integrated with existing leach systems, waste materials can be transformed into valuable resources, increasing mine life and reducing mine footprint. Hydrometallurgy can help to provide a greater and sustainable supply of battery metals, therefore enabling the transition to an electrified low-carbon economy."

Previous efforts to solve the sulphide leaching problem have typically focused on using very energy-intensive processes, such as subjecting the ores to high temperatures or crushing them very finely. By doing so, the copper might be extracted rapidly, before the passivation layer forms. However, these processes are expensive and uneconomic at scale. Other alternatives require massive capital investment to prove out a solution.

Jetti's patented catalysts disrupt the sulphur-metal bonds within the mineral, allowing copper extraction to take place unimpeded.

"Our technology was developed through years of research with partners at the University of British Columbia," Mora explained. "It uses a proprietary catalyst that enhances yields from heap leaching of chalcopyrite. The technology integrates seamlessly with process flow sheets at existing operations, which means utilizing the technology requires low capital and operating expenditure."

#### Economic and Environmental Benefits

When applied to low-grade copper primary sulphide ores, Jetti's technology increases copper extraction by up to 300% compared to traditional processes, and because it integrates with existing infrastructure, the additional costs incurred are minimal. Jetti can therefore effectively create a new mine in months rather than years with low levels of CAPEX and OPEX and, in an environmentally responsible manner.

"It is important to recognize that production via the leaching and SX-EW route has been in long-term decline due to declining reserve quality and lower ore grades," Mora added. "Jetti's technology can reverse this process by enabling existing SX-EW operations to process ore that was previously too low grade to be processed economically. This has the potential to reinvigorate a number of aging operations while providing an alternative to the development of brownfield concentrate operations."

While Jetti's technology does have the potential to be adapted to extract other metals, for now, the company plans to focus only on copper.

"Given the versatility of the technology, it has the potential to be used across the copper industry, so the opportunity is already very significant without looking at other metals," Mora said.

"For example, it can be applied at mines with existing SX-EW plants that have unutilized capacity; operations with historic dumps; greenfield deposits with large amounts of sulphide ore that might be currently uneconomic; and mines with concentrators that are unable to treat all the low-grade material in the deposit."

The potential to use in-situ leaching is mainly dependent upon the nature of the deposit, the natural fracturing density of the host rock in the ground and the presence of a naturally occurring containment layer such as clays. So far, few copper deposits have been found that meet these requirements. However, if those ideal settings are present on a primary sulphide copper deposit, then Jetti's technology could be adapted for in-situ use, too.

The principal economic benefits of the technology are twofold: first, because it integrates easily with existing SX-EW process flows, it can deliver significant increases in copper yield with minimal upfront CAPEX requirements other than the installation of an on-site catalyst addition facility — there is no grinding or heating required (in contrast to pyrometallurgy). The increased copper yield results in lower unit costs of production.

"Second, because it enables the exploitation of low-grade ores, it results in mine lives being extended through the conversion of resources into reserves by converting waste streams and uneconomic deposits into valuable assets," Mora said.

The environmental benefits can also be significant. Water usage is a particularly important issue in the copper industry. The biggest producers of copper globally are Chile and Peru, which are water constrained countries. In the future, these problems are likely to become more prominent as mines continue to deplete their reserves while copper demand increases to support the transition to low-carbon energy.

Additionally, using hydrometallurgical processes also requires less power and transportation than pyrometallurgy, meaning 40% less  $CO_2$ , 70% less SOx and 70% NOx associated emissions are generated.

Finally, because Jetti's technology enables operators to make better use of existing resources, it reduces the need to disturb untouched ground or to develop new mines, which are increasingly found in environmentally sensitive or water stressed areas.

#### Clareo Thinks Outside of the Box

Growth strategy specialist, Clareo, has been working with a number of companies including miners and technology



Jetti Resources estimates that 70% of the world's copper resources are tied up in primary sulphide ores, which are uneconomic to extract using traditional solvent extraction-electrowinning methods. (Photo: Jetti Resources)

developers to reimagine leaching applications for battery metals. Partner, Satish Rao, joined *E&MJ* to talk about technologies and concepts that could improve the horizons in copper production.

"Given the importance of battery metals and the enormous demand that everybody's foreseeing over the next couple of decades... Ore grades are already low, they're going to get even lower," he said. "The question is, can you go after battery metals, which the world is shifting toward because of ESG concerns, with wasteful processes?

"Of course not. The accounting at the end user will eventually drive back to how the metals were extracted. You have to go with the most sustainable approach and that will translate into the economics as well."

Copper sulphide ores are traditionally processed through concentrators, whereas oxide minerals are more amenable to leaching, which is significantly lower in cost. As the balance has shifted over the past 50 years and oxide deposits have become depleted along with highgrade sulphide deposits, attentions have turned to optimizing the extraction of lower grade sulphides.

"At the point where ore grades start to decline, making project economics work for a concentrator becomes harder," Rao explained. "In order for the concentrator to be efficient, you typically need to upgrade the ore, and there could be a lot of grinding and milling involved with that. When you're targeting low-grade ore that tends to be expensive and energy intensive.

"In leaching, project economics are often constrained by recovery times. The leaching process is also extremely inefficient. In the future, 50%-60% recoveries over a one- to two-year timeframe won't be good enough. We need to get recoveries to 70%, 80% or even 90%. If we can do that then the opportunity is immense."

While there have been advances in recent years in mobile conveyor technologies, better irrigation systems etc., the heap leach process has remained fundamentally unchanged. It is still dependent upon gravity to coax the lixiviant through the crushed material.

"If we look at new technologies, there are a lot of possibilities in nanotechnology, artificial intelligence, new materials, biotechnology... Initially, you think, what do they have to do with leaching? But, when combined with IoT-enabled sensors, they could really change the paradigm in conventional leaching applications," Rao said.

There are a number of ways that new technology can be incorporated into leaching. For example, a key challenge with heaps are "dead zones" — areas that do not get irrigated properly or receive inconsistent flow. This impedes or prevents the chemical reaction from taking place.

"That's where you could bring in sensors to monitor the flow," Rao said. "There are some increasingly low-cost approaches to understanding what's actually happening below the surface. And,



Jetti's leach catalyst technology is already in use commercially at Capstone Mining's Pinto Valley copper operation in Arizona. (Photo: Capstone Mining)



Demand for lithium hydroxide as a product for lithium-ion battery cathodes has grown hugely over the past five years. (Photo: Chuttersnap, Unsplash)

if you're in a position to measure flow, temperatures and chemical reactions throughout the heap, then you could mine much smarter."

#### Nanotechnology, Electromagnetics and More...

Rao and his team are currently advising a company called Moleaer, which started out in the water treatment and agriculture sectors, applying nanotechnology to deliver better oxygenation in water irrigation systems.

"They've created nanobubbles that can be filled with various gases," Rao explained. "And they behave differently to larger bubbles. With larger bubbles, because the air is lighter than water, they would float up to the top and pop. But nanobubbles tend to stay in a suspended state, which means that you could oxygenate the aqueous environment for a long duration without losing gas to the air.

"Those nanobubbles could potentially be used to oxygenate heap leach environments, too."

Clareo has been exploring ways to apply artificial intelligence, and rapid simulation and testing capabilities developed in the pharmaceutical industry to optimize lixiviant chemistries for leaching.

Biotechnology also holds much promise. While bio-based leaching has been around for a while, synthetic biology is pushing the boundaries in this field and, again, the ability to simulate the effects of different microbes at different scales quickly and accurately could be a game changer.

"If we can bring better computing power and more simulation into the field of bio-based leaching, I think that's where the next level of breakthroughs might come through," Rao said. "Companies like Cemvita Factory are starting to do that." The team at Clareo is also investigating some non-conventional ways to optimize leaching. For example, using electromagnetics or microwaves to pre-treat ore and improve the reaction rates.

"By and large, the industry is still focused on conventional ways to enhance leaching, and there's a lot to improve there. But what if we bring other disciplines into the mix?" wondered Rao. "Whether it's pre-treatment during agglomeration, or other areas before you get into an aqueous-based process."

In-situ leaching, while not new, could also offer possibilities when combined with new recovery technologies.

"With in-situ leaching, you don't have to build a processing facility so there's a lower capital intensity, and possibly a shorter time to production and improved safety," Rao said. "There's a lot of benefits beyond ESG.

"However, when leaching in situ, you still have to figure out the right preconditioning approach. If you can't do the traditional things like agglomeration, perhaps you could impart energy using vibrations, sound, lasers or microwaves. Or maybe you could use bacteria to weather the rock.

"Then you have to figure out how to extract, separate and transport the ore. And again, there's some crossover with new ideas for heap leaching. Can we construct something similar to a heap leach, but in-situ using the nanotechnology or sensors to understand the best lixiviant chemistry and flow through the ore?

"That's a strategic way to look at heap leaching; as a proving ground for in-situ leaching. And why stop there... why not do SX-EW in-situ as well? I do think there are opportunities if we just think creatively. Often the answers to these problems come from unexpected places. You just need to have an open mindset."

#### Lepidico: Upping the ESG Stakes in Lithium

Of course, copper is not the only "battery metal" that is ripe for recovery improvements through hydrometallurgy. Until 10 years ago, the lithium industry was primarily characterized by one hardrock mine — Greenbushes in Western Australia — and a number of large brine operations in South America. The market showed mid-low single-digit growth per year, and there wasn't much incentive to bring new capacity online. However, the advent of lithium-ion batteries changed everything, and demand for lithium hydroxide in particular as a product for lithium-ion battery cathodes (versus lithium carbonate) has grown hugely over the past five years with no signs of stopping.

Lithium mica and phosphates have largely been overlooked by the industry as sources of lithium hydroxide, until recently. However, lithium mica minerals including lepidolite and zinnwaldite are polymetallic and recovery can now be configured to create multiple product streams. This approach allows miners to diversify their business models and reduce their exposure to market risk.

Exploration and development company, Lepidico, has developed a suite of novel processes, including L-MAX and LOH-MAX to enable efficient, economic production of lithium from these minerals.

The company is the brainchild of its chairman Gary Johnson. During the 1990s and 2000s, Johnson worked with LionOre and Norilsk before setting up his own metallurgical consulting practice, Strategic Metallurgy.

"The team had been doing some work on mica minerals trying to produce sulphate of potash (SOP) fertilizer. It was a technical success but an economic failure," Joe Walsh, Lepidico's managing director, said. "There just wasn't enough value in the SOP to support the process. But it got the Strategic Metallurgy team thinking that there are mica minerals that contain other elements that intuitively have more value. For example, lepidolite, which also contains lithium, cesium and rubidium."

The team obtained a specimen of lepidolite, ground and leached it and managed to efficiently get the contained metals into solution. In 2014, after further development and several phases of seed capital, they had the bare bones of the L-MAX process and lodged a patent application. By 2015, the team had run their first continuous mini-plant trial in the lab. Walsh joined as managing director in 2016, put together a five-year strategic plan for the business and built a team with the objective of commercializing the technology.

"Nearly five years on, our strategy has not changed," he said. "The timing of a few things has pushed out as invariably happens in the mining space, particularly after a two-and-a-half-year bear market in lithium. But the strategy is very much the same, it's still centered around commercialization of the L-MAX process."

Lepidico remains closely aligned with Strategic Metallurgy and, in 2017-2018, as interest began to grow in lithium hydroxide as a product for lithium-ion battery cathodes, the team began to look at adapting L-MAX accordingly.

"In a risk-review, we had identified that at the backend of L-MAX, where lithium sulphate is converted to lithium carbonate using industry standard process steps, there was a potential flaw," Walsh said. "The conventional process is to use sodium carbonate to produce lithium carbonate, as well as byproduct sodium sulphate.

"While we had identified a purchaser for our sodium sulphate, we weren't convinced



Copper sulphide ores are traditionally processed through concentrators, whereas oxide minerals are more amenable to leaching which is significantly lower in cost. (Photo: Capstone Mining)

that, over the project life, there would a market for this product. Sodium sulphate is a mature market globally, with the main uses being in powdered detergents and in pulp and paper manufacturing.

"So, we challenged the team at Strategic Metallurgy to develop a new process to convert a lithium sulphate intermediate directly to lithium hydroxide without production of potentially problematic sodium sulphate, and that's how the LOH-MAX process came about."

The patent for LOH-Max was lodged in 2019 and Lepidico integrated it into the development plan for its Phase 1 project. Both L-MAX and LOH-MAX have now been successfully piloted.

"One of the things that Lepidico has been very keen to do is base it's process technologies on a reagent regime which is ubiquitous in the industry," Walsh said. "In leaching, the go-to acid is concentrated sulphuric acid. It's widely available and affordable versus other acids. And, when it comes to neutralization, the go-to reagents are either limestone or lime."

Lepidico has also deliberately steered away from using pressure vessels in its processes to limit their energy intensity; the whole system operates at atmospheric pressure.

"One of the advantages of leaching using concentrated sulphuric acid is that it creates an exothermic reaction," Walsh said. "We actually have to limit the acid addition to stop the first reactors from boiling. We use a modest amount of energy to initially warm up the reactors, but then the heat is generated from the reaction itself. It makes for a highly energy-efficient process.

"We are very mindful of our environmental and social credentials and responsibilities. Really, the only emissions are some  $CO_2$  and low-grade steam. And, if you compare our processes to the rest of the industry, we're right at the clean end of the spectrum, even on the  $CO_2$ basis. We have identified areas for improvement and will certainly be looking at opportunities to get our emissions down to zero in the future."

#### Creating a Profitable, Circular Process

How do L-MAX and LOH-MAX work?

"A lithium mica and/or phosphate concentrate is fed to the front end of the L-MAX process," Walsh explained. "It starts off with a concentrated sulphuric acid leach. With many other lithium processes, a lot of effort goes into minimizing the sulphuric acid addition. We're less sensitive to acid usage because we want to get all of the elements — lithium, cesium, rubidium and aluminum into solution, as we can derive value from most of these, whereas most other processes don't benefit from byproducts. We consume about a ton of acid for every ton of concentrate we produce. All of the



Both the L-MAX and LOH-MAX processes have now been successfully piloted. (Photo: Lepidico)

metals go into solution in a highly efficient manner, with extraction rates of well over 90% after 18 hours."

In fact, there are parts of the plant where Lepidico is looking to implement heat capture technology to minimize heat waste. Ultimately, the company is looking to build its own sulphuric acid plant and generate power as a byproduct, but that's a story for another article...

"The residue from the sulphuric acid leach is a highly reactive amorphous silica, which is an effective supplementary cementitious material," Walsh said. "By partly substituting cement in concrete, it can lower the  $CO_2$  footprint of the concrete and it also improves its compressive strength. This is the first byproduct from the process.

"We then cool and filter the leach liquor to remove the first precipitate. The liquor then goes through a series of neutralization steps, which allows various impurities to be selectively removed. To do that, we use lime or limestone. The pH ranges at which the impurities precipitate out are quite broad, so we don't need to finesse the pH too carefully. It's a userfriendly process in that regard."

There is some reasonably elegant chemistry involved to selectively remove the cesium, rubidium and potassium as one residue stream while leaving the lithium in solution.

"The lithium stays in solution right the way through the process creating an alkaline liquor and eventually lithium sulphate," Walsh said. "This is when the LOH-MAX process comes into play. LOH-MAX actually uses aluminum hydroxide rather than sodium-based compounds employed in conventional processes. And because there's aluminum in the system already, we're not introducing a new impurity into the process."

LOH-MAX is less energy-intensive than conventional lithium sulphide to hydroxide conversion processes because it only requires a single crystallization step and there's no requirement for a chiller. These features along with the addition of a recycle stream means it can also offer a four-percentage point improvement in recovery.

"Compared to a typical 20,000-mt/y spodumene conversion plant, the CAPEX saving is estimated at around \$50 million, the operating cost improvements are about US\$8 million a year," Walsh said. "When you package all of that up, the NPV benefit of LOH-MAX is well over \$100 million over a 10-year operating life for a nominal 20,000-mt/y output spodumene converter."

Lepidico has another patented but, yet unnamed, process that allows it to separate out potassium, cesium and rubidium from one of the L-MAX residue streams.

"Our main products are lithium hydroxide, cesium sulphate, rubidium sulphite and SOP fertilizer (potassium); those are all on the U.S. state department's list of 35 critical minerals," Walsh said. "I think this is the only process technology that addresses four of the 35 critical minerals. And then we get the additional benefits of the amorphous silica as well."

Cesium and rubidium are relatively small, opaque markets. Historically, the main source of cesium is a mineral called pollucite. Most of the worlds pollucite reserves are now depleted, and so that brings the focus to lepidolite as the next logical mineral source of cesium, and it also contains rubidium.

"We'll be bringing to market the world's first-ever commercial source of rubidium," Walsh said. "And rubidium sulphite can be used in many applications as a substitute for cesium sulphate."

With five potential product streams there can't be much waste from the process...?

"Through the neutralization stages, we're putting limestone or lime into the system, meaning that much of the residue that reports out is gypsum," Walsh said. "We're looking at building our Phase 1 Plant, which is really proof of commercialization, in Abu Dhabi and it's scaled for that purpose. The UAE imports mineral gypsum, and we'll be producing a locally manufactured source of synthetic gypsum."

The remaining residue is a mixture of gypsum and allunites and Lepidico has been working with the University of Waterloo in Ontario to evaluate the use of this residue material from the Phase 1 plant to rehabilitate landfill sites.

"One of the opportunities we see is to have a chemical process with only products and effectively zero waste," Walsh said.

Aside from the economic benefits, a zero-waste process is a significant step toward creating circular business models; something the mining industry needs more of going forward.

"We do have  $CO_2$  emissions albeit relatively modest by industry comparison," Walsh explained. "But we plan to capture that  $CO_2$ , scrub and clean it, and then it's either released, or we can compress the  $CO_2$ , pass it through the lithium hydroxide, which converts it into lithium carbonate if required."

Could you potentially capture more carbon than you produce?

"Yes, it's an opportunity that we will be considering as part of our strategy going forward," Walsh said. "There is a market for compressed  $CO_2$ ; it goes into carbonated drinks and has various industrial applications."

#### From the UAE to the UK

Lepidico has completed a definitive feasibility study for the vertically integrated Phase 1 project, which requires the re-development of two open pits at the Karibib mine in Namibia, along with building a new small-scale flotation plant to produce the lepidolite-amblygonite concentrate that will be exported to Abu Dhabi to feed the Phase 1 Project's L-MAX chemical conversion plant.

"Abu Dhabi is the world largest producer of sulphur, so there's an abundant, affordable source of sulphur, which we can use to manufacture sulphuric acid," Walsh said. "There are also markets for our bulk byproducts; the Middle East imports about 100,000 mt/y of SOP fertilizer largely from Chile.

"We'll produce about 12,000 mt/y of SOP and be the only local producer. There's also a market in construction for amorphous silica. It's a strategic location that will allow us to minimize our costs and maximize our revenue, and that more than offsets the cost of transporting the concentrate from Namibia to Abu Dhabi."

Part of the UAE's 2030 vision is to move its economy away from reliance on oil and gas and introduce new industries, which will now include producing lithium for use in electric vehicles.

"We've completed the definitive feasibility study, and the three main workstreams to transition the vertically integrated project to development are: permits and approvals, product offtakes and finance," Walsh said.

Lepidico is looking at commissioning in Namibia in the second half of 2022, with production in the latter part of the year. The Phase 1 chemical plant in Abu



Lepidico has developed a suite of novel processes to enable the efficient, economic production of lithium from lithium mica and phosphate minerals. (Photo: Lepidico)

Dhabi is set for commissioning in the first half of 2023.

And, as if that wasn't enough, the company also announced a collaboration with Cornish Lithium in December 2020.

"We see ourselves as being an enabler, collaborating with industry," Walsh said. "And that's exactly what we're doing with Cornish Lithium in the U.K. They've purchased the first license for our technology suite, which includes a royalty-free period.

"They can assist in broadening out the application of our technologies into the wider lithium mica mineral suite and demonstrate commercial viability on minerals that include zinnwaldite and polylithionite. In return, the technology gives Cornish Lithium a huge shot in the arm. It's taken us eight years to get to this point of technological development. They can now go straight into piloting. They purchased not just the license, but also the design pack for our pilot plant too, which should really enable them to fast track their project.

"We'll support them where we can, and the team at Strategic Metallurgy is supporting them as well," Walsh added. "I think it's a fabulous outcome for the industry, that there are green credentialed projects in the southwest of England and the UAE that could produce the first commercial quantities of lithium for both these countries."

# Change Your Mind, Change Your Mine

Advanced networks and communications solutions are gaining acceptance incrementally as knowledge of the numerous options and benefits available grows

#### By Jesse Morton, Technical Writer

As in the civilian world, advances in communications technologies underground have vastly outpaced the advances in pretty much all other areas. Meanwhile, many mines that were prefeasibility-studied 30 years ago, that reached first production 20 years ago, and that are now in the prime of their life have developed according to long-term plans crafted back when the archetypal mine phone was the gold standard.

When those mines have pushed their leaky feeder system as far as it will go, when their nearest mine phone is an uphill mile from the face, change is at hand. And change for the better. However, the first change required is one of mindset.

#### Ask Questions, Build a Vision

The biggest challenge most underground mines face when assessing their network and communication systems needs is a lack of vision, Matrix Team reported.

"They generally have an idea of what they want to see," Brian Jones, vice president, business development, Matrix Team, said. "But they may not fully understand the capabilities of what is out there or know exactly what the right questions are to ask when looking into communications systems."

Most have a very specific problem they want solved and begin their research as a quest for an exact solution.



NLT N-Connex allows users to customize their network. The modular network supports a range of solutions that use WiFi or Ethernet connectivity. (Photo: Matrix Team)

"Normally when you get to the minelevel guys, they'll tell you they want radios that work," Brad Coats, technical sales representative, Matrix Team, said. "That sometimes is their answer, communications, so they can speed up repair times."

They typically see adopting a network as an expense. "They ask, 'How do you justify the cost?" Coats said.

Also common is the mine with multiple separate networks. "They'll have cameras on one, and radios on a second," Coats said. "They are running a little bit of data and a little bit of control, and they won't integrate it into one network. So they are maintaining just a ridiculous amount of hardware and gear."

In both cases, the miner should be asking how going to a single high-speed network can up efficiency, Coats said. The answer plugs to solutions for communications, tracking, ventilation on demand, teleoperation, WiFi blasting, incab computers and analytics, and more.

"It is only limited by your checkbook and your imagination," he said.

For some, the first step in expanding their imagination requires considering communications outside of just voice, Jones said. "Realistically, right now the trend is moving toward data," he said. "The challenge is shifting thinking away from simply wanting to be able to talk on radios to putting in cameras and watching everything, and on to blasting from the surface over WiFi."

For those with multiple networks in place, it usually requires breaking from ingrained thought patterns. "You have to get people to get over the old adage of we've always done it this way," Coats said. "They could rip all that stuff out and put in one network capable of doing everything they are doing right now."

An underground limestone mine in Appalachia with an aging leaky feeder system and a failing radio system shows the thought process the typical customer tracks when shopping for communications and network solutions. "They were unhappy with the performance of what they had," Coats said. "This mine was ready to move forward and try something."

What started as a limited inquiry into strictly radios soon blossomed into an interest in tracking. From there the vision grew.

"The third piece that we added was the camera network," Coats said. "We plugged all the cameras in so now we can have six or eight cameras at any one time monitoring different parts of the mine."

The miner then adopted WiFi blasting. "They've enjoyed that because of a safety initiative they are working on," he said. "They set the system up. It hooks into the network. The blasters come outside and shoot. There is no one underground when a shot goes off."

Lastly, the mine added an air quality station. "They can keep track of all their gasses throughout the day," Coats said. "The software also does the trending."

Up next is individual vehicle diesel monitoring. "We monitor the airflow going into a piece of equipment, how much diesel it uses, how it is using the diesel, and what is coming out of the tailpipe," he said. "That can be used for preventative maintenance, but it also shows you how efficient your equipment is throughout the day."

The final piece is a new analytics offering by Matrix that synthesizes all the data generated by the network and distills it into useful information. "That is the next stage," Coats said. "It is getting to that point of being able to take complete control of your mine, knowing how efficient you are."

The many solutions adopted or under consideration were developed by Matrix or are the fruits of strategic partnerships.

For example, the backbone of the network adopted is Matrix's NLT N-Connex, a high-speed modular fiber-and-Ethernet network that is fully compatible with 802.3 and 802.11 devices.

The analytics offering under consideration, Matrix Analytics, arose from the acquisition of a company from South Africa. "It does a really good job of honing in and showing what is really important," Coats said.



The Maestro Plexus PowerNet delivers high-speed, digital communications and atmospheric monitoring via coaxial cable that provides power to wireless access points, cameras and any other IP-based device. (Photo: Matrix Team)

A small or midsized mine can easily fall into the trap of underutilizing data, he said.

"With all of those devices and machine monitoring, how is a small mine with 30 to 45 workers going to keep up with all the data created?" Coats said. "We use analytics and we crunch it down into a usable format."

A partnership with Maestro Digital Mine positioned Matrix to offer the MaestroLink Server, Plexus PowerNet and two air quality station solutions.

Maestro's first air quality station, the Vigilante AQS, was developed to capture an array of conditions in deeper mines, Maestro said. "Its objective is to monitor environmental conditions in real time for worker safety and health," said Shannon Katary, director of marketing and communications, Maestro.

"It had been so successful at being embedded in mines on many levels across the world that we realized we had to create a lower-cost version, the Zephyr AQS," she said. "It is just a slightly lower-cost version, which has about 75% of what the gold standards are for measuring, and it has led to uniting the industry on what it takes to monitor and control ventilation." Plexus PowerNet extends an existing network to the furthest working area, and is capable of supporting the air quality stations there. "Plexus is usually an added-on solution and integrates into mine-wide networks," said Cindy Chesney, director, global partnerships, Maestro.

"Plexus is agnostic, so it can attach and be affiliated with any underground networks," she said. "The one extreme benefit is power and data over a single coax cable."

MaestroLink Server is a software platform that allows the assimilation of the data coming in from the working areas.

Coats said the new network and communications solutions at the limestone mine quickly yielded dividends. "They started saving about an hour and a half per vehicle breakdown," he said. "That was one of the first things that they noticed."

With computers and tablets underground, reporting processes could be digitized and accelerated.

Mine safety and rescue processes were also streamlined. "With the tracking you can actually zero in on where a person is at, rather than having to in-



IWT's Uniti Node connects to the far end of the SENTINEL system for last mile WiFi, communications and tracking. It generates a signal out to 2,000 ft. (Photo: IWT)

vestigate a whole mine trying to find a person," Coats said.

The cameras helped reduce theft, and goosed production.

The environmental monitoring also nixed tasks that were time consuming. "They can check the mine air any time they want, rather than having to drive over to this location and check the air," Coats said.

Combined, the solutions result in increased production and safety. It is a future available to many mines, so long as they have the vision and can handle the changes, he said.

"They have to start asking the questions, and start picturing a future with a network," Coats said.

#### Get Assessed, Hire the Best

Many miners will argue they are paid to mine, not soothsay. They will farm that task out to third parties to come in, get a feel for the operation, develop a vision, and make recommendations. A major underground salt mine in the U.S. did exactly that when it determined it wanted a site-wide communication and tracking system.

The mine operates six yards, each worked by a crew under a foremen or group leader. Each yard has an average of 25 rooms. The mine blasts at the beginning of third shift. First and second shift muck and haul.

"This customer did not have a site-wide communication and tracking system," said Jeremiah Colling, program manager, Innovative Wireless Technologies (IWT). "Miners are working all throughout the different yards, maintaining and coordinating efforts without a comprehensive communications and tracking system," he said. "It was a challenge and an opportunity for improvement."

Daily production reports are submitted at the end of each day and are used to form the plan for the teams for the next day. "Like other mining operations, there is emerging change that requires changing plans on the fly, something they were not always able to do efficiently," Colling said.

As a result, there was often a considerable lag between identifying a challenge and allocating resources to meet a new need. The miner believed that a high-speed network could downsize the lag considerably. "Real-time situational awareness was one of the big problems they were trying to solve," Colling said.

To help solve this problem, they hired a consultant to do an in-depth analysis to identify where process improvements could be made, and what types of equipment and networking capabilities would be needed.

The report led to the selection of three suppliers for consideration, one being the firm hired to do the analysis, Colling said. "They ended up selecting IWT based on our strong background and a long history of successfully deployed communications and tracking systems in mines throughout the U.S."

The SENTINEL Communication and Tracking System was adopted for wireless voice, text, tracking and analytics services. The core infrastructure is lineor battery-powered mesh nodes that are installed above and below ground. The different types of nodes are used strategically, depending on the circumstances and areas.

The system continuously tracks both personnel and vehicles throughout the entirety of the mine using handsets and tracking tags.

For last-mile communications, the mine adopted the Uniti Node, a small device that connects to the far end of the SENTINEL system and goes into the corners of a working area. This provides communication and tracking, WiFi access, and creates a high-speed wireless digital network to backhaul important data. Each Uniti Node runs on DC power and generates a signal out to 2,000 ft.

"Since these are used throughout their working areas, mobile devices like smart phones, computers and tablets can be used to access their corporate network," Colling said.

"If somebody is doing maintenance on a piece of equipment, they now have the capability to pull up a drawing or schematic and troubleshoot from underground," he said. "Or they can use the wireless network to do a FaceTime call with someone above ground."

IWT's analytics services were also adopted. The first phase of this included digitizing many of the mine's reporting forms.

Historically, paper copy forms are filled out at the end of each shift and hand-delivered to an office above ground. The information is re-entered into a spreadsheet, and then made available to mine management. "This process results in a 24- to 36-hour delay after that first shift started the previous day," he said. "So the mine management isn't getting information until over a day later."

Digitizing the forms will eliminate this lag. "While they are underground, since they have WiFi at the yards, they will be able to fill out these forms so they are instantly available to mine management," Colling said. "This will decrease that delay from 36 hours to instantaneous."

The data generated is stored in a secure database and visually represented through a web interface. "With that, you can start picking out trends because all that data is available to you in real-time," Colling said.

The miner "really likes" the analytics because it helps them in identifying production inefficiencies, Colling said. "There are all these things that you can start to look at to identify workflow tempo, target inefficiencies and increase productivity."

The solution brings order to the "digital exhaust" created by the numerous devices, sensors and equipment, he said. "It could be location-based data," Colling said. "It could be communication data. You can correlate all that information to draw out patterns."

One such pattern is travel time. "Managing vehicle travel in real-time allows for route optimization and increased efficiency, or simply finding under-utilized equipment," Colling said. "It is all about identifying and improving constraints."

On the day of final acceptance testing, the system started paying for itself.

"They saw one of their belts was coming loose and starting to sag," Colling said. Previously, the fix would entail driving to find somebody, who could be above ground. "Now they just grab their handset and phone in the potential problem, and someone can get on it right away," Colling said. "Even before we left they were already seeing the value of the system and how it may have prevented future damage."

Using a third party to assess network and communications needs prior to contracting a supplier may be the best route to a coherent vision and solution adoption plan, Colling said.

"Nowadays, a lot of mines are looking at ways they can be more efficient and do more with what they already have," Colling said. "At the end of the day, getting an independent evaluation is helpful when trying to make sense and synthesize all the different potential solutions that are out there."

There is a galaxy of solutions out there. The latest to hit the market features capabilities beyond the imagination of the more pragmatic mine planners of yore.

#### **Envision Automated Ventilation**

For example, Strata Worldwide recently announced the Ventilation Automation and Control System for StrataConnect.



IWT's SENTINEL network supports wireless voice, text, tracking and analytics services. It is comprised of line- or battery-powered mesh nodes. (Photo: IWT)

#### COMMUNICATIONS

The system automates a mine's ventilation circuit based on gas levels, the number of personnel in a working area, and the number of vehicles in a working area.

The configuration of the ventilation is fully automated, and is automatically adjusted as factors change, Strata said.

"Strata's gas detectors and environmental systems continually monitor air quality, and as harmful gas levels fluctuate, the system automatically adjusts the speeds of the primary fans up and down, and turns secondary fans on and off as needed," said Rob Albinger, general manager, electronic safety, Strata Worldwide.

Automated management of ventilation should reduce energy consumption, which translates to cost savings. "Strata proves that automating the activity of the ventilation fan systems results in significant energy savings," Albinger said. "This in turn decreases mine energy costs."

The system represents the next step in the evolution of the StrataConnect wireless network and other related offerings.

Released in 2010, StrataConnect is comprised of strategically placed wire-

less nodes, called CommNodes. Each is powered by four D-cell batteries. The shoebox-size nodes are suspended inches from the mine roof. The signal strength between the nodes determines the placement of each.

The wireless network provides coverage that can be used to support a growing number of applications. Historically, it has supported wireless communication and tracking, remote control, remote monitoring and emergency alert broadcasts.

Simple and easy to install, Strata-Connect requires no cabling, no external antennas, and no battery back-ups. "It was originally released as a cost-effective option for coal mines to meet the US Mine Safety and Health Administration's requirement of post-accident two-way communication and location tracking," Albinger said.

"The flexibility and versatility of this technology has innately expanded its functionality, and its ability to be incorporated into third-party devices further expands its capabilities," he said. "Leveraging these qualities, Strata has been able to develop and enhance new solutions for underground automation,



The Ventilation Automation and Control System for StrataConnect automates ventilation controls. Based on data from gas detectors and environmental systems, it adjusts primary fan speeds and activates secondary fans as needed. (Photo: Strata Worldwide)

such as Ventilation Automation and Control."

Strata's networks can be installed point-to-point, and carry the data to and from the surface. Conversely, they can be set up locally underground and interfaced with the mine's existing infrastructure.

Strata also offers wired networks such as DigitalBRIDGE and DigitalBRIDGE Plus+. The former connects with fiber to transport data.

DigitalBRIDGE Plus+ connects to existing VHF leaky feeder networks. It delivers high-speed data over leaky feeder without affecting established radio communications. DC power can be added to run end-point devices.

Optional solutions that support Ventilation Automation and Control include the Trolex Sentro 8 SensorStation. The station monitors up to eight gasses and other variables, such as airflow, temperature and pressure.

The advent of Ventilation Automation and Control demonstrates the supplier's heightened focus on innovation and system development, Albinger said.

"The company's mission is to provide technologically advanced solutions to enhance and sustain underground connectivity, promote worker safety, and drive daily productivity," he said. "Developing a system to automate a mine's ventilation system to ensure working conditions remain safe and productive, as well as assist mines in operating more efficiently, demonstrates our commitment to the overall mission."

# Envision Computers in the Cabin

JLT Mobile Computers reported the new VERSO 10 vehicle-mounted computer is the industry's smallest, most-powerful rugged computer for mining applications with restricted space but high performance requirements.

The VERSO 10, introduced in 2020, "fits even into the tightest vehicle cabins, while giving customers the same high level of performance as larger VER-SO computers," said Christian Funk, product manager, JLT.

"With all connectors integrated into its casing, it is not only smaller, but also significantly lighter and comes at a lower cost," he said. "Secure fixed-mount installation addresses safety concerns inherent in certain vehicle types and mining deployments."

The computer is the latest addition to the VERSO Series, which are field proven to handle operations in "extremely demanding working conditions" and provide "the human-machine interface for operator interaction," Funk said.

VERSO Series computers come with 15-, 12-, or 10-in. displays. Customers choose between the Intel Core i3-7100U or the more advanced Intel Core i7-7600U processor with Turbo Boost.

The latter offers 50% higher CPU and 30% to 70% higher graphical performance. The standard 8-gigabyte (GB) DDR4 memory can be bumped up to 16 or 32 GB.

"With this boost, customers can run real-time video analysis or high-resolution graphical animations, as well as create highly intuitive new user interfaces," Funk said.

The computers feature integrated dual-diversity PIFA WLAN antennas, Bluetooth, and optional GPS/GLON-ASS/BeiDou and mobile broadband for reliable connectivity in areas with poor coverage.

The features combine to make the series "the most powerful and fastest mining computers in the industry," said Anette Malmstrom, business manager, mining segment, JLT.

"The series delivers up to 70% higher performance compared to predecessor computers and any known direct competitor," she said. "The computers enable mining customers to stay connected and run the most demanding data applications with ease."

The original VERSO Series launched in 2013. "The first computers in this series were the VERSO 15 and the VER-SO 12 with an Intel Atom D2550 processor, a wide operating temperature range, and fanless operation," Funk said. "Immediately popular, they are in mines all over the world today, from Boliden gold mines in Sweden to Australian coal mines."

For example, Bever Control, a supplier of advanced solutions for underground drill rig control, has used the computers for more than a decade. "A pioneer and world leader in its field, the company is an excellent example of the long-term and trusted relation-



The new VERSO 10 vehicle-mounted computer fits into the tightest vehicle cabins and can support real-time video analysis and high-resolution graphical animations. (Photo: JLT Mobile Computers)

ships JLT builds with its customers," Malmstrom said.

The cab-mounted computer screens are subjected to frequent vibrations and shocks, unstable power and network connectivity, and heavy usage. Through it all, the computers make it easy for the operator to understand sensor data as it relates to drill plans, make critical data-driven decisions, and control the rigs. "This is where the scratch-resistant touchscreens on the 15-in. JLT devices used by Bever come into their own," Funk said.

"They combine excellent durability with great user experience," he said. "In underground mining, the ability to adjust the screen brightness for low light levels is another key requirement."

Bever Control confirmed those capabilities. "The robustness of the JLT computers, both mechanically and electronically, fully satisfies our and our customers' needs," Thorvald Wetlesen, managing director, Bever Control, said.

The computers are in "several hundred drilling rigs in North and South America, Africa, Europe and Asia," Malmstrom said.

JLT offers the series on a trial basis. "We are proud to say that our devices often excel when testing different units in the work environment," she said. "The feedback we receive from testing is really important to help us make sure our customers get the best solution for their operation and a smooth deployment without any unwanted surprises."

The computers come with a comprehensive, no-questions-asked service agreement. It offers different levels of coverage, specific turnaround times, and zero exclusions, the company reported. "JLT:Care takes out the guesswork of calculating the hidden costs of downtime," Malmstrom said.

Adopting the computers usually means entering a symbiotic relationship. "We take great pains to understand customers' operations and setup, and we go further than anyone to secure the performance that is required," Malmstrom said.

"Not just what they do, but how they work, where their pain points are, what applications they use, which other devices they have on site, so we can find the right solution to fit their exact needs," she said. "It is this high-touch sales and support model that truly defines JLT's customer value and distinguishes us from the competition."

# **Mining Industry in Cape Town Will Recover**

In an arid economic landscape with COVID lockdowns, the mines provide hope

#### By Gavin du Venage, African Editor

Cape Town/Africa is back. The continent's resource industry is set to recover from the COVID-19 pandemic, amid signs a new commodity super-cycle is under way. This was the overarching message of this year's 2021 Investing in African Mining Indaba.

The event, billed as the world's largest mining investment conference, took place nominally from Cape Town, its usual setting. However, as has become the norm, events were held virtually in keeping with COVID-19 times.

With much of southern Africa in the grip of a second wave of the virus pandemic, the industry's response came under scrutiny. "Most mining houses, by virtue of their locations in rural areas, have risen to the occasion," ArcelorMittal Chairman Paul Mpho Makwana said. Mining companies rolled out water supplies, personal protective equipment (PPE) and sanitizers, often servicing communities far from the urban centers of the region.

Mines also made use of their extensive medical facilities, and experience with previous regional epidemics such as HIV/ Aids and tuberculosis. Both diseases are rife in southern Africa, and mining companies have built up years of experience in managing infections, treating the sick and implementing emergency measures such as sanitizing work areas.

As a program to provide vaccines begins to move forward, the industry would also assist where it could, Mkwana said.

While this year would continue to be disruptive to operations, as lockdowns and successive waves of the virus came through, he hoped conditions would have returned to near normal within a year.

"As we take off in an immunized 2022, we do so with a clean slate," Mkwana said.

#### **Helping Hand**

South Africa President Cyril Ramaphosa, in his address to the Indaba, acknowledged the value of the industry, still recovering from its near demolition under the previous administration of Jacob Zuma. It was the mining industry that provided some hope across an otherwise arid economic landscape for the country, especially after repeated lockdowns.

"The sector was among the biggest contributors to growth toward the end of 2020, contributing 288% growth in the third



Anglo American CEO Mark Cutifani.



Sibanye-Stillwater CEO Neal Froneman.

quarter," Ramaphosa said. "The ability of mining to weather the storm was in no small part because of industry and government working together."

Elsewhere in Africa, the industry also helped countries ride out the pandemic. Sierra Leone, a country once riven by war, has now become a major mining destination. President Julius Maada Bio told the Indaba that quick action — honed by fighting other diseases such as ebola — helped the country through.

"Mining companies provided beds, PPE and equipment," he said. "As a consequence, mine infections have been far lower than the national rate. As a result, no jobs have been lost or mines closed."

The Sierra Leone government meanwhile provided an updated mining code that made it easier for investors to establish greenfield projects. Also, new port, rail and energy facilities were being constructed. The country had large reserves of diamonds, rutile, bauxite, gold and iron ore, among others.

"Mining can only thrive where there is infrastructure to support it," Maada Bio said. "We are building and expanding our road networks. We continue to improve our electricity and water supplies."

Further south, Botswana is in the midst of pushing to expand its own mining industry, in large part to diversify away from its principle product, diamonds. As an industry where deals are typically concluded on a handshake, diamond sales were hard hit by the COVID-19 pandemic, President Mokgweetsi Masisi said.

"Our industry is dominated by diamonds," Masisi said. "This puts the country at risk from market fluctuations. It is imperative to develop other sectors such as coal and iron ore."

Other mineral potential income included rare earths, now in demand for power dense batteries and copper. As a result, the government was fast-tracking aerial surveys to identify deposits of target minerals.

"My government is taking steps to identify and map mineral deposits of these in this country," Masisi added.

#### **Going Green**

A departure from previous Indabas was the prominence of ESG, or environmental, social and corporate governance as a topic of discussion. Invariably, discussions around this thorny issue are reserved for the tail end of most mining conferences. This year, it was at the fore — a consequence of heightened public awareness arising from the COVID-19 pandemic.

For instance, the public mood shifted against coal, once the backbone of energy production and consequently industrial development. Instead, the demand for "green technology" had driven miners to abandon coal production. Yet, this too presented challenges as miners would once again be called on to produce the suitable minerals needed to build new technologies.

"As we mine less coal, we have to mine more copper, more nickel, more lithium to make these new technologies possible," Anglo American CEO Mark Cutifani said. "Even as Anglo was transitioning out of coal, a perception had grown that this meant mining as a whole, would diminish. Rather, it was likely to increase as demand for essential raw materials underpinned modern life.

#### **Regulatory Roadblocks**

Turning to more practical matters, industry executives applauded the changes that South African regulatory authorities had made, with the goal of becoming more investor friendly. Roger Baxter, CEO of the Minerals Council of South Africa, a body representing most of the country's mining houses, said, however, that progress remained slow.

Regulations remained over-bureaucratic and cumbersome, delaying projects.

"We have more than 20 billion rand (US\$150 million) in projects that can't go ahead because of regulatory hurdles," Baxter said. "Companies can increase their investment up to 80% if the blockages can be removed."

Ongoing uncertainty over whether black ownership targets would be adjusted, as well as chronic energy shortages, remained concerns. Although companies can now legally generate their own power, and are no longer bound to the national electricity utility Eskom, miners still had to go through a time-consuming regulatory process.

Consequently, companies were sitting on electricity projects that they could not yet switch on, while waiting for the sign-off from the authorities.

"We have more than 2 gigawatts of electricity projects in the mining sector," Baxter said. "Takes seven months to get a grid connection from Eskom. Then there's the regulatory authority itself, which takes a minimum of four months to issue permits."

Baxter's sentiments were echoed by Neal Froneman, CEO of Sibanye-Stillwater, a gold producer now transitioning to a platinum producer.

"First and foremost, we need an investor friendly environment," Froneman said. "We've made good progress, but there are aspects that are not investor friendly."

Baxter also touched on an ongoing issue that has probably done more to reduce mining investment across South Africa than any other; the thorny issue of mandatory black shareholders, known as Black Economic Empowerment (BEE).

Currently, mining firms are required to meet a minimum of 23% BEE, as well as a raft of obligations toward supporting black-owned businesses, and having black people serving in management. Miners have grumbled, but generally worked with these conditions, instituted to redress the apartheid legacy that saw white people run the country's mineral sector.

However, around 10 years ago, the state relooked at the existing targets, and began planning a shift that could have turned shareholders into minority partners in projects they themselves had funded.

Under Ramaphosa's administration, and that of his current Mines Minister Gwede Mantashe, this particular draft regulation appears to have been scrapped. It remains unclear, however, whether the government is done with fixed quotas, or plans to tweak the existing law further. Shareholders still fear they may find their holdings diluted, albeit not to the extent previously planned.

"We have to get to the point where we respect the rights of shareholders and owners," Froneman said. "This is going to require quite a lot more work."

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THE DEBTORS FILED A DISCLOSURE STATEMENT

(available at the Case Website) containing information that will help you decide how to vote on the Plan, which proposes to set up a trust to resolve all Talc Personal Injury Claims. Your legal rights will be affected if the Plan is approved.

Only holders of "Talc Personal Injury Claims," or their attorneys on their behalf, are entitled to receive a ballot to vote on the Plan.

Holders of Claims and Equity Interests in all other Classes under the Plan are presumed to accept the Plan, because they are either Unimpaired by the Plan or are Plan Proponents.

If you have a Talc Personal Injury Claim, you or your attorney on your behalf, as permitted by the Voting Procedures, have the right to vote on the Plan. The deadline by which ballots must be received by the Debtors' solicitation agent, Prime Clerk LLC ("Prime Clerk") is **March 25, 2021 at 4:00 p.m. ET**. If you are unsure whether your attorney is authorized to vote on your behalf, please contact your attorney. Both the Tort Claimants' Committee and the representative of future talc claimants support the Plan.

IF THE PLAN IS APPROVED BY THE BANKRUPTCY COURT AND THE DISTRICT COURT, all Talc Personal Injury Claims will be channeled to the Talc Personal Injury Trust and resolved pursuant to the Trust Distribution Procedures. If you are the holder of (a) a Talc Personal Injury Claim and you vote to accept the Plan, (b) a Claim that is presumed to accept the Plan, (c) a Talc Personal Injury Claim and you vote against the Plan and do not opt out of the releases, or (d) a Talc Personal Injury Claim entitled to vote for or against the Plan and you do not vote for or against the Plan and do not opt out of the releases provided in the Plan (subject to certain limitations described in the Plan), you will be presumed to grant the "Releases by Holders of Claims" set forth in Article XII of the Plan. Please read the Plan and other Plan Documents carefully for details about how the Plan, if approved, will affect your rights.

YOU HAVE THE RIGHT TO OBJECT TO THE PLAN.

The deadline to file an objection is May 28, 2021 at 4:00 p.m. ET. There are requirements that must be followed to file an objection, which are set forth in the Voting Procedures Order. Objections received after the deadline may not be considered by the Bankruptcy Court and may be deemed overruled without further notice. You can obtain additional information or instructions, review the Plan Documents, or obtain a solicitation package with a ballot to vote, by contacting Prime Clerk.

Imerys Ballot Processing Center c/o Prime Clerk LLC One Grand Central Place 60 East 42nd Street, Suite 1440 New York, NY 10165. Visit: ITArestructuring.com Request More Information: imerysinfo@primeclerk.com Request Ballot with Solicitation Package to Vote on the Plan: imerysballotrequests@primeclerk.com Call: (844) 339-4096 (Toll-Free) / +1 347 919 5767 (International)

# **US Courts Debate Claim Validity**

When it comes to the rights that mine operators can assert with unpatented mining claims, rulings revert the General Mining Law

A 2019 decision from an Arizona Federal District Court raised a number of questions about what appeared to be the only court decision to interpret federal law governing mining on public lands to preclude ancillary use of public lands for mining. The holding upheld in *Center for Biological Diversity (CBD) v. United States* would create a potential impact on the rights that a mining claim holder may assert under federal unpatented mining claims, particularly in the mine permitting process.

The case involves Rosemont Copper Co. and its application to the U.S. Forest Service (Forest Service) to operate a large-scale pit mine for copper, molybdenum and silver extraction within the Coronado National Forest in southern Arizona. The proposed Rosemont mine is on Rosemont's fee-owned patented mining claims and its federal unpatented mining claims. Over the course of 20 to 25 years, the mine would open a pit measuring 3,000 ft in depth and 6,000 ft in diameter. To recover the metals, the operation would extract approximately 1.2 billion tons of waste rock and produce more than 700 million tons of tailings, potentially impacting 3,653 acres of Forest Service lands.

In 2017, the Forest Service approved Rosemont's mine plan and authorized construction and operation of the mine. A coalition of environmental groups challenged the decision asserting the Forest Service and other federal agencies violated federal mining, environmental and public land use laws in the approval process, including the Mining Law of 1872 (General Mining Law), the Organic Act of 1897, National Environmental Policy Act (NEPA), the National Historic Preservation Act, the Clean Water Act, the Endangered Species Act and others. Several Native American tribes, represented by Earthjustice, also challenged the approval of the mine plan, and those suits were consolidated with CBD.<sup>1</sup>

#### The CBD Holding

On July 31, 2019, the U.S. District Court for the District of Arizona granted summary judgment to the plaintiffs and vacated and remanded the Forest Service's Final Environmental Impact Statement (EIS) and the Record of Decision, effectively preventing mine construction or operations at the Rosemont mine.

Key to the court's holding was its determination the Forest Service failed to sufficiently assess the validity of Rosemont's unpatented mining claims prior to approval of the mine plan. "Notwithstanding the applicable legal provisions to the contrary, the court found that this failure resulted in a flawed analysis and a defective administrative process," said Laura Granier, partner, Holland & Hart. "Although the agency followed the applicable law including the express provisions of its regulations, the court ruled that the Forest Service's assumption that Rosemont had valid rights to use the surface of the Forest Service lands led to the agency's reliance on the wrong regulatory framework, which, in turn, led the agency to inappropriately constrain its discretion to limit or restrict the proposed mining operations."

In particular, the Forest Service appropriately concluded it could not prohibit mining on Rosemont's unpatented mining



An artist's rendering of the proposed Rosemont mine shows the surface impacts of the operation.

claims because the U.S. Mining Law and the Forest Service regulations Part 228 do not allow for denial of an otherwise reasonable mining operation that is proposed in compliance with environmental requirements, Granier explained. "The court concluded that this reliance was a fatal flaw in the agency's analysis because the mining claims should have been essentially presumably 'invalid' and, therefore, the agency's discretion was not limited under the General Mining Law," Granier said. "Instead of applying the Forest Service Part 228 regulations governing proposed mining activities, the court held the agency instead should have applied discretionary land use regulations under which approval may be denied for any activity not meeting certain standards or not in the public interest."

Although the court acknowledged the Forest Service had no legal obligation to conduct a validity exam for each mining claim prior to approving the mine plan, and that jurisdiction to make a final determination as to claim validity lies with the Bureau of Land Management (BLM), it concluded the Forest Service could not presume Rosemont held "valid" mining claims, Granier explained. "Rather, the court concluded that the USFS's duty under the Organic Act — to protect the forest from depredations could not be fulfilled without first determining whether Rosemont had valid rights to the surface of USFS lands, which the court found 'must begin with a discussion of the validity of their claims' and, according to the court, '[t]his discussion necessarily must include whether the claimant discovered a valuable mineral deposit within the boundaries of their claim,'" Granier said.

The court further stated that, absent evidence of a valuable mineral discovery for each claim, the Forest Service could not rely on other statutes like the Multiple Use Act of 1955 or the Organic Act to create or enlarge mining rights not independently validated under the General Mining Law's "discovery" test.

After finding that claim validity was the linchpin for mine plan approval, the court concluded that "the administrative record shows no basis upon which the [USFS] could find Rosemont discovered a valuable mineral deposit within the facilities, tailings and waste rock ar-eas" in part relying on Rosemont's proposal to bury 2,447 acres of surface overlying its unpatented mining claims with 1.9 billion tons of its own waste."

The holding is significant for several reasons, Granier said. "The court rejected the long adhered-to agency policy of accepting the validity of unpatented mining claims included in mine permit applications," she said. "Although acknowledging that the USFS was not required to conduct a validity exam for each claim prior to approving the mine plan, the court reached its own decision on the validity of the claims. This approach circumvented the rigorous, well-defined process that is required for such determinations, which must be conducted by a certified mineral examiner in accordance with regulations and policy. While much of the evidence relied upon by the court to conclude the claims were invalid might have been rebutted by Rosemont in a full validity determination, the only evidence before the court was that placed in the administrative record, and thus there was no due process for Rosemont to defend the validity of its claims."

#### **Potential Implications for Mine Operators**

The CBD decision is on appeal. If the holding stands, it could raise questions about the long-standing operating practices of the hard-rock mining industry, explained Karol Kahalley, coun-

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sel, Holland & Hart. "Most mining operations take place on lands covering a variety of surface and mineral rights interests, including patented mining claims and other surface and mineral interests held in fee, leased surface and minerals owned by private parties, federal unpatented mining claims that may underlie privately held surface or federally managed lands, and non-mineral mill site and tunnel site claims," Kahalley said.

As a general matter, Kahalley said federal unpatented mining claims are characterized by the following rights, limitations and risks:

- Under the General Mining Law, if claims are located in compliance with statutory requirements, the claimant automatically acquires the full interest in the claims, without action by the government. This process is distinctly different from obtaining rights by leases or material sales contracts, which must be obtained with federal agency approval.
- A locator's possessory rights to mine all of the minerals to exhaustion are complete in unpatented claims, and the locator is never required to apply for or obtain a patent to fully mine the minerals found on the claims. Prior to patenting, surface rights for mining operations overlying unpatented mining claims may be constrained by the rights of the surface owner.
- Mill site locations are made in association with mineral claims and create the right of surface entry to support ongoing mining or milling operations. The maximum size of a mill site location is five acres.
- While mill site locations are intended to provide surface support for mining operations, the locator also has the right to possess surface areas of mineral (lode and placer) claims for purposes reasonably incident to mining.
- The use of one mining claim for incidental purposes to support another mining claim (e.g., for waste rock disposal) has been viewed broadly by the courts, but it is not without limits (e.g., location held invalid where claims were located in bad faith).
- Other than as required in a patenting proceeding, there is no statutory requirement for a validity determination of unpatented mining claims.<sup>2</sup> However, the U.S. may bring a claim contest at any time to challenge claim validity. A private party who asserts an interest in the same minerals covered by an unpatented mining claim also may contest claim validity.
- Because of the vast number of unpatented mining claims and the limited resources of the BLM, validity determinations have not typically occurred outside of the patenting process, with the following exceptions: (1) the claim is located on withdrawn lands and establishing validity is key to determining valid existing rights that may have existed before withdrawal, (2) an inquiry is requested by another agency, or (3) there is conflicting use of the land by various parties that requires resolution.

Based on the rarity of validity determinations, mine operators historically have relied upon the surface rights associated with unpatented mineral claims for a wide range of incidental activities," Kahalley said. "However, if the holding in CBD stands, the longstanding policies and practices of the agencies considering approval of mine plans may be called into question in evaluating discovery of a valuable mineral deposit prior to approval."

#### Last Year's Earthworks Decision

The long-anticipated October 2020 decision by the U.S. District Court for the District of Columbia was a significant victory for the mining industry and pre-discovery rights under the General Mining Law and stands in conflict with the Rosemont decision. In *Earthworks et al. vs. U.S. Department of the Interior et al.*, the court rejected the plaintiffs' challenges to BLM's 2008 Mining Claim Rule and 2003 Mill Site Rules.

Plaintiffs challenged the BLM's 2008 Mining Claim Rule claiming that unpatented mining claims are not within the protective scope of the Mining Law until discovery of a valuable mineral deposit has been confirmed on the claim and, therefore, under Federal Land Policy and Management Act (FLPMA), "fair market value" must be paid for use of unpatented mining claims of "unknown validity." Similar to the issues in the Rosemont appeal, Kahalley explained, industry intervenors carefully focused on the importance of vocabulary and avoiding the use of the term "invalid claims" to describe claims of "unknown validity."

The court adopted this same approach and also went on to use some of the same authority cited in the American Exploration and Mining Association's (AEMA) Rosemont amicus brief to explain why a pre-discovery claim cannot be presumed "invalid," Kahalley explained. "This is a tremendous victory not only for the industry but especially for AEMA, which has long fought to protect pre-discovery rights that are so critical to its members," Kahalley said. "Exploration is a statutorily granted right under the Mining Law. This is a big step to start correcting the misuse of the concept of 'valid' claims."

The D.C. District Court Judge ruled that the General Mining Law, implementing regulations, and related case law have never required the Department of the Interior or BLM to verify validity of a claim by independently confirming a discovery. Relying on the same case law and analysis cited by AEMA in the Rosemont amicus brief, the court ruled that a claim of unknown validity is not a legal nullity, noting the government cannot find such a claim invalid without a degree of process, Granier explained. "The court noted that it had never been BLM's practice to determine claim validity other than for patents or instances of withdrawals and that the cost to do so based on 250,000 existing claims and a cost of between \$12,000-\$80,000 per validity exam would exceed the BLM's budget many times over," Granier said. "The court refused to 'strain to read FLPMA' as 'silently working such a fundamental change to longstanding practice under the General Mining Law.'

The second major issue was to address Earthworks' claim that the 2003 Mill Site Rule incorrectly omitted any limitation on the number of mill sites that can be held per mining claim. Their claim asserted a limitation of one mill site per mining claim. The court relied on the lack of any statutory authority to support such a limitation notwithstanding Congress went to the trouble to limit the Mill Site claims to 5 acres, Kahalley explained, and the predecessor to the General Mining Law, the Lode Law of 1866, limited the number of mill site to one per load claim. The plaintiffs have appealed this decision in the D.C. District Court of Appeals.

For more information about this case and other mining related legal matters, readers can contact Laura Granier at Igranier@hollandhart.com and Karol Kahalley at: kkahalley@hollandhart.

<sup>&</sup>lt;sup>1</sup> The same plaintiffs also have challenged the Clean Water Act permit issued for the mine by the U.S. Army Corps of Engineers, and those cases are consolidated separately.
<sup>2</sup> In 1994, Congress defunded the process for patent applications, effectively creating a patent moratorium that remains in place.





### **GLOBAL BUSINESS REPORTS**

# **Mining in West Africa, Copperbelt and Angola** Driven by strong demand for gold and battery metals

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Cover photo: Process plant at Wahgnion, Burkina Faso. Courtesy of Teranga Gold Corp.

### A REPORT BY GBR FOR E&MJ

MARCH 2021

### GIOBAL BUSINESS REPORTS MINING IN WEST AFRICA

# Rich, yet underexplored, gold endowment

West African mining, stronger despite all



Mining site at night, Ivory Coast. Photo courtesy of Roxgold.

West African mining is enjoying a strong start to 2021. A younger and fitter population profile, but also the experience of dealing with epidemics like Ebola, have helped West African countries to minimize the impact of Covid-19. While some of their international peers stagnated for months, producers and juniors in the West African mining space have not only continued operations but accelerated activities in order to make the most of the boom in the price of gold.

The Birimian Greenstone belt, a goldbearing geological structure, stretches across lvory Coast, Ghana, Burkina Faso, Guinea and the Mali-Senegal border, forming two main parallel trends: the Houndé belt and the Boromo belt, as well as smaller anomalous structures such as the Hire Belt in lvory

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Coast, the Sebba belt in Burkina Faso, the Siguiri basin in Guinea and the Sefwi-Bibiani and Ashanti belts in Ghana.

In the past 10 years, there have been 79 million oz discovered in the region, and US\$5 billion spent. Nevertheless, these highly prospective grounds remain broadly underexplored. Countries like Burkina Faso and Ivory Coast, which make up 60% of the Greenstone belt, account for only 35% of discoveries made in this region. These vastly untapped lands spark the imagination of those seeking the next elephant gold discovery. With the spot price for gold averaging at US\$ 1,769 for 2020, that multi-million oz deposit may not be too far away.

The price upturn is set to manifest itself differently in each of the gold-focused nations: With little exploration underway, but a solid production sector, Ghana is more likely to see its majors take greater risks to ramp up production. By contrast, younger mining jurisdictions like Ivory Coast will be better positioned to advance exploration projects.

West Africa has been the home of many company-making assets, including (former) Randgold's Morila mine, IAMGOLD's Sadiola, and B2Gold's Fekola, all in Mali. Similarly, in Ghana, AngloGold Ashanti's Obuasi and Iduapriem mines, Newmont's Aykem, and Gold Field's flagship Tarkwa represent tier-one assets that brought success to some of the most profitable gold producers in the world. Their stories have encouraged waves of exploration in the region, juniors following the "neurologies" or so-called "closelogies" formed by the positioning of these world-class discoveries.

Typical of West Africa is that juniors, developers and majors alike tend to build diverse asset portfolios in different jurisdictions, and sometimes in different minerals too. The region enjoys good levels of regional integration, with regulatory frameworks that often compete against each other, but also copy each other. Through the ECOWAS membership, the adherence to the ODAHA



Sébastien de Montessus, CEO, Endeavour Mining Corp.

treaty, and the African Continental Free Trade Area Agreement (AfCFTA) which is currently in progress, West African countries subscribe to similar rules, which is something that service providers have long leveraged to grow their business.

More and more, developers and producers take advantage of the cross-borders to de-risk their value proposition. The multi-iurisdictional focus is both an optionality that West Africa offers, as well as a necessity in a region where the political situation in one country can rapidly change. Illustrating this principle, Endeavour Mining operates three mines in Burkina Faso (Houndé, Mana, Karma and Boungou) and two in Ivory Coast (Ity and Agbaou), together with development and exploration across the Birimian belt. CEO Sébastien de Montessus explained this diversification is central to Endeavour's strategy: "Our focus on West Africa is a big part of why we're able to maintain a diverse and active portfolio with a lot of growth, optionality and exploration."

Also, IAMGOLD runs the Essakane mine in Burkina Faso and has an exploration pipeline that combines the Senegalese Boto project with the Malian Diakha Siribaya, but CEO Gordon Stothart speaks of going a step further by integrating assets within three jurisdictions, Senegal, Mali and Guinea, under the Bambouk complex now under development.

Reflecting on current demand for gold, Stothart expects the next five to six years to witness intense M&A activity: "Because many players have exhausted their highgrade resources, I suspect a market reaction when producers start shutting down operations and supply drops."

Under normal circumstances, a big rise in commodity prices would drive M&A transactions and a stronger appetite for consolidations, yet travel restrictions have slowed these from concretizing. The first transactions, however, indicate a trend towards asset-optimization. A noteworthy example is the US\$2 billion acquisition of Teranga Gold by Endeavour Mining. Endeavour had already taken the title of West Africa's biggest miner after acquiring Semafo earlier in July 2020.

On the back of returning investor confidence, juniors have seen major re-ratings and their capital placements heavily oversubscribed. With an injection of both capital and enthusiasm, West Africa is perfectly suited to deliver the asset pipeline to respond to the new demand for gold in time to make the most of the current market. Besides low discovery costs, the turnaround times from discovery to production are very short. In only five years, Roxgold went from first drill hole to first pour at its Yaramoko mine in Burkina Faso. "Roxgold is a very different company to the one we were 12-18 months ago, having branched out from a single asset miner into multiple jurisdictions. We are well on the path to becoming a multi-asset producer, as we expect to more than double our production and cash flow within the next two years without the need to issue any shares," commented Roxgold CEO John Dorward.

Moreover, West Africa holds opportunities in other metals: Trevali is operating one of the only zinc-lead assets in Burkina Faso, the Perkoa mine: "Perkoa demonstrates that base metals can be found in the area. I believe more base metal mines will be active in the region in the coming decades, and we hope to be part of creating that opportunity in the country," said Ricus Grimbeek, president and CEO of Trevali Mining.

In the battery space, Iron Ridge Resources made the first lithium discovery in Ghana, defining a maiden resource of 14.5 million



Gordon Stothart, President and CEO, IAMGOLD Corp.

mt, running at 1.3 lithium oxide. The company has a lithium-gold combined portfolio and has recently been leaning more towards the latter commodity through the development of its flagship Zaranou gold project in lvory Coast, expected to hold in excess of 10 million oz. Vincent Mascolo, the CEO of Iron Ridge Resources, explained the principle behind its different jurisdictions/different metals strategy: "The rationale behind it is quite simple: we seek to immunize our business against commodity cycles and external forces beyond our control. Two years ago, we were primarily valued on our lithium project, but this market later declined."

#### The social license

Despite the contribution of mining to national GDPs, local employment, FDI, and its impact on generating related businesses, the question of whether the benefits of mining outweigh its negative impacts is regarded with some doubt. Acknowledging this predicament, the industry is now more unhesitant and outspoken about its goal: to prove that mining can be sustainable.



#### GEBR GLOBAL BUSINESS REPORTS MINING IN WEST AFRICA



Will Coetzer, Managing Partner, Stratum International.

During the difficult months of the pandemic, mining companies showed immediate support to host governments in West Africa. Barrick donated US\$1.5 million to the Malian government; IAMGOLD donated over US\$1 million across Senegal, Burkina Faso, Mali and Guinea; while Endeavour gave over CA\$6 million to help the region combat the pandemic, and these are only a few examples.

Beyond the pandemic, the mining industry has a broader socio-economic impact by supporting infrastructure development, and creating jobs and business opportunities for related services. In Burkina Faso, more than



Mark Bristow, President and CEO, Barrick Gold.

14,000 people are directly employed in mining, and there are 1,000 supporting businesses related to mining activity. Most companies in the region hire over 90% of their employees locally. However, Will Coetzer, managing partner of Stratum International, believes West Africa may face a great challenge in attracting the workforce it needs: "Some people were stranded for months onsite in West Africa, making significant personal sacrifices during the pandemic. When the situation stabilizes, I expect they may reassess their risk-taking. (...) West Africa is a very expat-driven, fly-in, fly-out market, with no readily self-sufficient labor."



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Todd Burns, President, Cypher Environmental.

Mark Bristow, president and CEO of Barrick Gold, shared with GBR his holistic vision for ESG: "Poverty remains one of the greatest challenges facing the world today and, in Africa, gold miners can make a significant contribution towards the economic development of their host countries (...) This should go well beyond the payment of taxes and royalties and the creation of employment."

Environmental concerns are also becoming more central in light of the pandemic. The current crisis has brought closer to home the potential imminence of other crises, be they natural or man-made. For miners, ESG and safety requirements have consistently become more comprehensive; the challenge is to implement these evenly across the world. On a corporate level, players across the value chain integrate ESG into their business plan; Cypher Environmental, a fast-growing environmental solutions company from Canada, donates 12% of profits to charities and allocates 5% of the value of a mining contract to investment in local communities: "Our ESG policy stems from a desire to make the world a better place, not just through addressing environmental problems, but also by becoming a trendsetter and encourage other companies to give back," explained Todd Burns, Cypher's president.

The investment sector is the final contributor in driving sustainable development and this also has heralded a preference for projects with strong ESG mandates. The African Finance Corporation (AFC) is looking at projects from an ecosystem-creation perspective, together with its potential for downstream beneficiation. Osam lyahen, senior director natural resources of AFC, said: "We invest in associated infrastructure for an asset, such as building a power station for a mine, and we believe this paves the right investment model Africa needs: No longer focused on individual investments, but on creating ecosystems around an asset."

# **Production and Exploration**

### Golden times for the production sector?

In West Africa, there are over 40 operating gold mines, many controlled by some of the world's largest mining companies, including Newmont, Barrick, B2Gold, Endeavour, AngloGold Ashanti, Nordgold, as well as midtier producers like Kinross, IAMGOLD, Gold Fields, Resolute, Golden Star, and Teranga Gold. The region's underexplored mineralization lends itself to mostly open-pit, near-surface, and thus cheap operations; most producers operate under an AISC of US\$1,000/oz.

Years of controlling expenses are now paying off handsomely as those who looked after costs are reaping the benefits of high margins. This is also an opportune time to plan for the future. Hicham Aziz, country manager for CAT equipment distributor Saudequip in Senegal, commented: "Mining companies have handled the crisis very well, with gold producers ramping up production to take advantage of the bull market."

# Time to build the pipeline for the future

Toronto-based Teranga Gold, one of the top performers on the TSX with mines in Senegal and Burkina Faso, dealt with a dilemma back in 2015 when its Sabodala mine in Senegal was maturing. Teranga's executive board pondered whether they should return money to shareholders or reinvest in the business, opting eventually for the latter. Teranga bought Gryphon Minerals in 2016, taking possession of two assets in Burkina Faso: the Wahgnion mine, which poured its first gold in 2019, and Golden Hill, an advanced exploration, grassroots discovery. "The board's decision was based on a view



Richard Young, President and CEO, Teranga Gold.

that the sector had underinvested during the bull market and that, ultimately, grades and production will decline," explained Richard Young, president and CEO of Teranga Gold.

As the cash from Q2 and Q3 this year begins to reflect on their balance sheets, producers face the same question that Teranga had five years ago: how to best take advantage of current market conditions? Strong gold fundamentals and solid cash flows allow producers the opportunity not only to pay off debts, but also to cut lower grades, expand their exploration budgets, and increase their pipelines, whether through organic or inorganic growth.

The matter of building a future pipeline is the most urgent. In the last six years, mining activity has continued, but exploration slowed down. As more gold was being extracted, fewer deposits were being discovered. In West Africa, the region's landmark mines, including Morila and Obuasi, are reaching the bottom end of their existing resources, and even producing mines such as Gold Field's Tarkwa or IAMGOLD's Essakane mine have between 10 to 15 years of LOM.

For the first time in 15 years, Gold Fields managed to replace the depleting reserves at its low-grade, high volume Tarkwa flagship mine in Ghana, which produces over 500,000 oz/year: "I believe we did not offer Tarkwa its fair chance for exploration, and so we have now changed strategy and launched an aggressive and ample exploration program," said Alfred Baku, executive VP and head of West Africa, Gold Fields.

The industry trend has been to focus on advanced-stage assets or exploration around the main mines, while budgets for greenfield exploration have halved over the past three decades. Recently though, the world's largest producers have shown more predilection towards developing their exploration portfolios: "With its refocus on geology as a core discipline, Barrick's exploration programs span the continent's main gold belts, where it is hunting for new



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Tier One assets as well as for additional reserves to extend the lives of its existing mines," Mark Bristow, president and CEO of Barrick Gold, told GBR.

Similarly, Teranga Gold has two contesting development projects that could turn into a third producing mine, the Golden Hill and the Afema, and has grown its annual production from 245,000 oz in 2018 to a projected 400,000 oz for this year. Exploration is also key at Endeavour Mining, which has one of the largest exploration portfolios in West Africa and discovered 8.4 million oz since 2016. After acquiring Exore Resources, ASX-listed Perseus came in the possession of 2,000 km<sup>2</sup> of land around its Sissingue mill in Ivory Coast, and the company will now pursue organic growth.

One hyped-up transaction is the ongoing battle for the takeover of ASX-listed Cardinal Resources, which has seen subsequent price increases in counter-offers by the two bidders: Russian producer Nordgold and Chinese competitor Shandong Gold. In a less mediatized transaction, Future Global Resources is acquiring a 90% stake in Bogoso-Prestea gold mine, also in Ghana, for US\$95 million. Other lower-scale consolidations are represented by Hummingbird Resources buying Cassidy Gold Guinea for US\$12.67 million, for a deposit of 1.1 million oz, grading 2.1 g/mt.

### Growing momentum in the Junior space

Since 2013, the junior space has suffered wavering investment appetite. Through this period, juniors have decreased aggregate budgets by 10% year on year, according to S&P Market Intelligence's recent data.

Gold explorers in Africa trade at lower rates compared to their Australian and Canadian peers due to the political risks associated with the jurisdictions of operation. The median valuation for African gold projects is at US\$18.87/oz, Australian juniors at US\$44.74/oz and Canadians at US\$29.81/oz, based on the Gold Junior Index. Undervalued, African-focused explorers have had a tougher job raising money in the cash-tight climate of the past decade, during which, only 25 major gold deposits were discovered. Nevertheless, more than 35% of all gold discoveries of the last 10 years were made in Africa. The undeniable resource potential is offsetting investors' and developers' risk aversion.

Moreover, discovery costs can be very low in West Africa, as junior explorer Tietto Minerals proved at its Abujar gold project in lvory Coast, where it has been running intense drilling campaigns at record low costs of US\$35 /m, while some Canadian explorers pay around US\$150 /m.

Tietto also expects easy metallurgy: based on this year's met tests, the ore identified is soft and easy to process with recovery rates of between 96% to 98%. Based on these credentials, Tietto Minerals has seen its price share rise from AU\$0.14 in March 2020 to a peak of AU\$0.70 in July 2020, before coming down to AU\$0.31 again in February this year. It remains one of the best valued companies in the region, and for good reasons: The Abujar gold project showcases a 3.02 million oz resource at 1.2 g/mt, following a consecutive third upward resource update. What excites the market is that Tietto has only drilled 10% of a land area of 1,114 km<sup>2</sup> of the main licence, and continues to show huge upside potential, so further resource growth will be the focus of its current 70,000 m drilling program.

When the soaring investment appetite for long-term value is met with short-term supply, explorers become essential players in closing this gap. Mike Brown, CEO for junior company Chesser Resources, expects to see a rush to assets in the short-term: "There is a scarcity of quality assets out there and so majors and mid-tiers will need a pipeline of projects to scale up resources," he told GBR.



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#### **MINING IN WEST AFRICA**

#### **Refilling budgets**

Many West African juniors have seen massive re-evaluations, especially in Q3 2020, on the back of an encouraging news-flow of recent discoveries: In Guinea, Predictive Discovery showcased its Bankan asset, expected to be in excess of 2 million oz. One of the largest tenure holders in Burkina Faso, West African Resources defined a high-grade, 1 million oz resource at M1 South Shoot, while Chesser Resources is returning spectacular drilling results at its flagship Diamba Sud in Senegal.

Completing one of the biggest capital placements, Tietto Minerals managed to raise AU\$56 million, which will fund the PFS, DFS and start moving the Abujar project towards construction. "The market has started to realize the value of our existing resource. We have been granted the mining license and we are now working on the mining convention," CEO Caigen Wang told GBR.

To a smaller degree, Mako Gold, selected among the five best precious metals companies in Africa to watch in 2020 by the Investing in African Mining Indaba, recently raised US\$10 million in a heavily oversubscribed placement to advance its Napié project in Ivory Coast, for which it hopes to have a maiden resource for Q1 2021. Mako Gold actually completed two financing rounds, one in



Caigen Wang, CEO, Tietto Minerals.

May and a second tranche in July, a decision which Peter Ledwidge, managing director, explained: "Some people were surprised by our subsequent AU\$10 million raising happening so quickly, but the logic behind this was that it is better to cash up now, not knowing how long the bull market will last."

Making the most of a friendlier investment climate, many juniors have gone to the markets over the summer and autumn of 2020 and found their placements oversubscribed. TSX-listed Roscan Gold closed a CA\$7.5 million financing, topped up by additional investment from Warrants Exercise of another CA\$3.3 million in July. Another Canadian junior, Newcore Gold, went to the market with an initial capital raising of US\$10 million to fund their exploration campaign at the Enchi gold project in Ghana, but ended up cashing US\$15 million after seeing its placement oversubscribed. Besides financing another 50,000 m of drilling, the raise also led to a diversification of Newcore's investment base, already 39% management owned, to more institutional investors.

This summer, the African Gold Group (AGG) closed an oversubscribed capital raise at US\$11.1 million within two weeks, also bringing in institutional investors. However, the company sits at the lower end of valuations in the region, despite its attractive near-term project with a published DFS. Its Kobada gold mine in Mali has an AISC of US\$782/oz, which is in the lower cost quartile in the West African space, together with a 100,000 oz/y production following an increase in reserves from 500,000 oz to 755,000 oz. "African Gold Group remains very undervalued compared to our peers. As a near development operating gold producer, we are running at a market cap probably three to four times lower than our peers who are not even at the same stage as we are. I believe there is a massive opportunity in terms of investment upside," CEO Danny Callow said to GBR.



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Rosh Pinah Mine, Namibia. Photo courtesy of Trevali.

West Africa is known as a high-risk, high-opportunity mining destination, and this profile has attracted a particular crowd of unwavering juniors, miners and investors. If producers have declared that they intend to stay cautious through the market upturn, juniors have been higher-risk takers, moving forward aggressively and flirting with shifting investors' preferences between different countries. Although the Birimian belt stretches across multiple countries, these receive uneven investment attention. An attractive fiscal code, political stability and access to infrastructure play strongly into the choice. While the previous cycle favored Burkina Faso and Mali, this time around Ivory Coast is the rising star in the region. Security is a key differentiator in turning the tables. The



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coup to remove Ibrahim Boubacar Keïta in Mali has been the most prominent issue since August 2020, but the violence in the Sahel region has spread outside of Mali, and Burkina Faso is now the epicentre of the troubles. Meanwhile, West Africa's darling for gold production, Ghana, has been losing its appeal in terms of exploration funding. Simon Meadows Smith, managing director of SEMS Exploration Services, a consultancy and exploration services company based in Ghana, believes this is due to a lack of recent activity on the exploration front: "Ghana has suffered from a perception issue. It is seen as a well-trodden jurisdiction, surrounded by countries with easier and better opportunities. That perception is wrong; there are fabulous opportunities in Ghana. but the lack of a news flow has not encouraged investors."

By contrast, Senegal has become an attractive alternative by virtue of its reputation for stability. Nigeria is also promoting itself as the newest postcode for mining in Africa.

#### Ghana: Greenfield exploration needed to rejuvenate the mature market

The continent's largest gold producer after dethroning South Africa in 2018, Ghana remains the sub-region's prime-rated jurisdiction. Yet the country's maturity in gold production is also read as a downside; Ghana's prospectivity at surface is reduced considering the extensive drilling in the country, while its metallurgy is becoming more challenging and deposits are found at greater depths.

Ghana's faltering reputation for exploration was caused by a dearth of major discoveries in the last five years. With the ex-

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ception of Cardinal Resources and Azumah Resources, there are a few greenfield projects underway. The country's stringent fiscal environment, compared to other "younger" jurisdictions, has not helped to attract new exploration. At the Ghana Chamber of Mines, president Sulemanu Koney has been advocating for junior-friendly policies, such as scraping VAT for services like assaying and drilling services, which are often outsourced, to make up for the high-risk nature of exploration and the urgent need to replenish the country's project pipeline: "We should create an environment in which mining companies can expand proactively and not wait for a pandemic to realize the importance of the gold sector," he said.



Arc. Olamilekan Adegbite, Ministry of Mines, Nigeria.

Ghana is often the trend-setter for regulation, having already triggered a movement towards more comprehensive local content policies. This year, the country is also revising its GIPC (Ghana Investment Promotion Centre) Act, raising the minimum requirement for foreign investment. Ivan Doku, principal resource geologist and country manager-designate at SRK Consulting, reassured that Ghana will remain a top investment destination in the long-run: "Investment decisions about exploration are based on a long-term view of the market. A host country's national policy framework on mining underpins decision-making – and the importance of political stability cannot be overstated."

The high gold prices in a jurisdiction producing 142.4 mt/y of gold have alerted some analysts that governments may increase taxation in a trend of 'resource nationalism.' George Kwatia, partner at PwC Ghana, is adamant the administration will remain mining-friendly: "The mining industry has been a staple of Ghana's history for centuries, and it remains the bedrock of our investment profile."

#### Mali and Burkina Faso: High prospectivity shadowed by security risks in the Sahel

On the podium of the top five largest gold producing countries in the region, Mali and Burkina Faso, both producing around 61 mt/y, cannot arouse much investment appetite due to security challenges on the ground. Intensified armed violence in Burkina Faso and the Malian coup of August 2020 are hallmarks of chronic insecurity in the Sahel region. Already experienced in mitigating such challenges, the production sector has been weathering the situation, but the exploration sector is struggling.

Gold production jumped to a high of 2.5 million oz/y last year, a volume which reflects the robustness of a sector made up of companies like Barrick, Endeavour, IAMGOLD, B2Gold, AngloGold Ashanti, and Resolute, all operating in either one or both of the countries. For Malian explorers who require lesser traffic of goods and capital, the political stalemate did not interrupt drilling, but they were more susceptible to price volatility. Roscan, a junior developer, saw its share price drop from CA\$0.47 to CA\$0.38 on the day of the coup. The destabilization in share prices reverberated to operators across the border in Burkina Faso: West African Resources share price decreased by 6.9% after the coup.

Junior explorers are less prepared to invest in security protocols, so that in Burkina Faso there are no sizeable explorers, and greenfield exploration will die out if the violence does not cease or the government does not intervene. In Mali, however, the junior space is more diverse, occupied by companies like African Gold Group, Roscan, Cora Gold, Firefinch and Compass Gold. Launched in 2017 by some of the former founders of IAMGOLD, Compass Gold took one of the last parcels of exploration land in Mali, a package of  $1,000 \text{ km}^2$ .

#### **Nigeria: The newest frontier**

"If Thor's Segilola mine was located anywhere else in the world, it would have been developed 10 or 15 years ago, but the current postcode prevented the asset from being developed," said Osam Iyahen, senior director of natural resources at the Africa Finance Corporation.

Developed by TSX-listed Thor Explorations, Segiola is Nigeria's most advanced gold project and Nigeria's attesting proof

that the country could be the next mining destination. Today, mining contributes 0.6% to the national GDP, but the country is looking to increase this figure to 5% by 2025.

The current administration set aside US\$80 million for exploration studies and current survey data has identified 44 minerals in the country. Nigeria is offering generous incentives, such as a threeyears tax holiday for explorers, 100% allowance on foreign capital, and duty-free shipments on mining equipment. On the other hand, it has also enshrined a Community Development Agreement (CDA) in its regulation, while driving forward a downstream policy to reduce imports. In the downstream sector, the industry is already showing great resourcefulness. Kogi Iron, an Australian listed company, made a successful iron ore discovery at Agbaja, but has decided since to integrate the ore deposit into a steel producing facility, the first of its kind in the country.



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The oil industry has nurtured the development of a robust infrastructure, as well as a competitive services sector, which are important assets for the mining industry. Nigeria's Mining Minister Arc. Olamilekan Adegbite said Nigeria has another winning quality: "If mining costs in well-established jurisdictions can amount to about US\$270/oz, in Nigeria this number goes as low as US\$80/oz. I truly believe Nigeria is the next frontier for mining:"

#### Senegal: Reclaiming attention to a prolific border

The Senegal-Mali-Shear-Zone (SMSZ) is scattered with world-class mines, including Sabodala and Massawa, Fekola, Luolo-Gounkoto, Sadiola, and Yatela on both sides of its border. Their analogous geologies mean that the two competing neighbours are judged by investors based on their perceived sovereign risk. The stark contrast between Senegal's reputed stability and its neighbour's instability plays to the advantage of Senegal.

Resolute Mining, for example, has been expanding its foothold in Senegal through the takeover of Toro Gold last year, which adds to Resolute's greenfield Mako gold mine in eastern Senegal. Another recent transaction was the acquisition of the Massawa mine by Teranga Gold, now merged with Endeavour.

New exploration targets confirm the mineralization across the identified trends. Chesser Resources is developing Diamba Sud, 7 km to the east of Barrick's Luolo-Guonkoto. Oriole Resources is developing its Senala project (former Delefin license), west of IAMGOLD's 2.5 million-ounce Boto gold project. IAMGOLD already signed an US\$8 million agreement to obtain up to 70% ownership of Senala.

Senegal has been going through a profound economic transformation, accelerated since 2014 through the government's Plan Sénégal Emergent (PSE), a US\$20 billion investment pushed by President Macky Sall to catapult economic development. Mining is a big part of



## Ivory Coast: The up-and-coming jurisdiction that has investors excited

lvory Coast's rich terrain, blessed with the largest share of the famed Birimian Greenstone belt, was broadly inaccessible to miners prior to 2012, when a gruelling military crisis that had lasted a decade finally ended. Since when, lvory Coast has become one of the fastestgrowing economies in the world.

lvory Coast reached record gold production last year, boosting its annual output by 35% after Persues's Sissingué mine came into production. On the exploration side, the country has not ceased to reward juniors with impressive finds: Tietto Minerals, one of the first entering the country in 2014, is developing a deposit of at least 3.01 million oz. Iron Ridge Resources came later to the country, but it quickly became one of the largest tenure holders.

Mako Gold's JV project with Perseus, the Napié project, also shows the characteristics of a large deposit, believed to be in the range of 2 to 3 million oz by the managing director, Peter Ledwidge. Meanwhile, Roxgold's Séguéla, currently at 900,000 oz of resource in the preliminary study, has chances to turn into a multi-million oz mine.

Combining the great geographical positioning of countries like Ghana with the untapped mineral resources of Burkina Faso or Mali, and with a transparent online available cadastre system and a growing services sector prepared for the influx of new investors, lvory Coast is unrivalled in terms of its opportunities. The outcome of recent elections re-opened questions over the country's stability, as well as causing delays to permit applications in the short term, but the country remains well positioned for future growth.



# Service and Equipment Providers

### Covid-19, a litmus test



Overburden removal. Photo courtesy of PW Nigeria.

While mining companies were deemed essential businesses and largely continued operations through the pandemic, the providers sector was cruelly divided into two categories: indispensable and dispensable. On the one end, logistics companies became critical in ensuring supply chain continuity, but consultancies and contractors were left with a distressed clientele that either renegotiated fees fiercely, delayed payments, or cancelled their obligations altogether. Federico De Simone, director of De Simone Group in Ivory Coast, said with cautious optimism: "2020 has been a taxing year in terms of project development and construction within our company, but we expect a sustained growth in 2021."

Ama Nketiah, regional manager of Knight Piésold (KP) Ghana, a consultancy specialized in geotechnical and environmental services, observed her clients' hesitance in advancing projects or making any major decisions: "Our clients were cautious due to the possibility of an outbreak shutting down their operations. Also, the logistical nightmare of getting people to site delayed the commencement of certain projects."

This slowdown made it difficult to maintain stable balance sheets, particularly for equipment and parts suppliers who need to import their products. "To keep the cycle going, we need steady cash flows, but since we buy in US\$, the conversion is unfavorable, leaving us with very small margins and with very little to reinvest into the business," said Peter Quarm, director at Dutylex, a lubricants solutions provider based in Accra.

In Ghana, the Cedi has been losing value over the years, making imports expensive. Borrowing rates in Ghana are much higher compared to the US or Europe: "While interest rates in the US hover around 0%, the interest rates for equipment financing are between 8.5% and 13% in Ghana. This makes us uncompetitive to foreign contractors who are able to source cheaper funds," shared Joseph Titus Glover, CEO of Quantum LC.

The anxiety around a shortage of supply also created a trend towards stockpiling. Mincon, an Irish-based engineering company specialized in developing and manufacturing hard-rock drilling tools, noted a growth in revenues over the months of the pandemic: "Many of our clients increased their replenishment orders for consumables and equipment to avoid running short in case of lockdowns or disruptions to shipping," said Martin van Gemert, managing director, Mincon West Africa.



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Mines in Africa are increasingly adopting new technologies, such as tooth detection systems. Photo courtesy of Motion Metrics.

Home to the world's largest cobalt producer and Africa's top-two copper producers, the Copperbelt region attracted a total of US\$2.3 billion in investment during 2019. Meanwhile, Central Africa attracted US\$8.7 billion of investment overall and maintained a GDP growth rate of 3.8%. The region's dependence on natural resources has contributed greatly to this rise, but is also a main cause of the fragility of its economies as it increases vulnerability to external shocks. While all the countries in the region witnessed growth acceleration from 2018-2019, real GDP growth in the DRC, however, decreased by 1.5%, primarily due to the uncertainties of a political transition, drops in copper and cobalt prices, as well as the Ebola outbreak. and GDP is expected to contract by a further 3.9% in 2020 and 3.4% in 2021, according to the African Development Bank (AfDB), as the Covid-19 pandemic takes its toll on the economy, resulting in further uncertainty in a continent already grappling with widespread economic and geopolitical instability.

However, Central Africa maintains favourable prospects for medium-term economic growth, according to the AfDB. Its economies have benefited from serious efforts at diversification and reform, including Cameroon attempting decentralization, DRC aggressively enforcing transparency initiatives, and the Central African Republic undertaking a full overhaul of its alluvial mining sector. However, this was during a pre-Covid global economy. Today, the region witnesses a growth rate of -4.3% for 2020, as global lockdowns and travel restrictions take their toll.

Both the mining industry and those that support it suffered, most notably logistics.

"Some problems were faced in March and April with South Africa, from where we receive major import flows, when their lockdown and road closures were imposed. Quarantine in Zambia has also been a challenge for our drivers on this corridor," explained Rodolphe Kembukuswa, general manager in Southern DRC of Bolloré Logistics, a leading transport and logistics provider. "Forwarding out of China and India was impacted, as sailing from February until July was forbidden which caused major project delays."

Due to port and refinery closures in addition to supply chain disruptions, demand for African commodities from China decreased, especially for copper. Even though copper was the worst performing metal in Q1 of 2020, it has had the strongest rebound since; from 2.8 US\$/Ib in January 2020 to 3.59 US\$/Ib in January 2021. Demand for copper will increase in the upcoming years as electric vehicles (EVs) are on the rise, which require four times more copper than a conventional car. The Copperbelt region has



Shahram Tafazoli, Founder and CEO, Motion Metrics.

already started attracting attention, especially the DRC as a producer of both copper and cobalt.

Meanwhile, mines in Africa are rapidly modernizing and equalling world-class industry standards offering ample scope for service providers. "I believe that technology is fairly independent of geography. Infrastructure is needed to develop complex technologies, but not to implement them. For instance, some of the poorest countries in the world have adopted some of the most sophisticated wireless technologies. A mine in Africa is just as likely to demand autonomous trucks as one in Australia or Canada," said Shahram Tafazoli, founder and CEO of Motion Metrics, a Canadian technology company that applies AI and computer vision to improve mine safety and energy efficiency.

#### The Democratic Republic of Congo (DRC): Africa's copper champion tackles a pandemic

The DRC is no stranger to disease outbreaks and perhaps because of this, managed to ensure one of the least impacted mining industries. "The mining industry, which contributes 40% to the DRC's GDP, was somewhat immune to the pandemic relative to other industries," confirmed Yannick Mbiya, regional director at Trust Merchant Bank in the DRC. "Mining companies took the necessary measures to be able to continue production safely and global commodity prices have remained broadly supportive."

DRC mining revenues were not heavily impacted and projects such as the long-anticipated Kamoa-Kakula mine – to be one of the largest copper mines in the world once completed – are ahead of schedule. The country's experience with Ebola allowed it to react faster, according to Marie-Claire Yaya, CEO of ITM Holding Africa, an international human resources solutions company: "The two outbreaks present significant similarities. The measures that were initially put in



Nigel Ferguson, Managing Director, AVZ Minerals.

place to counter Ebola, mainly handwashing and social distancing, played an important role in the fight against Covid-19. The DRC's contact tracing program also ranks highly relative to other African countries and is adopted from Ebola."

Contrary to other copper producing countries, copper production in the DRC increased in 2020 by 12% year-on-year from January to November to 1.456 million mt, according to the Central Bank of Congo. Demand for copper from EV sales is forecast to increase to 4 million mt/y by 2035, according to Wood Mackenzie, and, consequently, DRC's copper production is forecasted to increase to over 1.6 million mt/y over the next five years.

# The daunting challenge of huge potential

The DRC is struggling to foster a climate of confidence for investors, especially following the passage of the controversial mining code last year, which mining companies continue to protest. "The mining code is problematic due to the immense number of taxes it imposes. The over-taxation in the industry diverts investment from the country, especially the super tax on critical minerals," explained Nigel Ferguson, managing director of AVZ Minerals, a junior Australian mining company with a majority share in the Manono lithium project, located 500 km due north of Lubumbashi.

The code's amendments follow the recurring African trend of enhancing government control over minerals and rebalancing mining revenues in favour of the State. Protested changes include royalty fees, that increased from 2.5% to 3.5% for precious metals and from 2% to 3.5% for non-ferrous and base metals, as well as a new 10% royalty on minerals deemed by the State to be strategic, including copper, coltan and cobalt. A super profit tax was also introduced, due when the commodity price increases by 25% relative to that quoted in the feasibility study, paid in addition to the 30% net profit tax. Another key change has been the reduction of exploitation licenses from 30 to 25 years, as well as increased restrictions on the free disposal of funds by mining companies.

Coupled with the subcontracting law adopted in 2017, which stipulates that activities can only be subcontracted to Congoleseowned companies, investors in the DRC have become wary of regulatory changes. "The recent change in the subcontracting law stipulating that any subcontractor operating in-country must have a Congolese majority ownership of at least 51% was a challenge we had to overcome," confirmed



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#### GBR

#### **MINING IN COPPERBELT AND ANGOLA**

Richard Van Den Barg, director of T3 Projects, a South African construction contractor operating in the Copperbelt.

On the other hand, Noel Mabuma, CEO of Congo Equipment, the official CAT distributor in the DRC, offers a different perspective: "These reforms led to the entrance of more Congolese subcontractors to the market. They are still small and medium players, since running big projects requires skill and experience. It will promote SMEs with Congolese capital and grant more jobs to nationals."

The Congolese government must also resolve the infrastructural deficit that has plagued the nation for decades and continues to dampen economic development significantly. The flawed nature of the Sicomines minerals-for-infrastructure pact with China must be addressed, as it has failed to live up to expectations since 2007, so that it serves as a warning to other emerging economies to ensure benefits are of guaranteed value before exchanging their main source of wealth.

The DRC has yet to utilise its full hydropower potential. According to the USAID, the country uses only 2.5% of its hydroelectric potential. Hydropower offers a great alternative to power mines considering its lower cost and environmentally friendly



Construction of 1km power canal at Kibali. Photo courtesy of IOB.

nature. International development banks, such as the AfDb, have helped develop projects such as the Lungunfi II hydropower plant. Barrick already benefits from hydroelectricity at its Kibali gold mine, as it invested US\$207 million to build three hydroelectric plants, including the Azambi project developed in 2018, which reduced the mine's overall energy cost by 75% and allowed it to save fuel-related costs amounting to US\$19.2 million per year. "The project is an 11 MW run-of-river hydroelectric scheme located on the Kibali river in the North-Eastern district of the DRC. It produces approximately 64 GWh of renewable,



cost-effective and reliable electricity each year to power the remote mine and local community," explained Vishal Haripersad regional manager of Knight Piesold in Africa, who executed the project for Barrick. "The projects identified in the DRC for hydropower are often mega projects such as dams. However, you can harness the power of rivers to provide a clean source of energy to the mines and provide power to surrounding communities."

The government has yet to address the current power shortages, malfunctioning roads, and failing rail networks. On the other hand, mining companies also face challenges posed by artisanal miners in the DRC. The Congolese state is tolerating artisanal mining so to reduce unemployment and community distress. However, the activity results in high rates of accidents and fatalities, has a negative environmental impact and often interferes with formal mines. "The local community exercises small scale mining and it may see the arrival of big mining companies as a threat. This is an area where the government could better intervene to protect local communities and ensure they reap the benefits of formal mining in the region," explained Feni Matsando Samuel, CEO of Inter Oriental Builders, an indigenous contractor.

Formalization of artisanal mining activities offers a more viable solution than suspension of operations, as the industry is vital for world supply and for the DRC's attempt at inclusive growth and development, but the power of the government to control it is limited.

#### Zambia: Damsel in distress

Meanwhile Zambia, the world's seventh largest copper producer is drowning in debt to finance infrastructural projects under the government's Seventh National Development Plan (7NDP). The nation's overreliance on non-concessional external borrowing since 2014 allowed public debt to reach 80% of

MINING IN COPPERBELT AND ANGOLA

GDP by the end of 2019, compared to 35% in 2014. "Unfortunately, Zambia became Africa's first bond default during the Covid pandemic, as it continues to struggle with a debt amounting to US\$12 billion," highlight-ed Patrick Dikima, territory manager of Orica in Zambia. "Production recently increased amid the default, relative to last year, expected to reach 820,000 tonnes at the end of 2020, which is a positive and surprising outcome considering that Zambia missed its international interest payments."

Despite the problems in the DRC, which increased royalty fees and taxation, Zambia is struggling to recover its status as Africa's leading copper producer, which it lost to the DRC in 2013, as regulatory uncertainties plague the sector. From January to September of 2020, Zambia produced 646,111 mt, a year-on-year increase of 9.45%, compared to the DRC's 1.186 million mt in the same period. Between 2001 and 2016, changes in mining regulations led to the re-drafting of eight national mining contracts. The Fraser Institute's Annual Survey of Mining Companies ranked Zambia as one of the least attractive jurisdictions for mining investment in the world, with a score of 60.83 for 2020, ranked 51st out of 77 global mining jurisdictions. The introduction of a new controversial tax regime and the lack of trust between the government and mining companies will likely decrease its score further for 2020.

According to Sokwani Chilembo, CEO of the Chamber of Mines in Zambia: "The provision of indirect stimulus through targeted reliefs, especially on the double taxation elements on the non-deductibility of mineral royalty tax, would secure approximately US\$2 billion investment into the industry, half of which could finance the expansion of First Quantum Minerals' Kansanshi mine, and the other to finance EMR Capital's Lubambe mine expansion, a 10 million mt copper asset expected to produce 160,000 mt/y."

Concern over regulatory inconsistencies has eroded investor confidence, exemplified by the government's feud with Vedanta Resources in 2019, when it seized control of Konkola Copper Mines (KCM), Africa's largest integrated copper producer, on the grounds of an alleged breach of environmental and financial regulations. President Edgar Lungu's government also threatened to strip Glencore of its copper mining license after it announced closure of its Mopani copper mines due to logistical challenges and falling metal prices in April 2020 as a result of the pandemic. As mine closure is illegal, the closure decision defied the government. The feud escalated further when Mopani's CEO was detained at Lusaka airport.

"The position the government has taken with KCM could be seen or labelled as expropriatory in nature as KCM's liquidation was petitioned by ZCCM-IH on the ground that KCM was not paying dividends," elaborated Bwalya Musonda, partner at Bowmans Law, the South African law firm with offices across the continent. "These incidents will continue to spark fear that foreign investments cannot be protected in Zambia, which should not be the case."

A 'them and us' narrative defines current Zambian mining culture, as President Lungu's administration is pressuring foreign miners in an attempt to increase the government's stake to a majority in Zambian mines. "Under our new strategic plan goals, we address the minority stake that we have had for years and that we wish to increase over all our assets if the opportunity arises," confirmed Mabvuto Chipata, CEO of ZCCM-IH, the state mining investment company.

The mines where the government wishes to increase its stake are yet to be identified, however Glencore's Mopani Copper Mines tops the list, where ZCCM-IH owns a minority 10%. Mopani was forecast to produce between 50,000 and 70,000 mt of copper in 2020, however, it witnessed disruption in production as a result of the outbreak of Covid-19 and the resulting fall

ORIENTAL BUILDERS

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IOB has extensively worked with: Barrick - Kibali Gold Mine (Watsa/Haut Uele), Banro Corporation, the DRC Government, CILU (Cimenterie de Lukala), Malta Forest (Kolwezi/Lwalaba), NGO's, BCDC Bank and IOB own projects.

Our future plans include designing a surface drilling project to be started early 2021, expanding IOB to all the provinces of the DRC and opening the company to new projects in Africa.

#### SERVICES PROVIDED:

- Civil construction
- Road construction
- Import and export of goods
- Manufacturing of Hydra form bricks
- Batching and Supply of designed concrete
- Mining and Construction Logistics (Light and Heavy duty)
- Plant and equipment rental

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Special engineering tasks and underground work

Installation of roof and side sheeting

Fencing and fence gates

Hydro-power columns

Erection of antenna



Contact: Oscar Siviwe, CEO Phone: +243 820 998 423 +243 994 237 777 / +243 819 891 777 Email: etsoscar88@gmail.com tes.oscar@topengineeringservices.com Web: topengineeringservices.co in copper prices. As a result of the feud with the government and operational bottlenecks, Glencore is negotiating the sale of its 73.1% stake in Mopani to the Zambian government.

Foreign investors in Zambia are wary of expanding current mines or initiating new operations and exploration due to the current tax framework, the government's attitude toward foreign players in the sector, and an upcoming election scheduled for August 2021 that carries its own risks of further regulatory changes. Zambia is, however, well positioned to supply battery metals as one of the most prolific copper and cobalt producers. What it lacks is the corresponding legal, environmental and financial conditions to further encourage the growth of the mining sector.

#### **Diversification: Beyond copper**

Even though copper takes central stage in the Zambian mining industry, the country has vast reserves of gemstones such as tourmaline and aquamarine, but emeralds are the country's crown jewel, as Zambia accounts for 20% of global emerald supply as a result of their high-quality. The Kagem emerald mine in northern Zambia is the world's single largest producer of emeralds, majorityowned by Gemfields (75%).

Gold is also attracting attention in Zambia. Evans Kanche, managing director of the Association of Zambian Mineral Exploration Companies, elaborated: "Significant findings of alluvial gold in the north-western province have led to the metal being viewed as strategic by the government and efforts to promote its exploration and production are being undertaken. Legislation is to be put in place to facilitate the rise of the gold mining industry."

ZCCM-IH is attempting to harness the nation's gold potential by forging partnerships with players in the value chain. A partnership ZCCM-IH signed with Karma Mining Services and Rural Development, for example, will develop a gold processing and trading operation in Zambia through their subsidiary Consolidated Gold Company Zambia (CGCZ), initially by sourcing most of the gold ore from artisanal and small-scale gold miners. ZCCM-IH also signed a US\$2.5 million deal with US-based mining services firm Array Metals in May of 2020. Array Metals, holding a 35% interest in the JV, will work with CGCZ on the construction of a gold wash plant and mining machinery to mine and process gold. The project aims to produce 3 mt of gold within the next two years.

Zambia also possesses one of the highest-grade zinc deposits in the world. 20 km



Dr. Benedito Paulo Manuel, Director General, Sociedade Mineira de Catoca.

north of Lusaka is the Star Zinc mine, which has been intermittently mined for decades and is currently majority owned by AIMlisted Galileo Resources. Star Zinc is likely to supply up to 60,000 mt/y to Jubilee's Kabwe zinc refinery after obtaining a smallscale mining permit in Q2 of 2021.

Nonetheless, the mining sector in Zambia is hampered due to disruptions caused by power cuts. Addressing the electricity deficit is pivotal to the nation's economic growth and will facilitate diversification as it feeds into all other sectors of the economy. Diversifying the energy mix is the first step towards a more reliable nation-wide power supply, as Zambia's hydropower is highly susceptible to the effects of climate change.

## Angola: Diamonds face a rough year

The world's fifth largest diamond producer, Angola, expects GDP to contract by 4.1% in 2020, according to the Economist Intelligence Unit (EIU), as it suffers under the dual shock of the effects of Covid-19 and the fall in oil prices. The Angolan diamond mining industry, which President João Lourenço is determined to protect, has also experienced a difficult year as the diamond market struggled to find demand as an industry that thrives on face-to-face interactions. Anglo American's De Beers cut 2020 production by a fifth, Dominion Mines filed for insolvency protection and Catoca, operator of the fourth largest diamond mine in the world, shut down its mining processing factory. "From March to September, the global diamond market was stagnant, therefore a management mode was implemented in order to survive the pandemic while profits fell. Production plans for 2020 decreased by about 30%; only vital investments were kept," highlighted Dr. Benedito Paulo Manuel, director general of Sociedade Mineira de Catoca.

# **Overhead Crane is Installed in Underground Gypsum Mine**



USG's Shoals mine taps CraneWerks to install a top-running double-girder crane by R&M Materials Handling underground. (Photo: CraneWerks)

CraneWerks installed an 18-metric-ton (mt) overhead crane 122 meters (m) underground at the U.S. Gypsum Co.'s (USG) Shoals mine in Indiana, U.S.

The crane and hoist were supplied by R&M Materials Handling Inc., and were sold by Harriman Material Handling.

CraneWerks designed a two-piece 11-m bridge that was welded together in the south end of the mine. The crane operates on a 62-ft runway.

The miner chose a top-running double-girder crane because it offers the same hook height as a single-girder crane, but doesn't require as much headroom. The hoist and trolley ride on top of the bridge girders instead of being suspended from the bridge girder. The crane was available on a short lead time. The crane lifts equipment and components for assembly and maintenance.

USG reported the crane fulfills expectations. "We needed a crane capable of moving large pieces around for assembly of equipment in the mine, and the results suggest we found a solution," USG said. "We could have acquired a few telehandlers that had the necessary weight capacities, but the electric overhead traveling crane was the preferred option."

#### **Codelco Deploys AutoMine Elsewhere at El Teniente**

Codelco ordered Sandvik's AutoMine Fleet system for a new fleet of loaders at Pacifico Superior and Pilar Norte GTI at El Teniente mine.



Codelco deploys Sandvik's AutoMine Fleet at Pacifico Superior and Pilar Norte GTI at El Teniente. (Photo: Codelco)

The system will enable the miner to operate its new fleet of Sandvik LH517i and LH621i loaders autonomously. The project launched in December 2020 and is expected to be completed by mid-2021.

The companies have a rich history of working together. In 2004, El Teniente adopted the first-ever AutoMine Loading system. Currently, AutoMine is operating at Diablo Regimiento and Panel 2 at the mine.

The mine said the partnership and solutions align with its operating philosophy. "Above all, Sandvik's enhanced local presence and expertise will ensure successful implementation of these projects and strong support," said Juan Mariscal, senior business manager, Codelco.

#### Volvo, Foretellix Partner on Autonomous Technology

Volvo Autonomous Solutions (VAS) partnered with Foretellix on a Coverage Driven Verification solution for autonomous driving solutions operating on both public roads and in confined areas. The solution will enable massive scale testing of millions of scenarios.

The partnership will focus on providing high levels of safety and productivity, VAS reported. The solution will reduce costs and time to market. It will ensure faster operational readiness and the ability to safely scale up the system across multiple sites.

VAS said the partnership gives it access to state-of-the-art verification tools to help accelerate the time to market. Foretellix said the partnership sets a new



Volvo Autonomous Solutions taps Foretellix for its autonomous driving solutions testing tools to reduce costs and time to market. (Photo: Volvo Autonomous Solutions)

standard in the verification of automated driving systems.

The partnership arose after both companies conducted a pre-study that evaluated the Foretellix portfolio for this specific application.

#### **Redpath Drills Record Raise**

Redpath Group reported completing an 875-m-long, 6.3-m-diameter raise at Niobec mine in Québec, Canada. "The raise is the largest by volume ever completed in the Americas and in the Northern Hemisphere," Redpath reported. "It is also the third biggest globally."

A Redbore 90EX raisedrill, made by Redpath, did the job, which started in 2019.

The development is the fruit of an integrated process with the lowest-possible end cost and the highest standards of safety and productivity, the company said.

"The engineering and construction teams of our two companies worked in partnership to achieve this goal," said Johan Davel, general manager, Redpath Raiseboring. "The project finished safely and ahead of schedule."



Redpath completes the largest-by-volume raise in the Americas and northern hemisphere at Niobec mine ahead of schedule. (Photo: Redpath Group)

# Nutrien Uses Orwellian Tech to Redefine Work

Nutrien announced expanding its use of Proximity Trace, workplace tracking and surveillance technology, from Triax Technologies, as part of an effort to redefine work. Roughly 6,500 employees at the company's Saskatchewan sites and the corporate offices are scheduled to use the technology in the coming months, Nutrien reported.

Proximity Trace uses sensors on clothing or in hard hats to measure the distance between users. It sends an audible and visible alert when users get within 6 ft of each other. The sensors can collect data on the users and their interactions, and can support contact tracing.

Currently, 8,000 employees at the company's nitrogen and phosphate sites in the U.S. use the technology. Nutrien initially adopted the technology in summer 2020 when health authorities encouraged companies to take measures to slow the spread of COVID-19.

Data on the virus from China later showed working-age people in general have a roughly 99% survival rate for the virus. Most of those who catch it have either mild or no symptoms, and beat it within a week.

Now, Nutrien's usage of the technology is being expanded as the company moves to "redefine the future of work with safety and integrity at the forefront," Brent Poohkay, chief information officer, said. With the development, roughly 65% of Nutrien's global employee base will use Proximity Trace.

A medical expert at the company said he encouraged workers to "think of themselves as living within 6-ft bubbles." Since deployment of the system, physical distancing alerts have reduced the number of close contacts, positive cases and quarantines, Nutrien said. The automated data system has improved the efficiency and accuracy of tracking personnel and tracing contacts, it said.

#### Petra Diamonds Trials Hovermap at Finsch

Petra Diamonds partnered with Dwyka Mining Services to trial Emesent Hovermap technology at Finsch mine at scanning an indoor stockpile, orepasses and vertical shafts, and a series of access tunnels and ramps.

Petra Diamonds said hardware was lowered down ore passes, flown by drone into drawpoints, and attached to vehicles to scan shafts and ramps. Dwyka Mining Services then delivered point cloud data sets for Petra's survey team to geo-reference and analyze. Also delivered were visualizations of ore passes, allowing engineers to see their actual condition.



A visualization based on an ore pass scan by Emersent Hovermath, administered by Dwyka Mining Services, at Petra Diamonds' Finsch mine. (Photo: Emersent)

The visualizations exceeded all expectations, Alex Holder, projects lead, Petra Diamonds, said. "The data captured in one ore pass saved us significant time and effort by confirming it was irreparable," he said. "That saved us millions."

The data collected by Hovermet became the basis for a data library.

Petra plans to use the solution at its other sites in Africa, Emesent reported.

#### General Kinematics Acquires CYRUS Unit

General Kinematics announced the acquisition of CYRUS Schwingtechnik Business Unit.

Located in Recklinghausen, Germany, CYRUS provides modular vibratory machines for conveying and screening technology. CYRUS will operate as a separate brand under General Kinematics Europe.

General Kinematcis is a vibratory equipment manufacturer and system integrator located in Crystal Lake, Illinois, U.S. the company said the acquisition stemmed from successfully combining the offerings of both companies previously. "It made sense when the opportunity arose to build on that success as one integrated company," said Thomas Musschoot, president, General Kinematics.

#### Agnico Taps Robit for Drill Consumables

Agnico Eagle contracted Robit for drilling consumables for Kittilä mine with deliveries starting in May. Robit previously supplied diamond button bits to the mine for production drilling.

Robit said the long-term contract is the result of the relationship between the two companies. "It is also an investment to domestic market," said Tommi Lehtonen, CEO, Robit Group. "We are excited



Agnico Eagle contracts Robit for drilling consumables at Kittilä mine. (Photo: Robit)

of this collaboration, which in addition to product supply offers an opportunity to develop our products together with one of the leading mining companies."

#### Purvis Industries Acquires HydraGear

Purvis Industries acquired HydraGear LLC of Las Vegas, Nevada.

Purvis Industries said the acquisition will help it to successfully deliver key services to customers. "Our branches, especially in the West, are perfectly positioned to take full advantage of HydraGear's capabilities and we are eager to share those capabilities with customers," said Cameron Barker, vice president of corporate operations, Purvis Industries.

With 92 locations in 16 states, Purvis Industries, headquartered in Dallas, Texas, is one of the largest independent bearing and power transmission distributors in the United States.

HydraGear offers hydraulic service and repair in the western U.S.

#### BIA, EuroforGroup Partner on Drill Sales in Africa

BIA Group and Euroforgroup signed a distribution agreement for the Furukawa and RTDrill brands in Central and West Africa, strengthening their presence in these regions.

Euroforgroup distributes drilling machines and equipment to include Furukawa solutions in France, Maghreb, and Central and West Africa. With state-ofthe-art facilities, BIA sells and services solutions in 20 countries in West and Central Africa.

BIA described Euroforgroup as a firstclass partner whose offerings complement those of BIA. "I am confident about the capacity of both Eurofor and BIA teams to build a strong partnership that serves our customer better than ever," BIA Group CEO Vincent Bia said.

#### Cadia Adopts Hydrofloat Separators

Newcrest Mining adopted four Hydrofloat Separators by Delta, BC-Eriez Flotation for use in Stage 2 of the Cadia Valley Operations expansion project in New South Wales, Australia.

The development follows the successful adoption of four Eriez CrossFlow Separators and two HydroFloats at the Cadia Coarse Particle Flotation demonstration plant in 2018.

Newcrest Mining is the first mining company to commercialize HydroFloat coarse particle flotation in sulfides and the first to use it in a tail scavenging application.

#### **Continental Consolidates**

Continental reported all products, technologies and services are now combined under the Continental brand.

With the development, all products from PHOENIX, IMAS, Kolubara, Matador and National Belt Service were integrated into the Continental portfolio. LEGG and BELTTRADE belt products will remain available to North American distributors.

The company said customers will benefit from a stronger portfolio from a single source. "We will be joining forces to continue our customer-centric business approach," said Hannes Friederichsen, business unit head, conveying solutions, Continental.

#### SMT Scharf Canada Gets Mexico Distributor

SMT Scharf Canada partnered with Parts Service Supply Mexico to distribute the supplier's rubber-tired product line of machines. The latter will provide sales, parts support and service.

Parts Service Supply and two sister companies, Cominsa and Prossessa, were selected for their long history as major players in the mining industry in Mexico, SMT Scharf Canada reported. "Parts Service Supply prides themselves on being one of Mexico's top mining supply companies, and is founded on the principles of safety, ethics, quick support and premium technical knowledge," said Shannen Edwards, director, corporate development, SMT Scharf.

#### Electric Hydraulic Excavator is Commissioned

Youngquist Brothers Rock commissioned a Liebherr R 9150B E hydraulic mining excavator in electric configuration, which is reportedly the first such unit operating in the U.S. The Fort Myers, Florida, limestone operation also runs a R994 E and a Bucyrus Erie 1260 walking dragline.



Youngquist Brothers Rock commissions a Liebheer R 9150B E excavator for use in limestone in Florida, U.S. (Photo: Liebherr)

# Selective Electroplating Speeds Parts Repair

Equipment lifespan and machine condition are critical considerations for driving down costs. Remanufacturing is one of the best ways to achieve this, but what does it entail? Mark Meyer, North America sales manager for SIFCO Applied Surface Concepts (ASC), explained how selective electroplating can build components back to original specifications.

Mining is an intensely demanding industry for all types of equipment. Unpredictable field conditions and harsh operating environments can combine to increase the risk of wear and tear, corrosion and damage to component surfaces. If not properly maintained, many of these components — or entire pieces of machinery — may need to be scrapped, increasing capital equipment costs and downtime.

This result is far from inevitable though, if site managers and manufacturers can find a way to head off component failure. This is where remanufacturing comes into play, returning OEM parts back to original specification — or better — for a longer, more reliable lifespan.

#### Extending Operational Lifespan

Remanufacturing can extend the operational lifespan of equipment, but it's just as crucial to ensure that in doing so, downtime is also minimized. When the costs of such downtime are counted in millions of dollars, as in mining, any way to quickly, cost-effectively and sustainably enhance components, improve wear resistance and repair damage is key. Here, selective electroplating offers a vital benefit.

Selective plating is a method of repairing and restoring critical dimensions and surface properties of worn components back to OEM standards, using an array of solutions such as copper, nickel, nickel-tungsten and cobalt. Even more crucially, it can be completed on site to reduce downtime.

This is due to the focus on treating specific areas of a component by accurate, selective brush plating of materials on to localized surfaces and diameters, enabling in-situ repair and enhancement that is typically faster than alternative surface-coating methods. Compared to the other major electroplating method — tank plating — it does not require extensive masking or special fixtures and can plate deposits between 30 to 60 times faster without risk of part distortion because the process takes place at room temperature. All of this combines to make it a faster, more cost-effective and lower-risk option.

#### The Selective Plating Process

Given the severe and the harsh direct impacts experienced by mining components, selective plating needs to bond at the atomic level. This is not provided by traditional surface coating methods such as thermal spray, which form mechanical bonds.

Focusing on this atomic bond, selective plating uses electrochemical principles. An electrolyte solution, containing ions of the deposit material, is introduced between the negatively charged plating surface and the positively charged tool. This is powered by a portable power pack, enabling precision control over amperage, voltage and duration.

When the tool (anode) touches the surface, a circuit is created with a cover material around the tool providing a reservoir to ensure even distribution. The current within the circuit causes the ions between the interfaces to bond, building up the plating layer, and delivering a highly adherent and dense metal deposit.

Selective plating also allows for more accurate control of deposit thicknesses, frequently enabling parts to be plated to size with no post-machining. With repairs able to be undertaken in the most appropriate location — in the shop or on the job site — this accuracy is matched by a fundamental flexibility in the process.

#### Rejuvenating a Pinion Gear

We've discussed selective plating in principle, but what happens in practice? An example that illustrates its effect is the repair of a dragline pinion gear. SIFCO ASC is a global leader in selective plating, providing brush-plating solutions to improve part performance and reduce manufacturing costs through corrosion protection, increased wear resistance, increased hardness, improved conductivity,



After masking is applied to protect nearby surfaces, a gouge on the bearing journal of this dragline pinion gear is filled with copper and hand-finished, followed by plating of the entire journal with 0.006 in. of nickel to restore it to proper OD size.
anti-galling or slip. Recently, Horsburgh & Scott, a large gear manufacturing and repair company, called upon SIFCO ASC to repair two areas on a 16-in.-diameter by 5-in.-long bearing journal caused by a seized bearing that damaged the seat and created a gouge during removal.

With the first defect being a 0.030-in.deep gouge measuring 0.75 in. wide and 12 in. long, and the bearing seat being 0.012-in. undersize after clean-up, this presented an ideal situation for selective plating: a shallow groove that could be rapidly filled with a copper deposit through 100% tool contact. Meanwhile, the undersize condition required only 0.006 in. thickness of nickel.

Welding to fill the defect was rejected because heat and structural changes in the metal could contribute to potential distortion or stress. Machining the diameter was also decided against, as it would have presented distinct impracticalities for plating at a high thickness. Brush plating presented the ideal solution, with a deposit of approximately 30 Rockwell hardness required, nickel was chosen. First, the gouge was selectively filled with copper to bring the outside diameter (OD) back to round. The bearing journal was plated with 0.001 in. of copper, then masked for the defect repair. A graphite anode that covered the full length of the gouge shortened the plating time. The defect was then filled with three layers of copper and hand finished between layers. The final layer was dressed flush with the OD.

Once the gouge defect was repaired, the entire OD was brought back to size by plating with 0.006 in. of nickel. After the repair of the two defects, the component was as good as new and ready to receive a new bearing, making the dragline ready for action once again — and, crucially, in safe and efficient condition.

Dave Niederhelman, chief metallurgist at Horsburgh & Scott Co., said, "Over the years, SIFCO ASC has helped us find the most efficient ways to repair and maintain equipment, adding up to thousands of dollars, hours of downtime and manpower time saved. In this application, the SIF-CO Process extended the working life of the gear and improved the failure rate due to the nature of the nickel coating on the journal. The cost of manufacturing and material to replace the gear would have been extortionate in comparison, as well as causing weeks of downtime."

#### Cutting Environmental Impact

The selective plating process fits well within concepts of sustainability in the mining industry, given its far lower impact compared to other surface coating methods. Using less solution and chemicals, and generating very little waste, along with reductions in the carbon costs of emissions, transport and shipping, it's a more sustainable option at an ecological level. Plus, the reduction in fumes and hazardous waste to dispose of offers a safer, healthier working environment.

In a fast-moving quarter of the world's industrial landscape, remanufacturing and selective plating present a distinct way to do things better: returning vehicles, machines, and equipment to operational effectiveness with minimal downtime required. Increased wear resistance, surface hardness and low electrical contact resistance, or corrosion protection, are just some of the benefits of the process.



## Upgrading the Chains for Improved Productivity and Profit

Having survived a near-miss encounter with economic disaster caused by social and financial disruptions associated with the COVID-19 pandemic, mining companies are taking closer looks at two chains that keep them in business: supply chains — the links needed for smooth and continuous inbound and outbound logistical performance; and value chains, which include the sequence of activities involved in extracting and processing metals and other mineral commodities.

As McKinsey & Co. pointed out in a recent report, The Mine-to-Market Value Chain: A Hidden Gem, October 2020, mining value chains can be complicated, involving everything from equipment fleets to port facilities, and the effectiveness of links in these chains is often restricted by siloing among departments that don't always coordinate perfectly, share information or use a common decision-making process. Improved transparency across the entire chain, according to the report, can go a long way toward increasing earnings by optimizing throughput, product margins and operating costs. A company interested in achieving higher performance might start at one end of a chain (improve mine-to-market performance) or the other (optimize specific operations). Two recent events highlighted new tools for implementing either approach, and

both offer solutions for alleviating two major conservation issues — energy and water — facing the industry.

Simulating Life-of-Mine Plant Performance In a late 2020 announcement, Australian mining explosives and services provider Orica was named as the commercialization partner for the Integrated Extraction Simulator (IES), a cloud-based software platform designed to reduce the use of energy and water in mining through the application of simulation, optimization and machine learning. IES was developed by the Brisbane-based Cooperative Research Center for Optimizing Resource Extraction (CRC ORE).

Orica's interest was initially driven by IES's introduction of blast simulation into the mineral processing value chain, but the company also saw the wider application of IES as an obvious fit with its expanding digital solutions offer across the whole mining value chain. Orica said it intends to expand this capability into a global solution for mining companies, enabling them to design mineral processing using IES, and then leverage IES's capability every day to drive continual operational improvements. By harnessing the virtually limitless scalability available through cloud computing services, mining companies can now use IES to configure



The Grade Engineering suite of technologies is focused on helping producers identify and implement higher-efficiency mining and processing methods for potentially valuable lower-grade materials.

multiple design options for a mineral processing plant. IES then tasks each design and simulates its performance for every day of operation over the life of a mine.

Orica will take the reins of the platform's growth strategy from July 2021, with plans for global expansion of the technology as part of its vision of an integrated ore extraction mining services company. This includes investing in digital solutions where continuous innovation and open integration with other industry systems across the mining value chain are key to the delivery of mine optimization for customers.

Orica Vice President Digital Solutions Rajkumar Mathiravedu said, "From a technology perspective, we see enormous synergies with our existing blasting and measurement solutions, including BlastIQ, FRAGTrack and ORETrack. We are also excited to integrate our automated, data science-enabled blast design technology and solutions with IES, offering end-to-end digitized workflow solutions from orebody knowledge through to mineral processing in an open, secure and connected platform."

CRC ORE's general manager for the simulator, Nick Beaton, said, "We have demonstrated that the simulator can improve the value of major mine sites by some 5% to 6%, [and] this is significant for the mines using the simulator and for the whole industry. Optimization of processing operations by use of IES will also enable step-change reductions in power and water consumption, while greatly improving recoveries of marginal ores, all contributing to the future sustainability of mining operations."

#### Achieving Higher ROI, Lower Capital Intensity

At roughly the same time, CRC ORE announced that Ontario, Canada-headquartered engineering consultancy Hatch had been awarded an exclusive license to commercialize Grade Engineering Consulting Services, a suite of mining technologies designed to enable more-efficient treatment of lower grade ores and wastes to extract valuable minerals — consequently, increasing the life of mines and reducing their environmental footprint.

CRC ORE said achievable outcomes for mines, when deploying Grade Engineering at production scale, include significantly improved return on investment and lower capital intensity. They predicted that, as Hatch adopts Grade Engineering and extends its reach into the mining industry, the value of such outcomes will increase for operations, clients and communities globally.

As explained by CRC ORE, industry focus on throughput as the main driver of revenue has led to a bulk average mentality with respect to in-situ cut-off grades. In many cases, average grades used to define bench or stope scale processing destination decisions such as mill, dump leach or waste include significant sub-volumes of material outside cutoff specifications. An averaging approach ignores potentially exploitable grade heterogeneity below the scale of minimum mining unit even though significant localized-grade heterogeneity is a dominant characteristic of many base and metal deposit styles and ore types.

Localized-grade heterogeneity is often overlooked in favor of maximizing extraction rates and loading efficiency. This is coupled with a desire to blend ROM and produce steady-state feed in terms of grade and physical properties to optimize and maximize recovery of saleable product particularly in crush-grindfloat operations. Where blended supply of "averaged" feed struggles to achieve steady-state processing stability, this is an indication that significant heterogeneity exists within a resource that could be exploited rather than suppressed.

Grade Engineering recognized that, in many cases, out-of-specification sub-volumes assigned to destinations based on bulk averages can be removed using efficient coarse separation techniques in the "dig and deliver" interface. Coarse separation (~10-100 mm) can be used on a range of particle-size distributions ranging from ROM to SAG discharge. The earlier this occurs in the conventional dig and deliver mining cycle, the higher the potential net value of removing uneconomic material.

Opportunities for Grade Engineering are predicated on five rock-based "levers" linked to combinations of screening, sensor-based sorting and heavy media separation. These involve:

- Preferential grade deportment by size;
- Differential blasting for grade by size;
- Sensor-based bulk sorting;
- Sensor-based stream sorting; and
- Coarse gravity separation.

CRC-ORE said Grade Engineering had been developed and implemented by a consortium of more than 30 mining companies, equipment suppliers and research organizations. Emerging results from collaborative site activities demonstrate potential for generating significant value, which can reverse the trend of declining production due to declining feed grades.

Under the terms of the commercialization arrangement, Hatch will use Grade Engineering Intellectual Property for its consulting services. CRC ORE said its Grade Engineering team will relocate to Hatch's Brisbane office, supporting Hatch with current and potential users of Grade Engineering, and Hatch will invest to further increase the reach and applicability of the technologies.



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## **Tow Rope for Speedy Connection**



Phillystran announced the X-Tremaloop fiber rope link for towing trucks. Made from 12-strand X-Tremaline polyethylene rope, it can be managed singlehandedly, and can pull up to 90 metric tons (mt).

X-Tremaloop is the first synthetic rope where the soft eye can open and close, Phillystran said. "It uses a simple knotand-eye connection," said Greg Savage, market lead, mining, Phillystran. "A quick connection can be made without the need to open heavy hardware, such as a shackle or a pin in a truck."

Top benefits include increased speed of connection. "Logistically, being at 1/7th of the weight of wire rope, yet the same strength, these towing pennants can be easily moved around manually across a mining site," Savage said. "There are no sharp edges. The towing strop or pennant is entirely soft. This makes for ideal handling ergonomics."

It also translates to reduced vibrations, lowering maintenance costs.

X-Tremaloop can be used in place of conventional steel wire-rope towing strops or towing wires. "The only limit would be sharp edges," Savage said. "The X-Tremaloop can only operate on smooth surface areas."

The solution was initially developed for the maritime industry. "The concept derives from a synthetic rope-shackle developed a few years earlier," Savage said. "With the X-Tremaloop, the rope shackle is no longer required. It is now integrated into the towing rope itself."

The strength and simplicity of the connection ensure the solution is set to disrupt the space, Mark Pieter Frolich, commercial director, Phillystran, said. "Whether it's towing a truck or connecting two winch lines, the X-Tremaloop sets a new standard for ease of rope connections in the mining industry." *www.phillystran.com* 

#### Separation System Gets More Gold for Less

FLSmidth reported the new Knelson GX Concentrating Cone represents a breakthrough in gravity separation systems and increases recovery while cutting maintenance downtime.

The solution has enhanced water distribution within each ring, and increased active recovery surface area. The result is a step change in overall coarse and fine gold recovery, FLSmidth reported.

The cone also offers reduced water requirements. Because it is made of a tough polyurethane compound, maintenance and operational costs are reduced.



FLSmidth said the Knelson GX Concentrating Cone helps customers produce more gold with less resources.

Separately, FLSmidth reported the new AFP2525 Automatic Filter Press delivers high availability and efficiency with the "lowest cost per ton of production in the industry."

The unit delivers low cake moistures and high production rates of 300 mt per hour. Ultra-efficient water reclamation allows the miner to recycle and reuse a significant amount of water, reducing their fresh water needs, the company reported.

For ease of maintenance, it features fast plate-pack removal. Cloth change and plate maintenance occur outside the filter.

Fast filtration and high availability combine for low costs per ton. *www.flsmidth.com* 





#### Loader With Top Productivity

Sandvik introduced the renewed Toro LH410, a loader with a 10-mt payload capacity, the loader offers best-in-class productivity, high ramp speeds and fast bucket filling, and superior lift height compared to similar loaders, Sandvik reported.

"With all its features, this truly is an advanced and intelligent piece of equipment, definitely comparable to the large i-series loaders, but naturally in a smaller package," said Kimmo Ulvelin, product line manager of small and low-profile loaders at Sandvik. "We want to offer our customers possibilities for sophisticated and intelligent equipment also in the middle-size class."

The new LH410 has the same Sandvik Intelligent Control System as the company's large LHDs. It also has traction control, operator speed assist and an integrated weighing system. With an eye toward safety, Sandvik included a new retrieval hook, updated door interlocks, improved access ways and a new type of fire suppression system.

Toro LH410 has a full range of diesel engine options, starting from a powerful and fuel-efficient Tier II and ending at the state-of-the-art Stage V engine option. The Stage V engine uses passive DPF regeneration taking place during normal operation, minimizing downtime, and its modulating engine brake provides better control of vehicle speed downhill while also minimizing brake and transmission overheating and brake wear.

www.rocktechnology.sandvik

#### Twin-boom Drill Rig Aces Testing

Mine Master completed testing of the Face Master 2.3 at the Yubileinoe mine in Bashkortostan, Russia.

The twin-boom drill rig drills drifting face holes with diameters of 41 mm to 76 mm. For use in methane-free mines, the rig offers coverage of  $67 \text{ m}^2$ .

Both booms have telescopic feeders. Depending on the rod, the hole depth may range from 2.15 m to 4.01 m, or 2.44 m to 4.31 m. The hydraulic drifter's impact is rated at 20 kW.

The compact rig is known for its maneuverability, the company reported. Diesel-powered, it features four-wheel drive and a FOPS/ROPS-rated cab. Automation and remote monitoring capabilities use Wi-Fi. *www.minemaster.eu* 



#### 585-kW Engine Helps Up Productivity

Volvo Penta announced production of the Stage V/Tier 4F-certified D16 offroad engine. The 585-kW engine offers industry-leading fuel efficiency, low- to high-end torque, and high-altitude performance, the company reported.

The high power and high torque offered can contribute to increased productivity. Other benefits include a fuel consumption reduction of up to 10% over predecessor models. The six-cylinder design offers smooth operation with low noise levels, the company reported. It is simple to maintain, and has an extended oil service interval of up to 1,000 hours.

Volvo Penta reported the D16 is based on proven dual-turbo and other technologies that have undergone millions of hours of testing and real-world use. *www.volvopenta.com* 

#### Dust Suppression System

Terex introduced Aquamist, a dust suppression system that reportedly delivers better results than conventional jets or water sprays in managing dust buildup and for protecting workers.





The solution uses a high-capacity misting fan that produces water droplets as small as 10 microns. The droplets combine with dust particles and precipitate them. The solution could help companies comply with airborne dust management regulations, Terex reported. www.terex.com

#### **Torque-limiting Coupling**

Voith added Safe-Set EZi to the SafeSet series of torque-limiting couplings that protect drive trains. EZi features a peak shaving function, a



mechanism that gives protection during short transient loads without releasing, the company reported.

The coupling offers quicker, easier and safer resetting over predecessor competition. With multiple filling ports, it simplifies oil change procedures. The unit is compatible with Voith Dtect, which collects and presents data on slippage events.

EZi comes with a shear tube installation tools.

www.voith.com

#### Drone for Post-blast Monitoring

Blast Movement Technologies released FED 2.0, an aerial drone for post-blast monitoring with improved detection depths of up to 12 m. It enables the swift retrieval of Blast Movement Monitor location data, the company reported.

Based on the DJI Matrice M600Pro flying platform, FED 2.0 features an automated winch to lower the detector closer to the surface for greater detection depths.

FED 2.0 features an automated flight control and customizable flight plan. It has a built-in GNSS receiver to enhance positioning information, and a vertical and horizontal collision detection system. After battery replacement, it can resume the mission from where it was suspended. The onboard computer allows for immediate processing of incoming data. **www.blastmovement.com** 



#### Surge Protective Device Logs Events

Eaton announced the Power Xpert SPD, a surge-protective device with an advanced monitoring display. The unit offers remote



monitoring capabilities, cybersecurity functionality and historical surge logging.

The Power Xpert SPD can capture and categorize surge events according to IEEE standard C62.41. It allows customers to remotely monitor surge data in real time, or log surge events with time and date stamps for analytics and proactive maintenance. The device can also help protect against cyberattacks, the company reported.

www.eaton.com

#### Demand Chain Optimizer for Customer Satisfaction

RPMGlobal announced XECUTE now has a Demand Chain Optimizer (DCO) module that optimizes the flow of material all the way back to the mine. DCO removes many of the value chain challenges that can arise from an integrated supply chain, the company reported.

In development at an iron ore mine in the Pilbara, DCO optimization algorithms had XECUTE fulfill customer orders by blending product from multiple stockpiles.

XECUTE is a short-term scheduling solution that connects the mine plan to other department systems.

www.rpmglobal.com

#### US Drone Maker Launches Production

Aquiline Drones announced the production of Drone Volt's Altura Zenith and Hercules 2 drones. The drones were recently rebranded as the Spartacus MACKS and Spartacus HURRICANE, respectively.

Last year, Aquiline Drones signed exclusive U.S. manufacturing, sales and distribution licensing agreements with Drone Volt, a French drone manufacturer of professional civilian drones. It also entered a strategic partnership agreement with Drone Volt and Aerialtronics to be the sole manufacturer of the Pensar smart camera, a multispectral sensor with artificial intelligence and edge computing capabilities.



The developments come after the U.S. Department of Justice banned itself from purchasing or using drones made outside the states. *www.aquilinedrones.com* 

#### Structural Bearings for Extreme Applications

Hercules Engineering introduced custom-fabricated structural bearings made of H-Glide fi-



ber-reinforced composite pads sliding on 2B finish stainless steel. The bearings are for extremely high-stress applications requiring outstanding loadbearing performance in compact and wet spaces, the company reported.

H-Glide bearing pads cause less friction and less stress on the load-bearing components and structure. The bearings can handle point pressures of 350 to 500 megapascals, up to 40 times greater than conventional resistant and non-lubricated fiber-reinforced elastometric bearing pads, the company reported. They require no lubrication, absorb no water and release no contaminants.

hercules-engineering.com

#### Maintenance-free Crane Brake

Force Control Industries presented the MagnaShear line of low-maintenance easy-adjustment crane brakes. The brakes are designed for years of trouble-free maintenance and feature oil shear technology. Downtime is reduced and safety



is enhanced when maintenance and adjustments on the brakes are performed at height, the company reported. *www.forcecontrol.com* 

#### Software Updates for Hybrid Cloud Ecosystem

Seequent reported updates to Leapfrog Geo and Edge, and to Seequent Central. The updates are part of a transition to Seequent Evo, an ecosystem of hybrid cloud and desktop solutions.

Leapfrog Geo 6.0.1 delivers smoother workflows and improved performance, with up to 25% faster overall processing times, Seequent reported.

Leapfrog Edge 4.0.2 has a new parameter report facilitating the checking of estimates, allowing users to see their choices, which can then be exported to Excel.

Central 4.0 features new visualization capability, enhanced modelling workflows, improved direct communication tools, publishing improvements and improved import capability.

The updates allow better connectivity to cloud products and between different software solutions, and offer the advantages of cloud computing, Seequent reported.

www.seequent.com

#### Cloud-based Project Risk Management Solution

InEight Inc. announced enhancements to its planning, scheduling and risk offering for capital projects. A new analytics toolbox helps to remove risk from the bottom line for project managers, schedulers, planners and estimators.

The company described the cloudbased solution as state of the art, with built-in artificial intelligence. It continuously monitors a project, and uses data from previous projects to identify threats and recommend risk mitigation strategies. The solution's intuitive interface enables a seamless user experience that delivers clear and actionable insights on risk management, inEight reported.

Topmost benefits include cost-improved timeliness and adherence to budget. *ineight.com* 

#### Low-profile, Multipolarized Antennas

MP Antenna announced RuggedWave multipolarized antennas, which are designed for harsh outdoor environments and deliver a service life of more than 100,000 hours. The antennas are indestructible and



solve many of the latency and connectivity issues common in non-line-of-sight environments for Wi-Fi, private LTE and CBRS Mining Networks, the company reported.

The antennas feature a rugged machined enclosure, multiple antenna feeds, and a low profile design for integrating multiple-input multiple-output radio communications. They provide patterning and continuous wideband performance for frequencies that include 2.4 GHz, 4.9 GHz, 5.8 GHz, 900 MHz, LTE, CBRS and 5G.

The antennas are ideal for wireless systems and offer increased spatial and polarization diversity between antenna feeds to overcome fading and interference, and for multipath mitigation, MP Antenna reported. They are designed for above and underground mining networks, port communications and autonomous vehicle management in harsh environments. *www.mpantenna.com* 

#### **Protective Gloves**

Brass Knuckle released the SmartCut BKCR2403 protective glove that offers cut and abrasion resistance with durable grip, dexterity and flexibility. The light-duty glove gives both ANSI Cut Resistance Level 2 protection and tactile sensitivity for tasks requiring fine motor



skills, the company reported.

Built with a composite yarn of highstrength filament fibers and upwound with nylon and spandex, the glove allows a user to push buttons, set gauges or pick up nails. The 18-gauge high-performance polyethylene and glass-fiber shell is lightweight. The black polyurethane palm coating delivers reliable protection and enhanced grip.

It is more flexible, lightweight and comfortable than other cut-resistant options, Brass Knuckle reported. *www.brassknuckleprotection.com* 

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# **Several Metals Rise to Fresh Highs**

Copper, cobalt and palladium continued their upward march last month. During February, copper prices climbed 17.5% to \$9,198 per metric ton (mt) or \$4.18/lb from \$7,827/mt or \$3.56/ lb. This was the largest monthly gain for copper since 2016. A imbalance of supply versus demand created when smelters in China recovered from COVID-19 before many of the mines could reopen is pushing copper prices to new highs. As the economic recovery grows globally, copper demand will continue to increase.

Nonferrous base metals as a whole did well during February. Zinc and aluminum finished February up 9.4% and 8.5%, respectively. Iron ore climbed to \$171.74 per dry metric ton (dmt) from \$168.13/dmt.

Cobalt prices climbed more than 26% to \$51,990/mt or \$23.63/lb from \$41,420/mt (or \$18.75/lb). Market demand and speculation continues to drive the prices for battery minerals, such as cobalt, to new highs.

Platinum group metals rallied as well. Platinum prices increased \$85/oz (or 7.5%) to \$1,212/oz from \$1,127/ oz. Palladium continued to push its way toward \$2,500/oz, posting a \$107/oz gain (4.7%) to \$2,379/oz. Traders and speculators were simply saying the lack of metals is driving prices higher. Rho-

February 2021 M	etal Price Cha	nges		
	3/1/2021	2/1/2021	Diff.	
Gold (\$/oz)	\$1,724.00	\$1,861.20	-\$137.20	-7.4%
Silver (\$/oz)	\$26.53	\$28.55	-\$2.02	-7.1%
Platinum (\$/oz)	\$1,212.00	\$1,127.00	\$85.00	7.5%
Palladium (\$/oz)	\$2,379.00	\$2,272.00	\$107.00	4.7%
Rhodium (\$/oz)	\$27,900.00	\$20,300.00	\$7,600.00	37.4%
Ruthenium (\$/oz)	\$345.00	\$320.00	\$25.00	7.8%
Aluminum (\$/mt)	\$2,154.50	\$1,985.50	\$169.00	8.5%
Copper (\$/mt)	\$9,198.00	\$7,827.00	\$1,371.00	17.5%
Lead (\$/mt)	\$2,075.00	\$2,024.50	\$50.50	2.5%
Nickel (\$/mt)	\$18,655.00	\$17,807.00	\$848.00	4.8%
Tin (\$/mt)	\$24,505.00	\$24,325.00	\$180.00	0.7%
Zinc (\$/mt)	\$2,788.50	\$2,548.50	\$240.00	9.4%
Molybdenum (\$/mt)	\$27,300.00	\$24,860.00	\$2,440.00	9.8%
Cobalt (\$/mt)	\$51,990.00	\$41,240.00	\$10,750.00	26.1%
Iron Ore (\$/dmt)	\$171.74	\$168.13	\$3.61	2.1%

dium climbed 37.4% to \$27,900/oz from \$20,300/oz last month.

Gold and silver lost their luster during February. U.S. Treasuries and the dollar strengthened, taking more steam away from the gold rally. Gold prices fell \$137.20/oz (7.4%) to \$1,724/oz from \$1,861.20/oz. Silver followed suit, falling \$2.02/oz (7.1%) to \$26.53/oz from \$28.55/oz. Mining costs are also on the rise as inflation sets in. Morgan Stanley Research reported a 30% year-on-year increase in its Mining Cost Index as the cost for key inputs such as steel, rubber, diesel fuel and energy continue to increase. The firm explained that this is not necessarily bad news as historically, profit margins for mining companies increased during periods of robust demand.

Precious M	etals (\$/oz)	Base M	etals (\$/mt)	Minor Meta	ls (\$/mt)	Exchange Rates (U.S.\$	Equivalent
Gold	\$1,724.00	Aluminum	\$2,154.50	Molybdenum	\$27,300	Euro (€)	1.205
Silver	\$26.53	Copper	\$9,198.00	Cobalt	\$51,990	U.K. (£)	1.394
Platinum	\$1,212.00	Lead	\$2,075.00			Canada (\$)	0.790
Palladium	\$2,379.00	Nickel	\$18,655.00	Iron Ore (	\$/dmt)	Australia (\$)	0.778
Rhodium	\$27,900.00	Tin	\$24,505.00	Fe CFR China	\$171.74	South Africa (Rand)	0.067
Ruthenium	\$345.00	Zinc	\$2,788.50			China (¥)	0.155

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