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E&MJ ENGINEERING AND MINING JOURNAL

FEATURES

LEADING DEVELOPMENTS

AROUND THE WORLD

This month, E&MJ *turns its attention to raiseboring, where contractors are using experience and technology to pursue records. On the cover, the Rhino 100, which can operate in either direction, offers at least three times the capacity of other rigs in its class, according to the manufacturer. (Photo: Sandvik/TRB-Raise Borers)*

DEPARTMENTS

Steve Fiscor
Publisher & Editor-in-Chief

This Too Shall Pass

Here we are once again, staring at the teeth of the tiger. The last time was 2008 as the global financial crisis (GFC) was about to take down commodity markets and the economy with it. Many of the major mining companies, which were flush with cash at the time, did not feel the immediate effects of the credit crunch. They would eventually suffer from the economic slowdown, but they had the ability to pause and apply reason when others were operating in a state of panic.

The fear brought about by the coronavirus (COVID-19), which is a health crisis, not a financial crisis, has drawn a similar, measured response from leaders in the mining business. As the healthcare systems in large metropolitan areas were overrun with COVID-19 cases and death, miners around the world had a slight advantage with operations in remote low-risk locations. They faced a self-preservation choice: idle assets for 14 to 21 days (or perhaps longer) or continue to operate, while implementing healthy operating conditions, such as improved sanitary practices and social distancing. Some mining operations had no choice as governments mandated shutdowns.

Many mining companies are doing the right thing, right now. Several examples are profiled in this edition. (See COVID-19, p. 46.) That article mentions BHP's new CEO Mike Henry and the much-needed advice he offered on the importance of maintaining mental health during this difficult period. It's important to stay positive and take care of yourself mentally as well as physically and check on others. We could have easily filled every page in this edition with negative stories about mine closures in the affected areas and fanned the flames of hysteria, but we elected to look at the positive side of what was happening in the field as this edition went to press. We would also suggest you do the same. Rather than exposing yourself to the constant barrage of bad news in the mainstream media, tune in long enough for an update and then tune it out. If you want a break from the boredom of isolation, reach out to family, friends and peers to check on their well-being.

Moments like these define the character of an individual as well as an organization. Furloughing thousands of employees may preserve the business model. That's a difficult choice that many mining executives may face. Will they return when the economy recovers? The knock-on affect of those job losses will be devastating to surrounding communities. If those decisions must be made, it would be wise to describe them as temporary layoffs.

Hopefully, COVID-19 will soon run its course and the world can try to return to a new normal — whatever that may be. This too shall pass. The global economy will come roaring back and it will need more mined commodities than ever before. Take care, stay safe and be kind. Enjoy this edition of *E&MJ*.

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TECHNOLOGY DEFINING PRODUCTIVITY

Anglo Secures Future for Woodsmith Polyhalite Project

Anglo American, through its wholly owned subsidiary Anglo American Projects UK Ltd., has completed the acquisition of Sirius and its Woodsmith Project in the U.K. This follows the January announcement that the boards of Sirius Minerals Plc, Anglo American and Anglo American Projects UK Ltd. had reached an agreement on the terms of a recommended cash acquisition of Sirius.

"Today marks a new chapter for the Woodsmith Project, the employees of the business and everyone who has an interest in its future," Anglo American CEO Mark Cutifani said. "This is a project with clear potential as a Tier 1 supplier of premium quality, low carbon fertilizer to help meet food demand for a fast-growing global population."

The mining operation has been designed to have minimal physical impact on its surroundings and progressing its development, he added.

"We recognize the role the project will continue to play in its local communities and, as promised, I am pleased to confirm that we are today transferring £1 million into the project's charitable foundation," Cutifani said. He added that the company will contribute even more over the next three years.

Shaft sinking operations begin for the material transport system, which will deliver ore from the Woodsmith mine to the port at Teeside in northeast England.

Mining Industry Forms Green Hydrogen Consortium

Hatch, Anglo American, BHP and Fortescue have formed a Green Hydrogen Consortium to look at ways to use green hydrogen to accelerate decarbonization within their operations globally. Primarily, the consortium aims to collectively help eliminate the obstacles related to the adoption of green hydrogen technologies and encourage innovative application. The goal is to identify opportunities to develop green hydrogen technologies for the resources sector and other heavy industries, and provide a mechanism for suppliers and operators to contribute to and engage with these development activities.

Some of the proposed activities include undertaking research, technology and supply chain development, as well as piloting green hydrogen technologies to seek to de-risk and accelerate the process.

The companies involved in the consortium said they are committed to reducing their respective operational greenhouse gas emissions and to working collaboratively with others — including customers and suppliers — to find technological or other innovative solutions for the emissions associated with the use of their products and in their supply chains.

Hatch has been appointed as the project management and governance facilitator of the Green Hydrogen Consortium.

Teck Sets 33% Carbon Reduction Target

Teck Resources Ltd. announced it plans to reduce carbon intensity by 33% by 2030 as part of its new sustainability strategy and goals. This builds on the Teck's previously announced commitment to be carbon neutral across all its operations and activities by 2050.

"At Teck, we are always challenging ourselves to improve sustainability performance, so we can be sure we are providing the mining products needed for a cleaner future in the most responsible way possible," President and CEO Don Lindsay said. "We have set ambitious new goals for carbon reduction, water stewardship, health and safety, and other areas because we believe that a better world is made possible through better mining."

Teck said its planning to procure 50% of its electricity demands in Chile from clean energy by 2025 and 100% by 2030. It will also adopt zero-emissions alternatives for transportation by displacing the equivalent of 1,000 internal combustion engine vehicles by 2025.

"We established our first sustainability strategy and goals a decade ago and are proud of our progress to date," said Marcia Smith, senior vice president, sustainability and external affairs. "We know there is more work to do, and our updated strategy and new milestone goals provide us with a clear roadmap to advance our work to protect the environment, collaborate with communities and governments,

and foster a workforce that is respectful, safe, inclusive and diverse."

Teck also released the 2019 Sustainability Report, detailing sustainability performance, including reduced annual greenhouse gas emissions by 297,000 metric tons (mt) of CO_2e since 2011, the equivalent of taking 90,500 cars off the road.

Newmont Sells Stake in Continental Gold for $260M

Newmont Corp. has completed the sale of its 19.9% equity stake and convertible bond in Continental Gold Inc. for $260 million in cash. The sale was part of a contractual arrangement to support Zijin Mining Group's acquisition of Continental.

"Selling our Continental stake into a strong bid allowed us to generate $260 million in cash that will support our disciplined approach to capital allocation, including strengthening our investment grade balance sheet, investing in our highest returning projects, and returning excess cash to our shareholders," President and CEO Tom Palmer said. "Combined with the sale of our interests in Continental and KCGM, once we complete the sale of Red Lake, we will have generated more than $1.4 billion in asset sales in less than a year since closing the Goldcorp acquisition last April."

Colombia-based Continental Gold's flagship project is the Buriticá gold project located in the middle Cauca belt in the northwest region of Colombia. Fully permitted and on schedule for 2020 production, the project is easily accessible by a two-hour drive on the paved Pan-American highway from Medellín.

Sherritt Withdraws From Ambatovy Joint Venture

Sherritt International Corp. will not fund its 12% stake in the Ambatovy joint venture in Madagascar with Japan's Sumitomo Corp. and South Korea's Korea Resources Corp. (Kores) after Ambatovy made a cash call to boost its short-term liquidity. Sherritt announced it had become a defaulting shareholder.

First refusal to fund Sherritt's 12% share in Ambatovy will now pass to Sumitomo and Kores. Sherritt has lost voting rights and influence on operations at a local level.

The Ambatovy mine, which produced 33,733 metric tons (mt) of refined nickel and 2,900 mt of refined cobalt in 2019, will reportedly continue to produce after Sherritt's proposed exit.

Two years ago, Sherritt announced plans to reduce its stake in the Ambatovy joint venture from 40% to 12%, but has remained as the mine operator. At the time, Sherritt said the decision would allow it to eliminate $1.4 billion of debt."Nickel and cobalt production at Ambatovy will not be [affected] by the transaction or pending timelines," director of investor relations and communications, Joe Racanelli said, as reported by *Fastmarkets*.

Barrick Will Invest $1.3B in Pueblo Viejo Expansion

The proposed expansion of Barrick Gold Corp.'s Pueblo Viejo gold mine in the Dominican Republic will extend its life as well as its contribution to the economy until 2040 and beyond. President and CEO Mark Bristow said the project would require an initial investment of $1.3 billion to expand the process plant and the tailings facility.

This will allow the mine to increase exports by $22 billion and generate more than $4 billion in taxes at a gold price of $1,500 per ounce, according to the company. Between 2013 and 2016, Pueblo Viejo paid $1.8 billion in direct taxes and last year its exports accounted for more than 38% of the country's total.

The company's workforce, which is 97% Dominican, is expected to grow as the project develops and it will increase opportunities for female participation (currently 12% of the workforce). It will also further promote the development of the local economy based on the mine's suppliers and contractors.

"Our aim is to continue contributing to the social and economic development of the Dominican Republic by applying our sustainability philosophy to create long-term value for all our stakeholders, especially the governments and people of our host countries," Bristow said. "Without this project mining at Pueblo Viejo would have ceased in the next two years," Bristow said.

The expansion will enable the mine to exploit the lower grades in the orebody. Mill and tailings capacity will be expanded, without which mining would end in 2021 and production would end in 2031. The plan will allow mine to maintain total gold production averaging 800koz per year after 2022. It could also potentially convert approximately 11 million oz of indicated resources.

Conversion of Quisqueya I power plant (above) to natural gas will help reduce Pueblo Viejo's power generation costs by 30%. Greenhouse gases will be reduced by 30% and and the mine's dependence on oil will be significantly decreased.

Although Sherritt has increased its nickel and cobalt production guidance for 2020 via its 50/50 Moa JV in Cuba (with Cuba's General Nickel Co), no production guidance was released for Ambatovy, which increased its nickel output by 2% year on year in 2019.

The Moa JV is expected to produce between 32,000-34,000 mt of refined nickel and 3,300-3,600 mt of refined cobalt in 2020. It produced 33,108 mt of nickel and 3,376 mt of cobalt in 2019.

RUSAL Sees Revenue Decrease 5.5% for 2019

Aluminum producer RUSAL's revenue for the year that ended December 31, 2019, decreased by 5.5% to $9.71 billion as compared to $10.28 billion for 2018.

The company said the decrease in the price for aluminum in the last year was partially offset by the 13.8% increase in sales of primary aluminum and alloys in 2019 as compared with 2018.

"It is no understatement to say that during the last year, both RUSAL and the whole industry witnessed a variety of challenging conditions that included the average LME aluminum price slumping by more than 15%, which contributed to our annual revenue decrease, as compared with the 2018 results," CEO of RUSAL Evgenii Nikitin said. "The situation was aggravated by the missed mating season that was the result of the OFAC sanctions."

Teck Cancels $15B Frontier Oil Sands Project

Teck Resources Ltd. has withdrawn the Frontier oil sands project in northeastern Alberta from the regulatory review process. The $15 billion project would have produced 260,000 barrels of oil per day and 7,000 jobs.

"We are disappointed to have arrived at this point," CEO and President Don Lindsay said in a letter to the minister of Environment and Climate Change. "Teck put forward a socially and environmentally responsible project that was industry leading and had the potential to create significant economic benefits for Canadians."

He cited the growing debate around climate change and a framework that would address those concerns with resource development that would produce the "cleanest possible products."

"This does not yet exist here today," Lindsay said. He added that Frontier has been placed at the forefront of the issue and they do not see a "constructive path forward for the project."

He said low-carbon energy can be produced from the Alberta oil sands from projects like Frontier, by using best-in-class technology, "which would displace less environmentally and ethically sound oil sources."

Russian Platinum Backs Out of JV With Norilsk Nickel

Norilsk Nickel, the world's largest of palladium and high-grade nickel and a major producer of platinum and copper, reported that Russian Platinum has notified the company of its decision to terminate the negotiations regarding the Arctic Palladium joint venture and to proceed with the development of the Chernogorskoye Deposit and the southern part of the Norilsk-1 Deposit on its own.

UC RUSAL, one of Nornickel's shareholders, did not issue corporate approvals to Nornickel to participate in the proposed joint venture.

Nornickel has entered into discussions with Russian Platinum over the provision of certain services and resources, which will be required for these projects as well as a potential offtake at market terms for the products, the company said.

"Nornickel's management has always and still does consider Arctic Palladium as a promising Tier One asset able to meet the growing PGM demand," Vice President for Strategy and Strategic Projects at Nornickel Sergey Dubovitsky said. "In spite of the current and, we hope, temporary turbulence in the commodity markets, we maintain a very positive view on palladium fundamentals, which should remain strong in a strategic perspective. Being a responsible palladium producer and the market leader, we intend to develop a long-term operating and commercial partnership with Russian Platinum."

Ontario, First Nations Study Ring of Fire Road Access

The government of Ontario, the Marten Falls First Nation, and the Webequie First Nation have signed an agreement to advance planning and development of a proposed Northern Road Link to access mineral deposits in the remote Ring of Fire region of northern Ontario. Ontario Premier Doug Ford and Minister of Energy, Northern Development and Mines and Minister of Indigenous Affairs Greg Rickford were joined by Chief Bruce Achneepineskum of the Marten Falls First Nation and Chief Cornelius Wabasse of the Webequie First Nation for a signing ceremony at the Prospectors and Developers Association of Canada convention in Toronto in early March.

Noront Resources is the dominant holder of mineral lands in the Ring of Fire region, but project development has been long-delayed by lack of all-season road access. Noront completed a feasibility study of its most advanced project — the high-grade Eagle's Nest nickel-copper-platinum-palladium deposit — in 2012, but development has been stalled since that time.

Premier Ford said, "After 15 years of delay by the previous government, we said we would build a road to the Ring of Fire, and we are working with our incredible partners in the Marten Falls First Nation and Webequie First Nation to do just that and make sure we do it right. Together, we can bring jobs and prosperity to communities across the Far North. Promises made, promises kept."

Correction

In the March 2020 Coy cover story, the geology description for the mine was wrong. The sphalerite in the orebody does not occur in quartz veins and the country rock is not granite. Mineralization occurs in brecciated dolomite (dolostone). Breccia is a mass of rock that has been subjected to dissolution of some of the original limestone, collapse of surrounding rocks resulting from the removal of the dissolved limestone, and subsequent solutions depositing minerals in the open spaces between the blocks of collapsed rock. Gangue minerals in these deposits are (in descending order of occurrence) dolomite, calcite, barite and fluorite. Silica does not occur as vein quartz. It is most commonly found as druse on the limestone walls adjacent to breccia bodies. There is no granite in these Tennessee zinc deposits.

E&MJ *would like to thank long-time reader and professional geologist Robert J. Bayer for bringing that to our attention.*

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Feds Approve Moss Gold Mine Expansion

The decision will allow the Moss mine (above) to expand on to BLM-managed lands.

Northern Vertex Mining's Golden Vertex received final federal permitting approval for the Phase III expansion at the Moss mine in northwest Arizona. This will allow the company to expand its current operations from its patented claims onto its surrounding unpatented claims on federal Bureau of Land Management (BLM) managed public lands. The expansion along with a recently announced resource update is expected to significantly extend the life of the Moss Mine.

The BLM issued the Decision Record on March 18, announcing the completion of the environmental review of the expansion at Moss mine as proposed in the company's Mine Plan of Operation (MPO) with a Finding of No Significant Impact (FONSI).

"We are very pleased with the Decision Record, which is a tribute to the efforts of our employees to protect the environment and ensure an efficient, sustainable operation," said Ken Berry, president & CEO of Northern Vertex. Berry thanked the company's technical team in Arizona, the entire BLM team, and all of the respective advisors and consultants, for their "tireless efforts in this process."

The expansion is expected to increase efficiencies that will significantly reduce operating costs at the mine. It will also allow for additional exploration drilling.

US District Court Sides With Twin Metals

On March 17, a U.S. district court rejected a challenge to the Department of the Interior's (DOI) reinstatement of Twin Metals' two hard rock mineral leases in northeastern Minnesota. The court agreed that the DOI has authority to reinstate the leases and that the leases provided Twin Metals a non-discretionary right to a third renewal.

The leases were officially renewed in May 2019. Twin Metals said the decision "validates our position that these mineral leases that have been held by Twin Metals Minnesota and its predecessor companies for more than 50 years and should have been renewed in 2016."

This ruling came after an appeal from environmental groups that sought to overturn the President Donald Trump Administration's DOI decision in 2017 to reinstate two leases to mine on 5,000 acres of Superior National Forest land in northeastern Minnesota. That decision had previously reversed an agency decision to cancel the leases by the former President Barack Obama administration in 2016.

"We're very gratified that this decision — a summary judgment — validates our contention that the decision to cancel leases held in good standing for more than 50 years was arbitrary and wrong," CEO Kelly Osborne said. "Companies must be able to trust the regulatory process in order to risk the enormous capital required to extract metals such as copper, nickel, cobalt and platinum group metals that are vital to creation of the green economy our world so desperately needs."

The two leases were issued in 1966 to a Twin Metals predecessor company and renewed twice, in 1989 and again in 2004. When Twin Metals applied for a third renewal in 2012, the DOI said no in 2016, based on objections from the U.S. Forest Service. In May 2017, the DOI's top legal official, Daniel Jorjani, ruled that the earlier lease cancellation was erroneous on grounds that Forest Service approval was not a condition of the lease renewal and that the leases' renewal was required under the terms they were granted. The DOI reinstated the leases, which were formally renewed in May 2019.

Plaintiffs called the DOI decision, the Jorjani opinion, "arbitrary and capricious," but Judge Trevor McFadden disagreed in his decision.

He said the department has "inherent authority to timely reconsider its prior decisions and reasonably did so here."

Another decision dealt with whether or not Twin Metals had lost its "non-discretionary" or inherent right to a third renewal because production hadn't started in the first 20 years of the lease. Judge McFadden agreed with Twin Metals and the government, that the leases gave Twin Metals the right to the third renewal.

McFadden said, "Interior timely corrected an error that would have deprived Twin Metals of its right to valuable leases. Its analysis explaining the need to correct this error was thorough, thoughtful and reasonable — a far cry from 'arbitrary and capricious.'"

Black Butte Achieves Key Permitting Milestones

Sandfire Resources Ltd.'s 85% owned Black Butte copper project in Montana has achieved two key permitting milestones, which represent key steps to the company receiving a Record of Decision (ROD) for its Mine Operating Permit (MOP).

First is the release of the Final Environmental Impact Statement (EIS) by the Montana Department of Environmental Quality (MTDEQ). The MTDEQ commenced the EIS in September 2017 and released a Draft EIS in March 2019.

Issuance of the Final EIS signals that the MTDEQ, and its independent third-party environmental consultants, have completed all environmental reviews related to the Black Butte copper project and all issues raised during the public comment period have been responded to.

Second, the Montana Department of Natural Resources & Conservation (MTDNRC) has issued a Preliminary Determination (PD) in response to the water right owners' application to modify their irrigation water rights to include leasing water for mitigation for the Black Butte copper project. The proposed water right modification maintains water balance in the Sheep Creek drainage area.

The PD will also address Sandfire America's request for a groundwater permit and a high flow water right to capture spring run-off and store in a reservoir, which will provide water to replenish stream flows year-round. The issuance of the PD triggers a comment period for other water rights holders prior to a Final Determination.

The achievement of these key milestones requires the MTDEQ to release a ROD, whether positive or negative, for Black Butte Copper's MOP after a minimum of 15 days. Issuance of a positive ROD would require the MTDEQ to finalize a bond calculation within 40 days.

"The Final EIS represents a thorough evaluation of the potential impacts of this proposed project," MTDEQ Director Shaun McGrath said. "Our review was informed not only by the DEQ scientists working on the project, but also by the thousands of comments submitted throughout the process. It was truly an extensive effort and we appreciate the public's interest and participation."

All the technical studies have now been completed for the Black Butte copper project feasibility study, which commenced in October 2018. Sandfire America released an updated Mineral Resource in October of 2019 for use as the foundation for the FS.

GR Engineering Services, SRK Consulting and others are now completing documentation of the technical sections. Once the ROD is published, the company said it can ensure that the designs and financial modelling in the FS are consistent with the permit requirements and to inform a decision to mine.

Sandfire Resources Ltd. has agreed to provide a $2 million unsecured loan to Sandfire Resources America Inc. to cover anticipated expenditures through the ROD and completion of the FS. This is in addition to the $3 million previously advanced.

Sandfire Resources Ltd. Managing Director and CEO Karl Simich said the achievement of these two key permitting milestones marked another integral step toward a development decision for a showcase underground copper mine in Montana.

"We are delighted to have achieved these milestones, which represent the culmination of a robust and lengthy permitting process, and I would like to congratulate the team for their dedication, hard work and relentless focus," Simich said.

"The EIS clearly shows our ability to build a modern underground mine that can be developed and operated while fully protecting the environment and water resources."

Bingham Canyon is Temporarily Idled After Earthquake

Rio Tinto's Kennecott Utah Copper operations were impacted by a 5.7-magnitude earthquake near Magna, Utah, on Wednesday, March 18. The company said all employees have been safely accounted for and evacuated from the potential risk areas. At this point, it said limited damage to the operation has been identified with little risk to the surrounding community, including a hydrochloric acid release from the refinery. A detailed inspection of the complex is currently being conducted, in conjunction with the local emergency services and Utah Department of Transportation.

As a precaution, the company said all operations have been temporarily idled and, in line with standard procedures pre-agreed with the Utah Department of Transportation, State Road 201 has been temporarily closed while the inactive South (Magna) tailings storage facility is inspected. This is an inactive historic tailings storage facility that is stable and being actively monitored and managed, under a plan reviewed and endorsed by a panel of independent geotechnical experts and Utah's dam regulatory authorities.

Premier to Purchase Remaining Interest in GGM

Premier Gold Mines Ltd. has made an offer to acquire the remaining 50% interest in the Greenstone Gold Mines Partnership (GGM) from Centerra Gold Inc. Total consideration of the offer is approximately $205 million.

GGM's principal asset is the Hardrock Mine Project located on the Trans-Canada Highway near Geraldton, Ontario, Canada. Hardrock is one of the most significant large-scale, near permitted, mine development projects in North America.

The offer is comprised of a cash payment in the amount of $175 million, and in addition the assumption of all Centerra's obligations under the partnership agreement, including the remaining earn-in obligation of approximately $30 million.

Premier submitted the offer in cooperation and with the support of an assignee that has completed its technical due diligence in relation to the 2019 mineral resource estimate and recent economic update for Hardrock. The updated mineral resource estimate and economic study was prepared by G-Mining Services, the independent QP for Hardrock, on behalf of GGM. All work completed by G-Mining to prepare the updated estimate and economic study was in accordance with GGM budgets, approved by both partners and funded entirely by Centerra, the company said.

The proposed assignee has the financial capacity to both acquire Centerra's 50% interest and advance Hardrock through construction. The assignee also intends to work with Premier to assist in securing the financial resources required for Premier to fund its 50% share of related mine construction costs, the company said.

"This offer should be viewed favorably by Centerra as we believe that it represents a substantial premium to the median of current analyst consensus valuations attributed to Centerra's 50% interest in GGM, full recovery of their total investment in GGM to date, and aligns with Centerra's stated focus of maximizing the value of its existing operating assets over new build opportunities," President and CEO of Premier Ewan Downie said. "The value of the offer is in excess of Premier's market capitalization, especially when you consider the company's considerable cash position."

Hardrock is the product of more than 12 years of exploration, development and engineering work that resulted in the delivery of an initial Feasibility Study late in 2016. During that same time, GGM obtained both federal and provincial environmental assessment approval, filed an updated closure plan and signed long-term relationship agreements with all locally impacted First Nation communities.

NGM Converts Coal-fired Plant to Gas

In support of Nevada's carbon-reduction objectives and in partnership with Gov. Steve Sisolak's administration, Nevada Gold Mines (NGM) — the joint venture between Barrick Gold Corp. (61.5%) as the operator and Newmont Corp. (38.5%) — approved the conversion of its TS Coal Power Plant to a dual fuel process, allowing the facility to generate power from natural gas. This conversion will enable the facility to reduce carbon emissions by as much as 50%, according to the company. NGM is currently working with the state on final permitting to allow construction to begin near the end of 2020, with the goal of final commissioning in the second quarter of 2022.

As part of its overall Energy Management Strategy, NGM is also reviewing the potential for a 200-megawatt solar facility with battery storage. The intention is to phase construction, initially installing 100 MW that could produce power as early as 2022. A study is currently under way, and once the project is approved, NGM will work with the state and the Office of Energy on permitting.

NGM has two power generation facilities in northern Nevada with the TS Power Plant in Dunphy and the Western 102 Power Plant outside of Reno. The TS Power Plant commenced operation in 2008 and has a capacity of 215 MW power generation from its original coal-fired process. The Western 102 Power Plant has a capacity of 115 MW, supplying power from natural gas fired generators and a 1-MW Solar Facility.

Shareholders Approve Falco Acquisition of Golden Queen

Falco Resources and Golden Queen Mining Consolidated Ltd. announced that Golden Queen shareholders approved the plan of arrangement with Falco where Falco will acquire all of the issued and outstanding shares of Golden Queen. The transaction was approved by 99.64% of the votes cast by Golden Queen shareholders, with shareholders holding more than 6 million shares or 45%.

Upon closing, Golden Queen shareholders will receive 1.35 Falco shares for each Golden Queen share held. The transaction is subject to final approval by the TSX Venture Exchange and Supreme Court of British Columbia, along with other customary conditions.

Falco Resources Ltd. is one of the largest mineral claim holders in the province of Québec. Its principal asset is the Horne 5 Project located in the former Horne mine that was operated by Noranda from 1927 to 1976. Osisko Gold Royalties Ltd. is its largest shareholder (19.9%).

Golden Queen sold its 50% interest in the Soledad Mountain gold-silver mine located south of Mojave, California, to the Clay family in May 2019.

PFS Supports Foran's Zinc-Copper Project

Foran Mining has announced the results of a positive prefeasibility study (PFS) of its McIlvenna Bay zinc-copper volcanogenic massive sulphide (VMS) deposit in east-central Saskatchewan, about 85 kilometers (km) by road west of Flin Flon, Manitoba. The study forecasts production of 89.2 million pounds per year (lb/y) of zinc and 27.9 million lb/y of copper in separate flotation concentrates over a mine life of nine years.

Preproduction capital expenditures to develop McIlvenna Bay are estimated at C$261 million. The PFS is based on a probable mineral reserve of 11.34 million metric tons (mt) grading 4.01% zinc, 1.14% copper, 0.54 grams/mt gold, and 20.97 g/mt silver. The probable mineral reserve is contained within indicated resources of 22.95 million mt grading 3.05% zinc, 1.17% copper, 0.44 g/mt gold, and 16.68 g/mt silver.

Cash costs of production at McIlvenna Bay, including sustaining capital, smelting and refining charges, royalties, and product transportation are estimated at $0.41/lb of zinc or $0.44/lb of copper, net of byproduct credits.

"We assembled a project team that has deep experience with projects similar to McIlvenna Bay to prepare this prefeasibility study," Foran President and CEO Patrick Soares said. "We are proposing a modern underground mine supported by surface infrastructure designed to take into account feedback we have received from local communities. We are committed to taking the project through feasibility and into production in a safe, responsible manner that will provide economic benefits to the region for years to come.

"We are now in a position to advance discussions with potential investors with experience developing similar mines as we explore the best way to credibly and safely build and operate McIlvenna Bay. Our goal, as always, is to maximize value per share."

Underground mining at McIlvenna Bay will employ a combination of longitudinal long-hole retreat (Avoca) and sub-level transverse stoping methods to mine at a nominal rate of 3,600 mt/d.

The operation will use 50-mt, battery-electric trucks to bring ore to the surface along the ramp for the first three years of production, followed by the installation of vertical conveyor technology to move ore to the surface from deeper parts of the mine.

The McIlvenna Bay processing plant is based on a conventional mineral processing circuit, with crushing, ball milling, and sequential selective sulphide flotation to produce clean copper and zinc concentrates. Metallurgical test work yielded robust recoveries of 80% for zinc, 88.2% for copper, 79.1% for gold, and 58.0% for silver.

Plant tailings will be de-sulphurized, filtered, and either used for cemented backfill or deposited on a dry stack tailings facility.

On-site infrastructure will include offices, workshops, mine dry, water treatment facilities, fuel storage areas, and a paste plant. An overhead powerline will supply hydropower to the project from Pelican Narrows, 65 km north of the project site.

Atac Contemplates Initial 6-year Project at Rackla

Atac Resources has reported an updated mineral resource and preliminary economic assessment (PEA) for the Tiger deposit at the western end of its 1,700-km^2 Rackla gold property in east-central Yukon. The update incorporates recent work, including additional diamond drilling, metallurgical test work, and a revised geological model focusing on better defining high-grade trends.

The PEA describes a project that would produce a total of 267,000 ounces (oz) of gold over a six-year operating life at an average diluted feed grade of 3.82 grams per metric tons (g/mt) gold. Annual production would peak at 72,860 oz in the first operating year, while production during the first three years would average 61,900 ounces per year (oz/y).

(Continued on p. 22)

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Patricio Vergara

Codelco appointed **Patricio Vergara** as vice president of mining resources and development. He began his career in 1995 at Codelco, where he became chief of operations for El Teniente. He was then Freeport-McMoRan's Grasberg project manager in Indonesia, mining director at Twin Metals, USA, and practice lead UG mining at BHP Minerals Americas.


Michael Holmes

OceanaGold Corp. appointed **Michael Holmes** president and CEO to replace **Mick Wilkes** who stepped down for personal reasons. Holmes joined OceanaGold in 2012 as its COO. Prior to joining the company, he was the general manager of Glencore's Alumbrera operation. Wilkes joined OceanaGold in 2010 and led the transformation of the company from a single asset operator in New Zealand to a successful midtier gold mining company operating four mines across three jurisdictions.


Eva Bellissimo

McEwen Mining Inc. announced that **Chris Stewart** has left his position as president and COO. His responsibilities will be assigned to other members of the management team.

Premier Gold Mines Ltd. appointed **Eva Bellissimo** to the board of directors. Bellissimo co-leads McCarthy Tétrault's Global Metals and Mining Group.


Liangyou Jiang

China Gold International Resources Corp. Ltd. appointed **Liangyou Jiang** CEO and chairman of the board. Jiang joined the company in 2010 and served as general manager of Tibet Huatailong Mining Development Co. Ltd. Jiang has more than 30 years of experience in mine design, construction, operation management and corporate governance, and has served on board of several mining companies.


Sergey Dubovitsky


Alexey Bashkirov

Nornickel made a number of staff and organizational changes. These include appointing **Sergey Dubovitsky** as senior vice president for strategy, strategic projects, logistics and procurement. **Alexey Bashkirov,** member of the board of directors and chairman of the board's budget committee, will take over as senior vice president for commerce, business development, investor and public relations. Bashkirov will also head two new units — Innovative Development Department and M&A Department. **Elena Savitskaya** who currently serves as vice president and chief of staff, will additionally oversee Nornickel's social policy, HR strategy and corporate policy on benefits and compensations, staff recruiting, training, motivation and performance assessment. On top of that, she will supervise corporate healthcare development. Senior Vice Presidents **Sergey Batekhin** and **Larisa Zelkova** will leave the company. **Vladislav Gasumyanov** will step down as senior vice president for public-private partnership, while keeping his seat on the board of directors.

Westhaven Ventures Inc. appointed **Ryan Fetterley** as vice president of operations. He recently acted as a field operations manager for Goldcorp.

Talisker Resources Ltd. appointed **Leonardo de Souza** as vice president, exploration and resource development. **Ruben Padilla,** the company's former vice president, exploration, has been appointed director of geology.


Joe Conway

Compass Gold Corp. appointed **Joe Conway** as chairman of the board. His more than 30 years of mining and financial industry experience includes his tenure as president and CEO of IAMGOLD from 2003 to 2010. This follows the resignation from the chairman position of **James Henderson** who will remain on the board as a non-executive director.

SouthGobi Resources Ltd. announced that **Shougao Wang** has resigned as CEO. **Dalanguerban** has been appointed CEO. He joined China Nonferrous Metal Industry's Foreign Engineering and Construction Co. Ltd in 1985 and served in a variety of roles in various countries until his departure in 2017 when he was the chief representative of NFC in Mongolia.


Boaz Wade

G2 Goldfields appointed **Boaz Wade** to vice president of exploration, Guiana Shield. Most recently, he was leading the mine exploration geology team at Guyana Goldfields Inc.


Dr. Elaine Dorward-King

Bunker Hill Mining Corp. appointed **Richard Williams** to the board of directors and as executive chairman. He is currently a nonexecutive director of Trevali Mining Corp. Formerly the COO of Barrick Gold Corp. and executive envoy to Tanzania, he has also served as CEO of the Afghan Gold and Minerals Co. and as a non-executive director of Gem Diamonds Ltd.

Novagold Resources Inc. nominated **Dr. Elaine Dorward-King** to the board of directors, which will be presented at the Annual Meeting of Shareholders on May 14. Most recently, she served as an executive vice president of Newmont Corp.


David Lewis

Laurion Mineral Exploration Inc. appointed **David Lewis** as exploration manager for the Ishkoday Project. Lewis is a structural and exploration geologist with 17 years of experience conducted on a variety of mineral deposit types, including both lode gold and vein-hosted deposits.


Ben Pratt

Liontown Resources Ltd. appointed **Adam Smits** to the newly created role of COO. He was most recently the COO and executive director for Nzuri Copper.


Adam Smits

The Mosaic Co. named **Ben Pratt** senior vice president of government and public affairs and will join the company's senior leadership team.

Generation Mining Ltd. appointed **Drew Anwyll** as COO. Most recently, Anwyll was senior vice president of technical services, interim COO and vice president of operations.


Drew Anwyll

Guerrero Ventures Inc. appointed **Elif Lévesque** as CFO. Most recently, she was vice president of finance and CFO of Osisko Gold Royalties Ltd.


Katharine MacGregor

The U.S. Senate confirmed **Katharine MacGregor** as the deputy secretary of the *U.S. Department of the Interior.* MacGregor has been serving as the deputy chief of staff exercising the authority of the deputy secretary since May 2019. MacGregor has served in several positions at the department since joining the President Donald Trump administration in January 2017, including principal deputy assistant secretary of land and minerals management and deputy chief of staff.


Greg Cook

Motion Industries Inc. promoted **Greg Cook** to executive vice president and CFO. Cook joined Motion Industries as senior vice president and CFO in November 2016.


Asa Weber

Eriez Flotation appointed **Asa Weber** to the position of Global StackCell product manager.

Epiroc appointed new members to group management. This included **José Manuel Sanchez** as president, surface division; **Sami Niiranen,** president, Underground division; **Jess Kindler,** president, Parts and Service division; **Jonas Albertson,** president, Technology and Digital division; **Goran Popovski,** president, Tools and Attachments division; and **Nadim Penser,** senior vice president human resources.


José Manuel Sanchez


Sami Niiranen

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Vale Will Begin Disposing of Tailings From Dam Breach at Feijão Mine

Vale said it will separate waste — such as metals, rubber, and wood — before disposing of the tailings in the extraction site (above). (Photo: Vale)

Brazil's Vale has begun to streamline the process to remove and dispose of the tailings from the dam failure that occurred on January 25, 2019, at the Córrego de Feijão mine in Brumadinho, Minas Gerais, that killed at least 259 people and surrounding communities are still reeling from its damage. Brazil's National Mining Agency (ANM, Agência Nacional de Mineração) and the State Department of Environment and Sustainable Development (Semad, Secretaria de Estado de Meio Ambiente e Desenvolvimento Sustentável) authorized the company to dispose of the tailings that have already been inspected and released by the Military Fire Brigade of Minas Gerais at Córrego do Feijão mine, in Brumadinho.

This measure is part of the Integrated Tailings and Waste Management Plan delivered and approved by the relevant authorities. The company expects the tailings deposited at the valley of Ferro-Carvão stream up to the confluence of Paraopeba river will be removed and disposed of in the extraction site by 2023.

Vale said it will separate waste — such as metals, rubber, and wood — before disposing of the tailings in the extraction site. This process complies with the specifications of the environmental agencies so that the tailings conditions are adequate to be disposed of and for the proper disposal of waste. In order to carry out this action, the company will use the screens from the Dry Ore Treatment Plant (ITMS, Instalação de Tratamento de Minério a Seco) of Córrego do Feijão mine and other mobile screens.

Fresnillo Announces Early Start for Juanicipio

Mexican miner Fresnillo said it is expecting to start production at the Juanicipio mine, a joint project in the northern part of the country with Canada's MAG Silver, earlier than expected. This raises its expectations for initial production at an additional cost of $45 million.

Fresnillo, which cut its production forecasts four times last year, has been trying to reduce capital investment and costs after its earnings almost halved in the first six months of 2019. However, the company said it now sees Juanicipio will reach 85% of planned capacity in the fourth quarter of 2021, above the previous estimate of 65%.

The company also said that the pre-operative capital cost of $395 million, estimated at the beginning of 2018, was revised to $440 million.

Fresnillo builds, develops and operates the Juanicipio mine, of which it has a 56% stake, while the remaining 44% is owned by Canada's MAG Silver.

The mining project, located in the Fresnillo municipality, in northern Zacatecas State, is expected to produce 11.7 million ounces (oz) of silver and 43,500 oz of gold per year once it is in operation. Overall, Fresnillo produced 51.8 million oz of silver and 875,913 oz of gold in 2019.

Nexa Targeting Zinc, Lead, Silver at Hilarión in Peru

Nexa Resources has announced the results of a preliminary economic assessment (PEA) of its underground Hilarión zinc-lead-silver project in Ancash province, Peru, about 230 kilometers (km) north of Lima. The study describes a potential underground mine producing an estimated average of 115,000 metric tons per year (mt/y) of zinc, 20,000 mt/y of lead, and 2.6 million ounces per year (oz/y) of silver in separate zinc and lead-silver concentrates.

A resource of 44.7 million mt grading 3.54% zinc, 0.72% lead, 0.06% copper, and 30.43 grams/mt silver was considered in the PEA life-of-mine plan. The planned mine production rate is 10,000 mt/d over a 16-year mine life. Average mill recoveries are estimated at 90% for zinc, 86% for lead, and 80% for silver, with no copper recovery estimated in the PEA.

Mine-site processing will be based on a conventional comminution and flotation plant producing separate zinc and saleable bulk lead-silver concentrates. Nexa anticipates that the zinc concentrate will be processed at the company's Cajamarquilla smelter near Lima.

The Hilarión project has an estimated capex of $585 million. An additional $165 million of sustaining capital is estimated over the mine life, including $44 million in mine closure costs.

Mining will be based on sublevel long-hole stoping, with loose backfill, and transverse long-hole stoping, with paste backfill. The deposit has favorable sub-vertical geometry, allowing for good operating parameters and use of gravity to enable good muck flow.

The main zone of the deposit has an average width of approximately 16 meters (m), while there are numerous veins that on average are approximately 6.5 m wide. The mine will be accessed using multiple ramp entry points and a 3-km conveyor tunnel or ramp.

Sale of Ravenswood Gold is Complete

Resolute Mining Ltd. has successfully completed the sale of the Ravenswood gold mine in Queensland to a consortium comprising a fund (EMR Fund) managed by specialist resources private equity manager EMR Capital Management Ltd. (EMR Capital), and Singapore-listed mining and energy company, Golden Energy and Resources Ltd. The sale of Ravenswood has been completed in accordance with the transaction terms and timeline outlined in the definitive agreements signed in January.

Resolute has received A$100 million of upfront proceeds consisting of A$50 million in cash and A$50 million in promissory notes that earn a 6% coupon. Resolute retains additional upside exposure to Ravenswood through two further notes valued at up to A$200 million, which may result in payments to Resolute of up to A$50 million linked to the average gold price over a four-year period; and up to A$150 million linked to the investment outcomes of Ravenswood for the EMR Fund.

"The sale of our Ravenswood gold mine delivers on our objective of ensuring a new long-life future for Ravenswood while maximizing value for Resolute shareholders," Resolute Managing Director and CEO John Welborn said. "Settlement enables us to focus our attention and energy on our African portfolio and the abundant opportunities for further growth and value creation."

Ravenswood was a strong performer for Resolute for more than 15 years and mined and processed more than 40 million metric tons (mt) of ore and produced almost 2 million ounces (oz) of gold.

More than 40 million mt of ore where mined and processed at Ravenswood (above) to produce almost 2 million oz of gold.

King of the Hills Resource Increases to 4Moz

Red 5 Ltd. has reported an updated mineral resource estimate for the Eastern Margin Contact Zone of its King of the Hills gold mine in the Eastern Goldfields region of Western Australia. Indicated and inferred resources now total 90.7 million metric tons (mt) at a grade of 1.4 grams/mt gold for 4.07 million ounces (oz) of contained gold.

The mineral resource includes both open-pit and underground components. The open-pit indicated and inferred resource totals 80.4 million mt grading 1.3 g/mt gold for 3.37 million oz of contained gold at a 0.4 g/mt gold cut-off, while the underground indicated and inferred resource stands at 10.3 million mt grading 2.1 g/mt gold for 0.7 million oz of contained gold at a 1 g/mt gold cut-off.

The King of the Hills property continues to have significant potential for further resource growth, with ongoing drilling planned and a large proportion of the prospective granodiorite-ultramafic contact remaining untested by drilling. A final feasibility study and an updated ore reserve for an integrated bulk open-pit and underground mine and stand-alone process plant is on-track for completion in the third quarter of 2020.

Red 5 Managing Director Mark Williams said, "The updated mineral resource model has seen a 69% increase in the open-pit component of the mineral resource. We are now looking at a very large-scale open-pit mining operation at King of the Hills, with a significant portion of the previous underground resource now captured within an expanded pit shell.

"Based on this updated resource model, we continue to forge ahead with the final components of the bulk mining final feasibility study, including mining and engineering studies and an updated ore reserve.

NQ Acquires Beaconsfield Gold

NQ Minerals Plc entered into an agreement to purchase the Beaconsfield gold mine, located 200 km from its Hellyer base and precious metals operations in Tasmania, for A$2 million ($1.2 million). The company said it will be working with its consultants and the Tasmanian government to ascertain what is required to reopen Beaconsfield as soon as possible.

"Acquiring an established gold processing plant for a fraction of the cost to build and permit a new one, not to mention the typical lead time associated with permitting a new facility in Tasmania, is an exciting opportunity," said David Lenigas, NQ's Chairman.

Gold production took place at Beaconsfield in two main phases. From 1877-1914, it recovered 855,000 ounces (oz) from a little more than 1 million metric tons (mt), averaging 25.6 g/mt gold. More recently, from 1999-2012, it produced 920,000 oz from 2.72 million mt, averaging 10.5 g/mt gold.

As part of the initial program of works in assessing the potential to re-open Beaconsfield, NQ will be engaging independent consultants to re-assess the existing gold resources available within the mining lease, taking into consideration the increase in the gold price since the mine officially ceased underground operations in 2012.

Amplats Idles Waterval Converter Plant

Anglo American Platinum (Amplats) temporarily shut down the entire Anglo Converter Plant (ACP), part of the chain of processing facilities, and the need to declare force majeure. The company's ACP phase A converter plant, at Waterval smelter in Rustenburg, was damaged following an explosion within the converter on February 10. Nobody was injured in the incident and work has started to repair phase A, which is expected to be completed by the second quarter of 2021.

As per normal business procedure, the phase B unit was commissioned to take over from the phase A plant and was in the process of ramping up to steady state, when water was detected in the furnace, according to the company. Notwithstanding extensive testing being conducted to determine the source of the water, and a number of circuits being isolated, water continued to be observed in the furnace. This poses a high risk of explosion and the company determined that it has no other option but to temporarily shut down the phase B unit, to ensure the safety of all employees, and avoid a catastrophic event. It is anticipated that the repair works to fix the phase B unit will take approximately 80 days.

As a result of the temporary closure of the entire ACP, Amplats has had to declare force majeure to customers, suppliers of third-party purchase of concentrate and suppliers of tolling material. Production from mines will continue, and the concentrate from the mines will continue to be smelted at one of its four smelter complexes.

The revised 2020 guidance for Amplats' refined production for platinum is 1.5 million to 1.7 million oz, down from 2 million to 2.2 million oz. Palladium production will drop to 1.1 million to 1.2 million oz from 1.4 million to 1.5 million oz.

Sanbrado Project in Burkina Faso Pours First Gold Bars

West African Resources poured the first gold at its Sanbrado open-pit/underground gold project in Burkina Faso on March 18. Gold bars weighing 23.9 kilograms (kg) were poured in the first smelt on site.

Sanbrado project development was based on a feasibility study completed in April 2019. The study assumed an initial 10-year mine life based on probable reserves of 1.7 million ounces (oz) of gold in 21.6 million metric tons (mt) grading 2.4 grams/mt. The project will produce an average of 217,000 oz per year (oz/y) of gold during its first five years of operation, with a 14-month post-tax payback on preproduction capital costs of $186 million.

The West African Resources team celebrates the first dore pour.

Project economics are robust, with all-in sustaining costs of $600/oz over the first five years and $650/oz life of mine. Year one production is expected to exceed 300,000 oz.

At the time of the first gold pour, approximately 75,000 mt of ore grading 1.5 g/mt gold had been processed since startup of the Sanbrado plant, and the plant was exceeding nameplate capacity. Metallurgical recoveries were exceeding 90%. All critical spares and reagents were on site, and no process interruptions were anticipated.

Open-pit ore stockpiles totaling 250,00 mt grading 1.5 g/mt gold had been placed on the run-of-mine pad. First underground development ore had been mined and stockpiled.

West African Resources Executive Chairman Richard Hyde commented, "This is a major milestone for West African Resources and marks the beginning of a new phase in our company's story. To successfully transition from an exploration company to a gold producer is without doubt a great achievement for all involved."

Underground development at Sanbrado continues to progress as scheduled. The first development crosscut on the 2120 level, 300 m below surface, intercepted visible gold north of the mine plan. Some 1,200 mt of underground ore had been mined and stockpiled.

West African Resources holds a 90% interest in the Sanbrado gold project. Faso has a free-carried 10% interest. The project is located 90 km east-southeast of Ouagadougou.

Teranga Completes Acquisition of Massawa Project

Teranga Gold Corp. has completed the previously announced acquisition of a 90% interest in the Massawa Gold Project from a subsidiary of Barrick Gold and its joint venture partner.

"Now that the transaction is complete, we are turning our focus to integrating the high-grade Massawa deposits into our mine plan and leveraging our existing infrastructure at Sabodala," President and CEO Richard Young said. "The combination of the two assets results in significant capital and operating synergies and creates a top-tier gold complex."

Emerald Resources Awards Mining Contract for Okvau Project in Cambodia

Emerald Resources has signed a mining contract with MACA Ltd. for supply of earthmoving equipment and performance of contract mining services at Emerald's Okvau open-pit gold project in Mondulkiri province, eastern Cambodia. The contract is valued at $230 million over seven years. Mobilization activities are planned to begin in August ahead of preproduction mining in October.

Scope of works for the contract includes site preparation, drill and blast, load and haul, and maintenance works. First gold production is planned for the second quarter of 2021.

Emerald Resources is an Australian company headquartered in Perth, Western Australia. The company recently completed a definitive feasibility study (DFS) of development of a 2-million-metric-ton-per-year (mt/y) mining operation at Okvau, with gold production planned at 106,000 ounces per year (oz/y). Preproduction capital costs to develop the project are estimated at $98 million. C1 cash costs of production are estimated at $650/oz.

The DFS only considered an open-pit mining operation. The Okvau deposit remains open at depth, with high-grade shoots providing longer-term underground potential. High-grade resources have been defined immediately below the floor of the final pit design.

The DFS is based on an ore reserve of 14.3 million mt at a grade of 1.98 g/mt gold. Processing recovery is estimated at 84%. The life-of-mine strip ratio is 5.8:1, waste to ore.

Substantial opportunities exist for new gold discoveries across the broader Okvau and adjoining O'Chhung project areas covering approximately 400 km^2. Further drilling around the Okvau deposit and exploration targets within close proximity to the deposit offers an opportunity to expand the existing resource inventory and add to the current production target, both in terms of annual production and mine life.

Grade-control drilling begins at the Okvau project in Cambodia. (Photo: Emerald Resources)

Emerald Resources Managing Director Morgan Hart said, "We are extremely pleased to have appointed MACA as the mining contractor for the Okvau gold project operations, which continues the existing relationship between the Emerald and MACA management teams. The signing of the mining contract follows a thorough and collaborative process with both teams in finalizing the mining schedule for the development and operation of the project. The signing of the contract gives us greater confidence to achieve our goal of becoming the first modern, large-scale Cambodian gold producer by Q2 2021."

Letter to the Editor:

As always, I look forward to your comments and was glad to see that *E&MJ* attended the permitting session at the 2019 American Exploration & Mining Association meeting. I also presented at that conference and the theme was "the luck of the draw;" that is, the amount of trouble one might have depends greatly upon who one draws as a district ranger, forest supervisor, even the regional forester. In my case I drew a mean spirited, dishonest, Forest Supervisor.

I have just passed my sixth season of trying to permit a simple small-miner/recreational type of placer operation in a historic placer mining district that will disturb no more that 1 acre, including access. I discussed all the hoops I had to go through to obtain my POO permit only to have him bring in a temporary district ranger to deny my route. Totally dishonest, in my view.

President Trump is doing his best to drain the swamp but we are still dealing with public land management directives and officials from the Obama administration, and he cannot drain it fast enough (by getting rid of these mean-spirited malcontents).

They are so obsessed with preservation that they cannot accept that we have to develop minerals where they are, and the same geologic forces that created our landscapes concomitantly created mineral deposits. We once had a public lands management philosophy that accepted this, and until we again have that in place, the public land wars that started during the Carter administration will continue.

Keep up the good work.

Andy Johnson
Butte, Montana

Newcrest Signs A$60 million Farm-in, Joint-venture Agreements With Antipa

Newcrest Mining has signed A$60 million in exploration farm-in and joint-venture agreements with Antipa Minerals covering a 2,180-km^2 southern portion of Antipa's 100% owned ground in the Paterson province of Western Australia. The project has been named the Wilki project.

Key terms include an initial A$6 million minimum exploration expenditure within two years to be managed by Antipa; a further A$10 million exploration expenditure within five years of commencement for Newcrest to earn a 51% joint-venture interest; and a further A$44 million exploration expenditure within eight years of commencement to earn a 75% joint-venture interest.

Newcrest will also acquire a 9.9% interest in Antipa by subscribing for A$3.9 million in shares at A1.7 cents/share.

Initial exploration activity on the Wilki project will include a field reconnaissance program, with mapping and geochemical sampling; aerial electromagnetics over areas not previously covered by aerial electromagnetics; an induced polarization survey to target prospects beneath cover; and reverse circulation and diamond core drill programs testing defined targets under cover.

Antipa Executive Chairman Stephen Power commented, "We are delighted to welcome Newcrest as a shareholder of Antipa and to be partnering with them to progress the exploration of our Wilki project in the world-class Paterson province of Western Australia.

"This transaction demonstrates Newcrest's commitment to the region and its strong belief in the prospectivity of the Wilki project, which is strategically located surrounding Newcrest's long-running Telfer gold-copper operation and ore-processing facility.

"The agreement with Newcrest is designed to ensure that a robust exploration program will be undertaken across the Wilki project over the coming years, including the drill testing of a number of highly prospective targets. Furthermore, the share placement positions Antipa in a strong financial position, enabling the company to progress exploration activities on its remaining 100% owned tenure."

Newcrest's Telfer operations are located 400 km east of Port Hedland. Production totaled 452,000 oz of gold and 15,000 mt of copper during the company's fiscal year to June 30, 2019.
(*www.antipaminerals.com.au*)

Exploration Briefs

San Marco Resources has initiated a drill program at its 100% optioned Buck gold-silver-zinc property in north-central British Columbia. Highlights of the Phase I program include up to 2,000 meters (m) of HQ diamond drilling; investigation of potential depth extensions of known mineralized zones; step-out drilling in areas of potential new discoveries; and confirmation of bulk-tonnage potential and zones of high-grade mineralization.

Since very little drill core from historical drilling is available for review, this initial drill program will provide fresh drill core for detailed logging and support of what appears to be a large, highly altered gold-silver-zinc breccia system.

San Marco Vice President of Technical Services Sharyn Alexander commented, "We are very excited to begin drilling at our Buck property. We have a strong technical team with years of combined experience, and we are eager to test some very interesting targets outlined during our data compilation and review.

"Data to date indicate the Buck property hosts large areas of surface and near-surface mineralization, and it is anticipated that the current drilling will confirm this and give indications of depth potential."
(*sanmarcocorp.com*)

Otis Gold has signed a definitive option agreement with **Centerra Gold** whereby Centerra may earn up to a 70% interest in Otis's Oakley project in Cassia county, southern Idaho. Terms of the agreement call for Centerra to spend $7 million on exploration and make cash payments to Otis of $550,000 over a six-year period.

Centerra can earn a 51% interest in the Oakley project by incurring $4.5 million in exploration expenditures and making cash payments of $250,000 to Otis over a three-year period. Centerra will then have an option to acquire a further 19% of the project by incurring an additional $3 million in exploration expenditures and making a cash payment of $300,000 over three years.

The Oakley project hosts gold-silver epithermal hot spring-type mineralization at Blue Hill Creek and Cold Creek and detachment-related gold-silver mineralization at Matrix Creek. Blue Hill Creek has an inferred resource of 163,000 ounces (oz) of gold in 9.97 million metric tons (mt) at a grade of 0.51 grams/mt gold. The Blue Hill Creek resource is hosted in rocks of the Tertiary Salt Lake formation within a northwest-trending Tertiary graben that is part of a north-trending, five-mile-long by one-mile-wide zone of low-sulphidation, hot spring-type gold occurrences along the western margin of the Albion mountains.
(*otisgold.com*)

Mawson Resources has announced that the best drill hole of the 2020 winter season at its Palokas prospect in northern Finland returned 7.2 m grading 21.7 g/mt gold from 267.9 m down hole, including 2 m grading 52.7 g/mt gold from 271.0 m. The hole is a 120-m step-out that further extends high-grade gold beyond previously defined resources.

The 2020 drill program aims to extend and infill mineralization and provide data to allow re-estimation of the previously announced December 2018 resource during the third quarter of 2020. The Palokas deposit remains open at depth and along strike.

Mawson Chairman and CEO Michael Hudson commented, "Improving grade and continuity of high-grade gold-cobalt mineralization at depth is particularly encouraging. Strong news flow is anticipated to continue over the coming months, with only 13 holes reported from a total 34 holes drilled to date, with drilling ongoing."

Mawson Resources is a Canadian company headquartered in Vancouver, British Columbia.
(*mawsonresources.com*)

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Coronado Suspends US Production

The Curragh mine in Australia (above) will continue to supply Coronado customers with coal.

In response to an economic downturn in Europe, Brazil and the United States, Coronado Global Resources is temporarily idling its U.S. operations. The company will continue shipments to these regions from existing inventories of approximately 750,000 metric tons (mt).

In Australia, the Curragh mine will continue to operate to accommodate metallurgical coal export requirements of its key customers in India and the Asia Pacific. Curragh also supplies coal under a long-term contract to the Stanwell Power Station, a Queensland government-owned entity.

Coronado will furlough all U.S. hourly employees. Salaried employees in the U.S. will continue to maintain the integrity of each operation for rapid resumption of operations, comply with all regulatory obligations. Coronado said it will continue the company-paid portion of heath care insurance premiums for all furloughed employees at this time.

"Given the challenging and unprecedented macro environment, these are prudent measures designed to ensure that Coronado remains in a solid financial position," said Garold R. Spindler, managing director and CEO, Coronado Global Resources. "We will continue to deliver on our commitments to our global customers."

The company said the temporary halt at the U.S. mines may impact the previously announced saleable production guidance for fiscal year 2020 of 19.7 million to 20.2 million mt, but how much is unknown.

WVDEP Files Suit Against ERP Environmental Fund

On March 26, the West Virginia Department of Environmental Protection (WVDEP) filed suit against ERP Environmental Fund Inc., the company that acquired more than 100 mining permits out of Patriot Coal Corp.'s bankruptcy in October 2015. The overwhelming number of ERP's permits are in West Virginia, with others in Kentucky, Illinois and Tennessee.

The suit, filed in the Circuit Court of Kanawha County, alleged that ERP had accumulated 160 violations of the state's environmental laws, had failed to abate 118 cessation orders, and is the subject of 41 orders to show cause why its permits should not be revoked. The suit sought the entry of injunctive relief barring ERP from violating the state's environmental laws and asked the court to appoint a special receiver to assume control of ERP's assets, operations and affairs to ensure its compliance with the environmental laws.

WVDEP's requested temporary order would also bar ERP's creditors and other parties in interest from taking actions against ERP's assets and interfering with the special receiver's actions.

According to the WVDEP's motion, ERP laid off all its employees and management on March 20, and ceased all operations, leaving its mining sites abandoned.

The WVDEP has proposed that Doss Special Receiver LLC be appointed as ERP's receiver. Doss Engineering Inc. and its principal, R.B. (Barry) Doss, are the principals behind Doss Special Receiver and will perform the functions of the receiver. Indemnity National Insurance Co., which issued approximately $125 million in surety bonds backing ERP's obligations under its mining permits, has agreed to provide $1 million in funding to Doss Special Receiver to fund its operations for an initial period of 90 days.

WVDEP Cabinet Secretary Austin Caperton said, "ERP essentially walked off from its operations on Friday, leaving the public exposed to health and safety concerns. The WVDEP had no option but to step in to seek the appointment of a receiver to take control of ERP's operations to protect the public health and safety."

After an emergency hearing held on March 27 despite the closure of the court due to the coronavirus, the state court entered a temporary order appointing a special receiver over ERP Environmental pending further proceedings in the case. The court enjoined creditors and other parties with interests in ERP Environmental from commencing or continuing litigation against it or the special receiver.

The court indicated that further proceedings would be held in the case at a time to be determined, both in view of the coronavirus emergency affecting the court and the possible referral of the case to the West Virginia Business Court Division.

ERP is associated with the Virginia Conservation Legacy Fund, a nonprofit operated by businessman Tom Clarke. In addition to the Patriot mines, Clarke also purchased mines from Cleveland Cliffs, Walter Energy and Alpha Natural Resources.

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Preproduction capital costs to develop the project are estimated at C$110.1 million. All-in sustaining costs of production are estimated at $661/oz. The post-tax payback period is estimated at 1.4 years.

Atac President and CEO Graham Downs said, "The updated geological model and PEA envision a smaller but higher-grade operation than contemplated by the 2016 resource estimate and PEA. We are very encouraged by the short payback period and high IRR, which are calculated at a base case substantially lower than current gold prices.

"The updated deposit model has also identified strong high-grade trends that are open along strike and at depth. Tiger's high grades and margins, coupled with nearby satellite targets, provide a compelling case for advancement."

Consistent with previous studies, the Tiger project has been modeled as an owner-operator, truck-and-shovel, open-pit mining operation, with a conventional carbon-in-pulp (CIP) gold recovery process. Year-round operations would be supported by a 68-km tote road that would connect the project to the Yukon highway system near Keno City.

A total of 2.7 million mt of mineralized material and 14.4 million mt of waste rock would be produced from the pit. Mineralized material would be crushed, ground and cyanide leached in a conventional CIP circuit, with production of doré bars on site via standard adsorption, desorption and recovery treatment. The processing plant would operate year-round at a throughput rate of 1,500 mt/d.

The Tiger deposit mineral resource update was completed by Mine Development Associates. The PEA update was completed by Tetra Tech Canada (mining, processing, infrastructure, financial analysis, and environmental); Knight Piésold (tailings and waste management); and Blue Coast Metallurgy (metallurgy).

Vanadium One Advances Mont Sorcier Iron Ore Project

A preliminary assessment (PEA) of its Mont Sorcier iron and vanadium project 18 kilometers (km) east of Chibougamau, Quebec. The PEA outlines a drill-blast-haul, open-pit mining operation, followed by magnetic separation to produce approximately 5 million metric tons per year (mt/y) of vanadium-rich iron concentrate. Based on test work to date, this material would be amenable for use as direct blast furnace feed.

Upfront capital costs to develop Mont Sorcier are estimated at C$457.5 million, with a pay back of three years and an after-tax IRR of 33.8%. The project benefits from robust in-place infrastructure, with access to all-season roads and low-cost provincial hydro power. Given the project's proximity to Chibougamau, no permanent camp will be required for the anticipated permanent workforce.

The project is within 20 km of a rail head servicing a railway that runs approximately 370 km to the port of Saguenay. The railway is currently underutilized and has sufficient capacity to service the requirements of the Mont Sorcier project. The PEA assumed all concentrate will be rail hauled to Saguenay for international shipment to China.

The Mont Sorcier PEA was completed by CSA Global Consultants Canada Ltd. CSA has developed a mine plan that calls for processing of 555 million mt of the current resource base over a 37-year mine life at an average strip ratio of 0.89 to 1.

Mining operations will reach peak material movement of approximately 44 million mt/y. Mining costs are estimated at C$2.29/mt of material moved. SiO_2 content will be kept under 2.5% through pit grade-control to maintain above 65% iron in the concentrate.

Metallurgical test work by COREM has confirmed the production of premium, high-grade 65.8% iron concentrate with 0.67% V_2O_5 content. The PEA calls for crushing and grinding to a P95 of 45 microns to ensure production of premium concentrate grades, followed by three stages of magnetic separation.

Life-of-mine operating costs are estimated at C$52.38/mt of concentrate produced, delivered to the port of Saguenay, and loaded onto a vessel. Additional selling costs related to ocean freight are expected to add C$27.78/mt of concentrate, assuming delivery to China. Transport costs could be reduced significantly should the company find a North American purchaser.

In light of the robust PEA results, Vanadium One is in the process of developing a detailed development plan and budget to determine the requirements to bring Mont Sorcier to a development decision. The company will undertake additional drilling to improve resource confidence levels to support a formal feasibility study, with a total of approximately 12,000 m of drilling planned to complete this program.

NEWS - CALENDAR OF EVENTS

JUNE 1-5, 2020: Elko Mining, Elko, Nevada, USA. Contact: Web: www.elkocva.com.

SEPTEMBER 7-11, 2020: Electra Mining, Johannesburg, South Africa. Contact: Web: www.electramining.co.za.

SEPTEMBER 8-11, 2020: UGOL & Russia, Novokuznetsk, Russia. Contact: Web: www.ugol-rossii.com.

SEPTEMBER 28-30, 2020: MINExpo INTERNATIONAL, Las Vegas, Nevada. Contact: Web: www.minexpo.com.

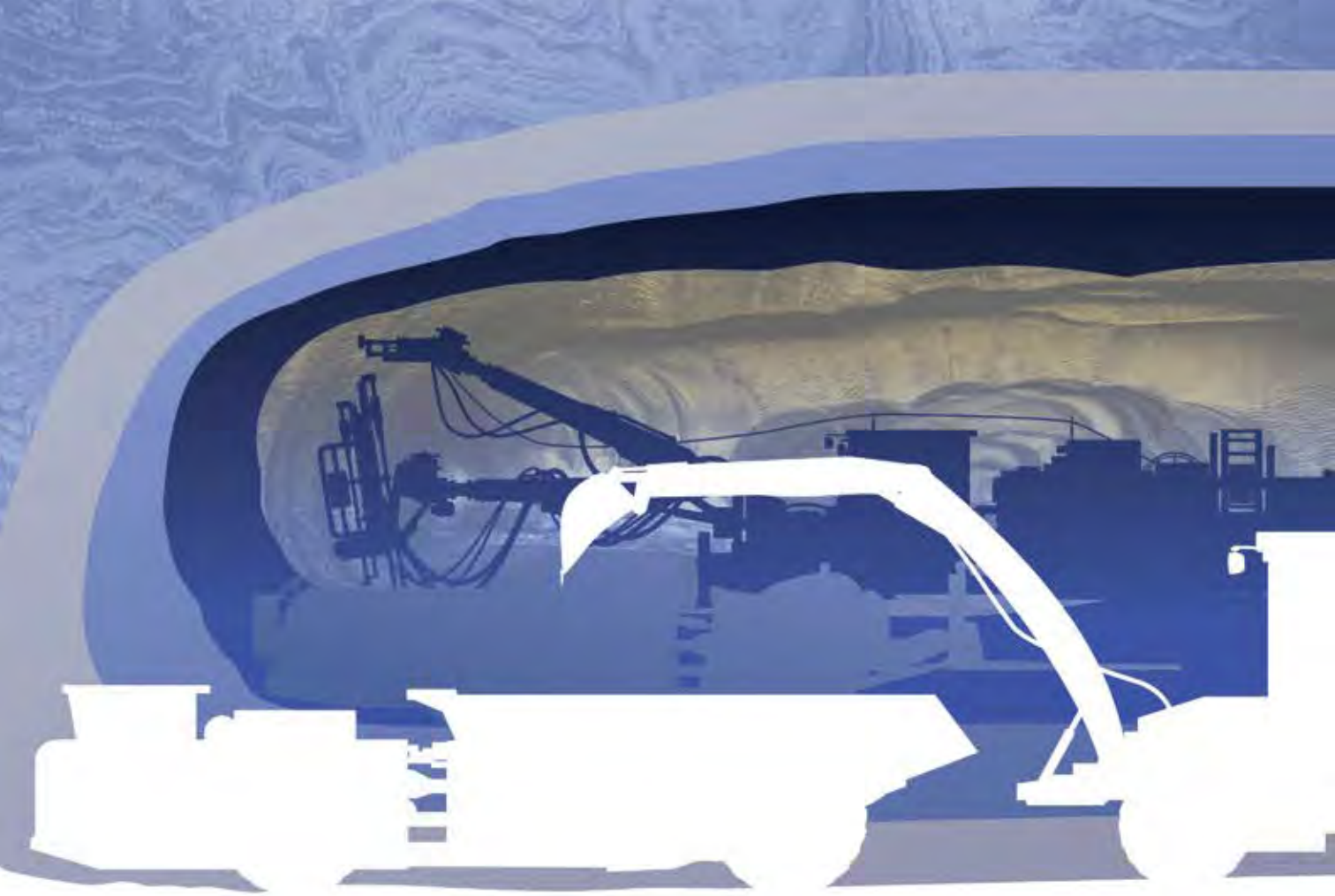
OCTOBER 20-22, 2020: MiningWorld Russia, Crocus Exhibition Center, Moscow. Contact: Web: https://miningworld.ru/.

NOVEMBER 7-14, 2020: ALTA 2020 Nickel-Cobalt-Copper, Uranium-REE, Gold-PM, In Situ Recovery, Lithium & Battery Technology Conference & Exhibition, Pan Pacific Hotel, Perth, Australia. Contact: Web: www.altamet.com.au/conferences/alta-2020/.

NOVEMBER 9-13, 2020: Expomin, Espacio Riesco, Santiago, Chile. Contact: Web: www.expomin.cl.

FEBRUARY 8-11, 2021: Investing in African Mining Indaba, Cape Town, South Africa. Contact: Web: www.www.miningindaba.com.

MARCH 14-17, 2021: Haulage & Loading 2021, Hilton El Conquistador Resort, Tucson, Arizona. Contact: Web: www.haulageandloading.com.



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The Dud Before the Storm?

In 2019, gold miners processed more ore to produce an annual increase in output, which for most was still below the average for the prior decade

By Jesse Morton, Technical Writer

A haul truck makes it way up the ramp at the Twin Creeks mine in Nevada, which is now operated by Nevada Gold Mines (NGM). Barrick Gold and Newmont partnered to form NGM in 2019. (Photo: Newmont)

Going strictly by the numbers in the corporate reports, last year was a big year for gold mining. And yet, it was a dud.

In 2019, in the months following the two biggest mergers in the history of gold mining, with absolutely soaring gold prices, the world's biggest pure-play gold miners[1] increased total gold output (TGO) by a whopping 10% year over year (yoy).

The group combined produced almost 30 million oz, about 2 million oz more than was produced in 2018, and easily the most in the last half decade. It is about a 4% increase over the average for the preceding five years (from January 1, 2014, through December 31, 2018).

Eliminating South Africa's beleaguered Sibanye Stillwater, which saw its gold ops costs literally skyrocket, the average all-in sustaining costs (AISC) for the group fell by about 2% yoy, to roughly $930 per ounce (oz). Adjusted for inflation, that AISC is roughly the five-year average for the group. Relatively low average AISC would be due in part to the so-called synergies unleased by mega mergers and partnerships.

Meanwhile, the average price received for the group spiked a whopping 10%, to close to $1,400/oz, which is about 12% higher than the five-year average for the group.

The roughly $500/oz margin was the highest going back more than five years and a staggering 21% increase yoy.

Thus, going by TGO, price and AISC, 2019 could easily be remembered as a banner year for the group. The back story is, however, that on average the group mined about 25% more rock and processed almost 15% more ore, just to raise TGO by 10%.

Worse, reality is that, despite the substantially higher prices, despite mining considerably more rock, only four of the 10 in the group actually produced more gold in 2019 than they did on average for the preceding decade. The theory of peak gold, while impossible to prove outright, lingers due to such numbers.

Nonetheless, a look at the box scores shows an industry that undoubtedly charged forward as prices spiked, and that is also beset by serious challenges, like declining grade and the related nagging costs.

The numbers also reveal the effort to seize on relatively high prices will likely continue through 2020, as about half of the group aims for a TGO above their average for the preceding decade.

Below, the group is ranked by TGO and their corporate reports summarized.

1. Newmont (6.4M oz)

According to corporate reports, Newmont reported a net income of $2.9 billion for 2019. In 2019, it paid down $1.2 billion in debt. It paid out $1.4 billion to shareholders through dividends and share repurchases.

Newmont Mining reported a total gold output for 2019 of 6.4 million oz, up 17% yoy, up 26% over the average for the company for the previous five years, and up 25% over the average for the previous 10 years.

With an AISC of $966/oz, the company ranked in the middle of the pack. It was an increase of about 6% yoy, and an increase of about 4% over the average for the previous five years. Newmont processed about 205.2 million metric tons (mt), about 9% more ore yoy, significantly more than any of the rest of the group.

Part of the explanation for the amazing numbers is the company grew significantly last year. In January, it moved to acquire Goldcorp Inc., a company previously ranked in the top 10 globally

[1] For the purposes of this article, the world's biggest pure-play gold miners are Newmont, Barrick, AngloGold Ashanti, Polyus, Kinross Gold, Newcrest Mining, Gold Fields, Agnico Eagle Mines, Harmony Gold and Sibanye.

for TGO. On April 18, 2019, the acquisition closed.

On July 1, 2019, Newmont and Barrick Gold partnered to establish Nevada Gold Mines LLC (NGM). NGM is owned 38.5% by Newmont, and owned 61.5% and operated by Barrick.

Attributable gold production for NGM, which includes the Carlin, Phoenix, Twin Creeks and Long Canyon mines, was roughly 700,000 oz.

The company reported new production elsewhere in North America at Éléonore, Porcupine, Peñasquito and Red Lake. That was partially offset by lower ore grade at the Cripple Creek & Victor (CC&V) mine. It also reported new production in South America at "Cerro Negro following the completion of the Newmont Goldcorp transaction and higher leach production at Yanacocha, partially offset by lower ore grade milled and lower recovery at Merian."

Newmont reported "lower production from Australia due to lower ore grade milled at Kalgoorlie and Boddington, partially offset by higher mill throughput at Tanami." It reported higher production from Africa thanks to higher grade ore milled and higher throughput at Ahafo.

Major highlights of 2019 included the completion of "four projects on four continents, on time and within budget, with internal rates of return of at least 15%: Tanami Power in Australia, Borden in Canada, the Ahafo Mill Expansion in Ghana, and Quecher Main in Peru." Tanami Expansion 2 (Australia) received government approval. The project will extend to 2040 "the life of this world-class mine, which has produced more than 10 million oz since 1986." In October, the board of directors approved full funding of the project. Autonomous haulage at Boddington received government approval. Also in 2019, Newmont divested its 50% interest in Kalgoorlie Consolidated Gold Mines (KCGM) in Australia, which operated the Super Pit.

In 2019, the company reported project expenditures of almost $500 million, and sustaining expenditures of roughly $1 billion. The total of $1.5 billion was a roughly 40% increase yoy, and a 70% increase over 2017.

Newmont plans to spend roughly $230 million on exploration in 2020, down 13% yoy. For 2020, it expects to log roughly $1 billion in sustaining expenditures, and roughly $625 million in project expenditures. It reported it will produce roughly 6.4 million oz gold at an AISC of roughly $975/oz.

Newmont "had attributable proven and probable gold reserves of 100.2 million oz at December 31, 2019."

2. Barrick Gold (5.5M oz)

Barrick Gold reported net earnings of roughly $4 billion. The company reported it halved its debt. It reported net earnings per share of roughly $0.51 for the year.

Barrick produced roughly 5.5 million oz gold, up 21% yoy, but down 1% over the average for the previous five years, and down 16% from the average for the previous 10 years.

Barrick reported an AISC of $894/oz, the third lowest in the group. That was up 11% yoy, and up 12% over the average for the previous five years.

To produce 21% more gold yoy, Barrick basically doubled the amount of ore it processed yoy. It also mined almost 90% more ore yoy.

Some of those numbers can be explained by the fact that the Barrick of 2019 is significantly larger than the Barrick of 2018. In the closing months of 2018, Barrick acquired Randgold Resources, which at the time was one of the world's biggest pure-play gold producers. And, as mentioned, in 2019, Barrick partnered with Newmont to form NGM. In late 2019, Barrick also sold it interest in KCGM, a move which would only marginally impact 2019 gold production numbers.

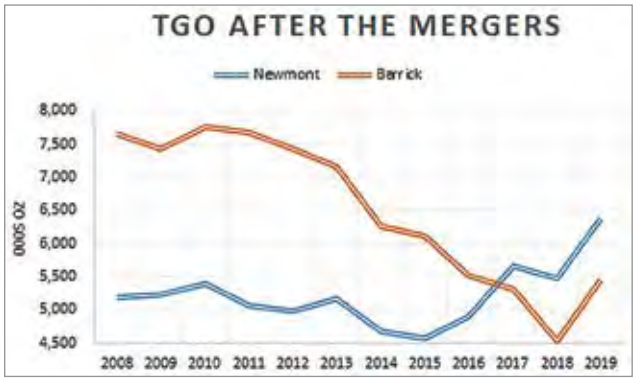
Other major highlights of the year include the formation of a joint venture with the Tanzanian government, creating Twiga Minerals Corp. to "oversee the management of Barrick's local operations," to include Acacia Mining; the phase in of solar power at Loulo-Gounkoto, which produced 715,000 oz; and the coal-to-gas conversion of a power plant at Pueblo Viejo. Kibali produced 814,000 oz. Porgera produced almost 600,000 oz, up 39% yoy. Veladero produced roughly 550,000 oz, down 1% yoy.

For 2019, Barrick reported total capital expenditures of $1.5 billion, up about 11% yoy. It reported it expects total capital expenditures of as much as $1.9 billion in 2020. It expects to produce roughly 5 million oz gold with an AISC of about $945/oz.

Barrick reported that at the end of 2019 it had reserves of 71 million oz.

3. AngloGold Ashanti (3.3M oz)

AngloGold Ashanti reported a gross profit of $983 million, up roughly 27% yoy. It reported headline earnings of $379 million, which still translated to a $0.03 loss per share on the year. It reported



Life after the mega merger. Total gold output shoots skyward after the world's two biggest pure-play gold miners each acquire other top tier gold mining companies.

Prices before the storm. Capping a four-year run, the average realized price for the group for 2019 nears $1,400/oz. With those prices, less than half the group was able to raise output above the average for the preceding decade.

adjusted net debt of $1.6 billion, down about 5% yoy. The company produced 3.3 million oz gold, down roughly 4% yoy, down roughly 14% from the average for the preceding five years, and down roughly 19% from the average for the preceding 10 years.

For 2019, the company reported an AISC of $998/oz, up roughly 2% yoy and up 1% over the average for the preceding five years.

AngloGold Ashanti processed roughly 56 million mt ore in 2019, down about 27% yoy. It also mined about 7% less ore yoy.

In 2019, the miner managed to enter agreements to sell its South African assets and the Sadiola mine in Mali. It achieved first pour on time and within budget at Obuasi, where the Phase 2 ramp up is under way. Iduapriem (Ghana) produced 8% more gold yoy, reaching a record annual production of 275,000 oz despite downtime to repair a cracked trunnion journal on Sag Mill 2. Geita (Tanzania) produced 600,000 oz, an increase of 7% yoy, and hitting the highest level in 13 years. The pit there is transitioning to underground operations.

The rest of the operations either produced the same amount or less gold yoy for a variety of reasons, the main being lower grades in general.

For 2019, AngloGold Ashanti reported capital expenditures of $814 million, down roughly 13% yoy. Total sustaining capital expenditures were $436 million, down roughly 13% yoy.

The company expects to log close to $1 billion in total capital expenditures for 2020. It reported it expects to produce about 3.2 million oz of gold at an AISC of $1,070/oz.

At the close of 2019, AngloGold Ashanti reported reserves of 43.9 million oz.

4. Polyus (2.8M oz)

Russia's Polyus reported an adjusted net profit of $1.6 billion for 2019. Net debt was $3.3 billion, up 6% yoy. TGO was 2.8 million oz, up 16% yoy. It reported the board was considering a H2 2019 dividend of $3.5 per ordinary share.

For the sixth year in a row, Polyus ranks first in the group for lowest AISC. In 2019, it dropped $10/oz, to $594/oz, which is down 8% from the average for the preceding five years.

To raise TGO by 16% yoy, Polyus processed 16% more ore yoy. It also mined 54% more ore yoy.

In 2019, Olympiada produced 1.4 million oz, an increase of 5% yoy. To do so, it deployed 11 new haul trucks and a new hydraulic excavator. There the company continued a throughput capacity expansion project.

Similarly, at Natalka, the company executed debottlenecking tasks, adding four Knelson concentrators. It also deployed two haul trucks and a shovel. Natalka produced 405,000 oz in 2019.

Verninskoye, which produced 256,000 oz, an increase of 15% yoy, also executed tasks on a mill expansion project. Kuranakh continued fleet replacement and commissioned a thickener and adsorption line.

The mill at Blagodatnoye is in the process of having upgrades designed. It produced 420,000 oz in 2019.

For 2019, capital expenditures decreased to $630 million from $736 million, a drop of 14% yoy. "This decrease mainly reflects the lower capital expenditures at Natalka, which was fully ramped-up in 2018, and lower capital expenditures at Olimpiada and Blagodatnoye," Polyus reported.

For 2020, Polyus expects to log capital expenditures as high as 750 million. It forecasts producing 2.8 million oz. The company reported reserves were 64.4 million oz.

5. Kinross Gold (2.5M oz)

For 2019, Kinross reported adjusted net earnings of $422 million, which translates to about $0.35 per share. Debt and total liabilities were up only slightly yoy.

Kinross produced 2.5 million oz in 2019, up about 2% yoy, but down 5% from the average for the previous five years, and down about 2% from the average for the preceding 10 years.

For 2019, Kinross reported an AISC of $983/oz, among the highest in the group. That number is a slight increase over the average for the previous five years.

Kinross processed slightly less ore yoy in 2019; however, it processed about 10% more than the average for the preceding five years. It mined about 7% less ore yoy. Nonetheless, the amount mined was about the same amount of ore that it has mined on average annually for the preceding five years.

Highlights for 2019 include record annual production at Paracatu, with a TGO of 620,000 oz, "mainly due to an asset optimization program that improved mill efficiencies and enhanced the understanding of the orebody." Tasiast also logged record production, up a whopping 56% yoy, and costs, "as the mine continued to benefit from the Phase One expansion and the mills strong performance." Production increased 8% yoy at Kupol-Dvoinoye "primarily due

At Blagodatnoye, Polyus moves 25 million m^3 rock. The mine produced roughly 420,000 oz gold. (Photo: Polyus)

to higher-grade ore processed." Round Mountain saw the completion of the Phase W project.

Capital expenditures in 2019 were $1.1 billion, an increase of roughly 10% yoy. The company plans to log roughly $900 million in capital expenditures for 2020. It reported it expects to produce 2.4 million oz gold in 2020 at an AISC of roughly $970/oz.

Kinross reported that, as of the close of 2019, it had about 54 million oz in reserves.

Located above the Arctic Circle in Russia, Kupol produces roughly 130,000 oz gold in 2019, up 8% year over year due largely to the plant processing higher grade ore. For the year, the mine was the highest producer for Kinross behind Paracatu. (Photo: Kinross)

6. Newcrest Mining (2.3M oz)

Newcrest Mining reported profits of $561 million for fiscal year 2019, which for the Australian company ended at the close of June 2019. It reported a net debt of $395 million, down 62% yoy. The company reported it paid out a small dividend on the fiscal year.

In the calendar year 2019 (ending December 31), Newcrest produced roughly 2.3 million oz of gold, down 3% yoy, down 2% from the average from the previous five years, and down slightly from the average for the previous 10 years.

Newcrest reported an AISC of $804/oz for the calendar year 2019, up 3% yoy, and up slightly over the average for the previous five years. It ranked second in the group for lowest AISC.

In the calendar year 2019, Newcrest mined about 8% more ore yoy and about 29% more ore than it mined on average annually during the preceding five years. It processed about 5% less ore yoy, and about 8% less ore than it processed on average annually for the preceding five years.

For fiscal year 2019, Cadia produced almost 1 million oz of gold at "a record low AISC of $132/oz," the company reported. Lihir managed to hit a sustainable mill throughput rate of 15 million mt per year (mt/y) per year. "Telfer increased its gold production and improved its AISC" yoy.

In March 2019, Newcrest acquired a 70% interest in Red Chris mine in Canada. The transaction closed in August. In Q1, the company "entered a farm-in agreement with Greatland Gold for the Havieron tenement" near Telfer. Havieron could develop into an underground mine.

Newcrest logged capital expenditures of $531 million for fiscal year 2019, down roughly 2% yoy. It projects logging capital expenditures for fiscal year 2020 of as much as $780 million. The company reported it expects to produce in the range of 2.4 million oz gold in 2020 at an AISC in the range of $1,800/oz.

Newcrest reported that as of the end of 2018, the company had gold reserves of roughly 54 million oz.

7. Gold Fields (2.2M oz)

Gold Fields reported headline earnings of roughly $160 million, which translates to $0.20 per share. It reported a net debt of roughly $1.3 billion, down roughly $350 million yoy.

The miner produced 2.2 million oz in 2019, up 8% yoy, up 2% over the average for the previous five years, and yet down 7% from the average for the previous 10 years.

For 2019 for lowest AISC, Gold Fields ranks highly. It reported an AISC of $897/oz, down roughly 9% yoy, and down 10% from the average for the preceding five years.

The company processed about the same amount of ore yoy.

In 2019, the Gruyere project was completed, with commercial production achieved at the end of September. The environmental impact assessment for Salares Norte was approved in December, and the board received the feasibility study in February 2020. The company's Ghana mines produced 840,000 oz in 2019. The Australian operations almost produced 1 million oz. The company reported a fatality at South Deep in H1 2019.

Gold Fields reported that in 2019, capital expenditures decreased by roughly 25% yoy to $613 million. It reported it expects capital expenditures in 2020 to be roughly $630 million. About $400 million of that will be sustaining capital expenditures. The lion's share ($111 million) of growth capital expenditures will go to Salares Norte in 2020.

Gold Fields reported it expects to produce close to 2.3 million oz in 2020 at an AISC of roughly $930/oz.

The company reported that at the close of 2019, it had 50.2 million oz of gold equivalent reserves.

8. Agnico Eagle (1.8M oz)

Agnico Eagle Mines reported a net income for 2019 of $473 million. The company paid out a Q4 cash dividend of $0.20 per common share in March. "Agnico Eagle has now declared a cash dividend every year since 1983," the company reported. It had total liabilities of $3.7 billion, up more than $300 million yoy.

The miner produced 1.8 million oz of gold in 2019, up 10% yoy, up 10% over the average for the preceding five years, and up 10% over the average for the preceding decade.

For lowest AISC, the company ranked in the middle of the pack in 2019.

It logged an AISC of $938/oz, an increase of 7% yoy, and an increase of 10% over the average for the preceding five years.

The miner processed slightly less ore yoy, but processed 16% more ore than it processed on average annually during the preceding five years.

In 2019, the company gained approval for the Meliadine Phase 2 expansion. And it advanced the Amaruq underground project. LaRonde produced 403,000 oz. Meliadine produced 238,000 oz.

Total capital expenditures were $824 million in 2019, down roughly 18% yoy. Of that, roughly $314 million went to sustaining capital expenditures. The company reported it expects total capital expenditures of $740 million in 2020, of which $382 million will go to growth projects. The company plans to spend roughly $130 million on exploration.

Gold production is projected to be 1.9 million oz in 2020 at an AISC in the $1,000/oz range.

The company reported that at the close of 2019, it had reserves of 21.6 million oz.

9. Harmony Gold (1.4M oz)

For fiscal year 2019, South Africa's Harmony Gold reported a net loss of roughly $150 million. It paid no dividend. It reduced net debt by $8 million yoy to $348 million.

For calendar year 2019, the miner produced 1.4 million oz of gold in 2019, down about 3% yoy, but up 18% over the average for the preceding five years, and up 11% over the average for the preceding 10 years.

For calendar year 2019, Harmony Gold reported one of the highest AISC/oz of the group, at $1,271, up slightly yoy, but up 8% over the average for the preceding five years.

For calendar year 2019, the company processed about the same amount of ore that it processed in calendar year 2018, but it processed almost 30% more ore than it did on average annually for the preceding five years.

For fiscal year 2019, the company reported a 17% increase in production at its Moab Khotson and Hidden Vally operations. That would be record production at the former. At Tshepong, gold production fell by 15% yoy, due to "a lack of flexibility, a result of the decline in the availability of stoping panels to mine. Production also decreased at Joel mine and Target 1 mine. At the latter "a capital efficiency project to move the ore and rock crusher, associated mining activities and services closer to the working areas, is under way to improve the overall efficiency and productivity of the mining circuit."

Harmony reported it achieved "a 2% increase in underground grade mined."

In 2019, Agnico Eagle gained approval for the Meliadine Phase 2 expansion in Nunavut, Canada. Above, the Meliadine Mill. (Photo: Agnico Eagle)

For fiscal year 2019, the miner reported capital expenditures of roughly $300 million.

The miner expects capital expenditures of $334 million for fiscal year 2020. It anticipates producing in the range of 1.46 million oz at an AISC in the range of $1,000/oz.

The company reported that as of the end of June 2019, its "attributable gold equivalent mineral reserves were estimated at 36.5 million oz.

10. Sibanye Stillwater (930,000 oz)

For H2 2019, Sibanye Stillwater reported headline earnings of $19.3 million. For the calendar year, it reported a loss of roughly $70 million. For H2 2019, gross debt was $1.9 billion, up 12% over H2 2018. For the year, the company reported earnings per share of $0.02.

In 2019, Sibanye Stillwater produced just under 1 million oz of gold. Production was down 20% yoy, down a whopping 35% from the average for the preceding five years. (Technically not a pure play gold miner, it produced almost 600,000 oz platinum.)

The company had the highest AISC of the group, at $1,544/oz, up 41% over the average for the previous five years. Such reflects the impact of a five-month strike and "reduced production volumes."

Meanwhile, in 2019, the company processed more than 50% more gold ore yoy. It basically doubled the amount of ore it processed on average annually for the previous decade.

The company reported that a solid operational recovery in H2 upped production numbers for the year after disruptions in H1. The big one was the strike, initiated by the union, started in November 2018, and resolved in April 2019. It was settled in the company's favor, Sibanye Stillwater reported. "While the financial impact of the union strike was significant, we have consistently maintained that absorbing the strike impact was necessary for us to re-establish respectful and more cooperative relations with the union."

It reported that its gold operations returned to profitability in H2 2019.

The company logged capital expenditures for 2019 of $235 million, including $141 million in growth capital.

Sibanye Stillwater reported it forecasts 2020 capital expenditures to reach

For the sixth year in a row, Polyus posts the lowest AISC. Newcrest is runner-up for the second year in a row.

In a league of their own: Newmont and Barrick stand well above the rest for total gold output. Less than half the group produced more gold in 2019 than their averages for the previous decade.

as much as $230 million, with $16 million going to growth capital. It expects gold production to hit close to 1 million oz, with an AISC in the $1,400/oz range.

The company reported that as of December 31, 2019, it had gold reserves of 15.4 million oz.

2020 Guidance

Newmont lists the top four factors influencing gold price as gold sales or purchases by central banks, their monetary policies, dollar strength and speculation.

Based on Newmont's statements alone, it appears the conditions are right for a sustained rally in gold prices. As of press time, the U.S. Federal Reserve had dropped its key rates to zero in hopes of juicing liquidity across the economy.

Meanwhile, the U.S. federal government passed massive bailouts.

These inflationary responses should provide buoyancy for gold prices. Should is the key term. To make matters worse, a glut of oil has wreaked additional havoc on the market.

Yet, while the prospects for gold prices seem good, the prospects of a relatively stable and steady upward rise in prices is decidedly not, due to speculation in futures, mainly by the major financial houses historically in league with the Federal Reserve. History proves those financial houses, in a stocks crash, will quash gold prices via the futures markets. History shows they do it well.

For example, in September 2019, three traders from the precious metals desks at two major global financial houses were charged with, among other things, racketeering, after they spoofed futures markets to prompt what were effectively bear raids on precious metals during the stock meltdown of the Global Financial Crisis. The Department of Justice (DOJ) described their activities as a coordinated market manipulation scheme that launched in May 2008.[2]

"The defendants engaged in widespread spoofing, market manipulation and fraud while working on the precious metals desk at (JPMorgan and another major global bank) through the placement of orders they intended to cancel before execution in an effort to create liquidity and drive prices," DOJ reported.

"In thousands of sequences, the defendants and their co-conspirators allegedly placed deceptive orders for gold, silver, platinum and palladium futures contracts traded on the New York Mercantile Exchange Inc. and Commodity Exchange Inc., which are commodities exchanges operated by CME Group Inc," DOJ stated. "By placing Deceptive Orders, the defendants and their co-conspirators allegedly intended to inject false and misleading information about the genuine supply and demand for precious metals futures contracts into the markets, and to deceive other participants in those markets into believing something untrue, namely that the visible order book accurately reflected market-based forces of supply and demand."

According to the DOJ, they did it as an "enterprise," thus the racketeering charge. This is to say it was a coordinated "scheme," a "widespread" conspiracy, run by high-level people at a couple of the biggest banks in the world. It worked to "trick other market participants" en masse into "buying and selling precious metals futures contracts at quantities, prices and times that they otherwise likely would not have traded."

In short, during the severe economic crunch, the big banks rigged the gold market. They did it for years. And when the law finally showed up, only three people had to fall on their swords.

This gig can easily be replicated today to rig not only the precious metals markets, but to fuel dead cat bounces in stocks, and to prop up the dollar (Federal Reserve Note). The latter two historically have an inverse relationship to gold.

Therefore, while a cratering global economy typically would boost gold prices, the template exists for major market rigging. However, as central banks turn to negative interest rates and bailouts, and as governments hand out fiat currency to pacify increasingly distraught populations, the long game may inevitably be a dollar (Federal Reserve Note) crash, followed by an attempt to return to some form of gold standard.

It should be noted that before the recent markets chaos caused by an oil glut and COVID-19, with prices having risen for four straight years, only half the group forecast 2020 TGO above their average for the preceding 10 years. It may be that no matter what gold prices do, some of the biggest pure-play gold miners in the world are simply incapable of seizing the opportunity and seriously boosting production.

[2] See *Current and Former Precious Metals Traders Charged with Multi-Year Market Manipulation Racketeering Conspiracy*, by the United States Department of Justice, at www.justice.gov/opa/pr/current-and-former-precious-metals-traders-charged-multi-year-market-manipulation.

The Raiseboring Revolution

Equipment and services for raiseboring are in high demand and R&D is booming

By Carly Leonida, European Editor

The Rhino 100, primed and ready for action.

Raiseboring contractors and equipment vendors have plenty to talk about at present. The market for new rigs, rebuilds and add-on features is looking extremely healthy and, despite the cloud of uncertainty that is COVID-19 hovering on the horizon, services are in demand aided by elevated gold prices.

One of the biggest developments over the past year has been the launch of TRB-Raise Borers' Plug'n'Drill module for the Rhino 100 rig, which allows operators to switch between up and down drilling in less than 30 minutes with optimized performance in both directions. A number of companies are also developing remote operation modules, and digital control systems that allow data collection while drilling are becoming more and more popular.

In a part of the mining sector that has stuck steadfastly to traditional equipment and techniques with some manufacturers resisting digitizing their rigs (for good reason, conditions in raiseboring are extremely demanding), these developments represent an important step toward increased speed and safety.

New(ish) Kid on the Block

The Rhino 100, which is often attributed to Sandvik, was in fact was developed by the team at TRB-Raise Borers. The two companies share the same Tamrock history and, when Sandvik took over Tamrock in 1992, it retained a minority share in TRB.

"Ever since those days, Sandvik has been our distributor and relationship has continued to be very close. Sandvik makes the tools, we build the rigs," CEO Jarko Salo said.

"We are a relatively small, but very flexible company offering different services to the mining industry when compared to standard players. We customize and want to offer unique solutions. And, this is where the Rhino 100's origins are. We listen to our the customers very carefully, meaning, historically, we have not been 'everybody's supplier,' but the situation has changed in a big way during the last couple of years without any formal marketing effort. The rig and the results have really done the marketing for us."

TRB offers a range of Rhino raise boring products from small to large diameter raise drilling. The prototype Rhino 100 was launched 2012 at Outokumpu's Kemi mine in Finland, before heading to neighbor, Agnico Eagle's Kittilä mine 2014.

"Kittilä and their mine design really took full advantage of the capabilities and we received tons of inquiries based on their results," Salo said. "And, now the mining operation revolves around two Rhino 100s. They have really turned their operation around with this new method."

The next few years were spent interviewing customers at mines around the world and, after incorporating these views into the latest Rhino 100 design, TRB launched Gen3 in early 2017. The rig has been further developed over the past 12 months with the addition of a Plug'n'Drill module — the current cause of excitement within the industry. This allows one rig to be used for both upward slot drilling and back reaming with changeover in 30 minutes.

"Plug'n'Drill was originally deemed a crazy idea, but our original Rhino 100 concept is versatile and sophisticated enough to allow it," Salo said. "Certainly, there are other rigs, which can drill both directions, but customers were not that happy with them. Previously down-drilling rigs had difficulty handling the falling muck if drilling up … Similarly, up-drilling rigs had trouble drilling down because the rig was designed for something else. Gravity plays a role in drilling operations and how the output is handled. Some rigs can be turned around and equipped for the alternative drilling direction. However, the results were not optimal, and it required a lot of manpower, time and space… hardly a solution for production drilling."

With Plug'n'Drill, a single operator can switch the drill direction quickly (while underground), with little effort and the drilling module is optimized for the job:

Sandvik Launches DU412i With V-30 for Slot Raising

Sandvik has launched its first automation ready underground ITH longhole drill for production drilling, service support and mechanized slot raising. The DU412i offers mechanized pipe handling in V-30 slot raising applications and is fitted with an onboard booster and a drilling module for fan or parallel 90-216 mm longhole drilling, using 3- to 8-in. ITH hammers. Equipped with the V-30 head, the drill provides mechanized reaming of 30-in. slot raises.

Sandvik says the DU412i's automation packages allows for repeat drilling cycles with speed and precision. Unmanned drilling through breaks and shift changes increases fleet utilization; one operator can supervise multiple units, improving product safety and productivity.

Teleremote drilling operation on the DU412i improves productivity and safety. Radio-remote tramming gives the operator visibility to safely tram the unit between fans and set it up very precisely without being in the operation area. The tramming is possible on either diesel power or using the electric power pack.

In the V-30 slot raising configuration, the unit is delivered with blind bore feed and split centralizer, spaced out RH6250 rotation head and PC225 carousel. The storing capacity of the carousel allows up to 40 m of continuous drilling and slot raising. The unit is fitted with KSU34 onboard booster (34 m^3/min at 28 bar) and single-hole automation for 6½" pilot hole drilling and for reaming the pilot to 10" can be utilized. Pipe handling during reaming the raise to 30" with the V-30 head is mechanized.

The layout of the carrier allows ground access to all service points, while swing-out frames offer ease of access to other components and safety in service.

up drilling, down drilling or conventional raiseboring. Salo said the rig offers at least three times the capacity of other rigs in its class and some customers have seen productivity gains of 30% or more.

"We call it world's fastest raise borer," he said. "One mine claims the Rhino 100 contributed $6 million to its bottom line in one year. The rig resulted in 5.5% better recovery at its gold mining operation."

There are a number of reasons why both drilling directions may be required at a project: first, flexibility in the mine design; it is sometimes beneficial to be able to drill slots both upward and downward, and occasionally mine designs are changed partway through an operation's life. Slots provide void spaces in the stope into which blasted ore can expand to improve fragmentation.

"Also, sometimes slot raising is done only upward. In such a mine, they may require escapeways and these are typically drilled down," Salo explained.

The benefit of the Rhino 100 concept is that, instead of bringing multiple rigs/contractors on site, one rig can perform all tasks with the addition of one extra drilling module. It is much cheaper than the alternative making it especially attractive for remote sites.

"Demand has been strong globally, but more so in Australia. The Rhino 100 has taken the mining market by storm," said Salo proudly. "Australian mines have seen the benefits of the new concept in slot raising and insist on using it in their production drilling due to the benefits. Single rig, single operator can dramatically cut the turnaround time and bring stopes online faster than ever before. Profits have soared."

Barminco was the first contractor to boast a Rhino 100 with the Plug'n'Drill module. The company put the new module to work in the goldfields of Western Australia, namely at AngloGold's Sunrise Dam mine, and was reportedly so pleased with the performance it ordered a second.

Byrnecut Australia will soon introduce its fourth and fifth Rhino 100. The first three are in service at various mines across Australia including Saracen's Carosue Dam operation near Kalgoorlie and Northern Star's Jundee gold mine.

General Manager Mark Hanigan recently posted a video of the Rhino 100 with the Plug'n'Drill module drilling a 36-m-long hole at Gold Field's Invincible operation on Linkedin, which received more than 11,500 views in just one week.

"The hole was for an escapeway and was drilled to 1.06 m in diameter with the reamer head being pulled through at the collar," he wrote in the post. "Our average advance rate for reaming of the hole was 1.3 m per hour and was completed in three shifts. This new technology is proving to be the way forward for small diameter slots and raiseboring on a truly mobile carrier."

In a press release announcing the project, Hanigan cited speed, safety and

Terratec's Universal Borer at a gold mine in Western Australia.

The Master Drilling team take a moment out on site.

labor savings as three reasons why his team favor the Rhino 100. While it takes a team of two people between two and three days to prepare a traditional raise borer for duty, a single operator can tram the Rhino into the mine and be drilling within a matter of minutes.

When operating traditional raise borers, the operator is generally stood in the open less than 5 m from the hole being drilled and must drill deep into the rock before erecting a muck chute.

"With the Rhino 100, the muck chute opens and closes," Hanigan said. "You open it up, push through the rod, and when you're ready to start drilling, you can close the chute up. It covers the hole, stopping the dirt cuttings flying out and hitting the operator. The Rhino 100 also removes the exposure of the operator to the risk of flying debris as you're 6-7 m away from the work area and operate from within a cab."

LKAB Sweden has also recently commissioned a Rhino 100 at its Kiruna mine and is set to trial the new Rhino Remote control module once disruption caused by the COVID-19 virus has died down. According to Salo, this is one of the first commercially available teleremote raiseboring systems. It removes the operator from the production drift, improving safety significantly. The Rhino Smart control system, which also features on the Rhino 100, allows measuring-while-drilling data collection for detailed performance benchmarking, all of which should add up to optimized operation.

"I expect they [LKAB] will break all raiseboring records and will regularly be drilling more than 500 m per month," Salo said. "I believe this will be a significant milestone in raiseboring history."

Delving Deeper

Every contractor interviewed for the article noted an increase in the depth of rais-

es they are being asked to drill over the past few years.

"Shallow, high-grade deposits are becoming scarcer each year, and the industry is responding," said Johan Davel, general manager for Raiseboring at Redpath. "Mining operations are progressing deeper, increasing the demand for ventilation raises, rock passes, escapeways and a variety of vertical development."

Redpath provides in-house manufacturing alongside contracting services for its raise drill fleet. The company's full suite of drills, from the Redbore 30 to the Redbore 100, offer the ability to excavate raises up to 8 m in diameter with depths greater than 1,000 m. Redpath is also a key player in the boxhole/upream market, with numerous purpose-built machines operating in world-class mines, globally.

"As block caving becomes a more predominant mining method, mine operators are turning to Redpath for its boxhole capabilities. Raiseboring is replacing traditional excavation methods, with numerous companies and countries moving away from traditional drill and blast alternatives for their vertical development needs," he added.

"A number of our clients are mining gold, alongside other precious metals such as copper, nickel and zinc. This diversification allows a steady flow of interest from clients, whether the economy is struggling or flourishing. With current market conditions, clients' gold-mining operations are enjoying high demand for their goods, and that demand often translates into interest for raiseboring services."

Davel noted that, at present, global demand for raiseboring services is high, so these projects are actively engaging the majority of Redpath's fleet and workforce.

"The challenge is in managing demand and asset allocation to be able to suit all our clients' needs," he said. "In addition, the global COVID-19 pandemic is certainly a risk to our business that was not predicted at the beginning of the year. Redpath, and also our clients, are not immune to the risk it poses to the economy and our industry specifically."

Redpath has embraced digital technologies to create high-tech performance and safety features, especially over the past five years. The company has deployed a variety of digital monitoring and automation technologies globally, with usage for these technologies increasing rapidly each month.

"Newly developed safety innovations including intelligent machine behavior, which is allowing raisebore operators to mitigate the impact of adverse in-hole conditions. Redpath has had semiautomatic and remote capability for more than 20 years, and these new advancements will only further this technology as we move forward. Technologically advanced sensor arrays, which relay and record the current status of the machine are an integrated component of the Redbore drills," Davel said.

Redpath currently is readying itself for two major Canadian projects, both of which will result in records within North America: one project will feature two raises, both exceeding 1,000 m in length —

far exceeding the current record of 845 m set by Redpath in 2010 — while the second project consists of a single raise with record-setting excavation volume.

"We are proud and excited to collaborate with our clients, and look forward to safely executing these projects," Davel enthused.

South Africa-based, Master Drilling, is seeing similar demand.

"The main requirement for raiseboring is still for ventilation," Izak Bredenkamp, group business development manager at Master Drilling, told *E&MJ*. "As mines get deeper, the demand will increase for raisebored holes. Our key markets are deep-level underground mines. In the RSA context, this is mainly for gold and PGM mines."

Master Drilling now has 152 raiseboring machines in its quiver, ranging from small to XXL in size for hole diameters of 250 mm up to 8 m.

"In the last five years, we've reamed around 500,000 m over various diameters," Bredenkamp said. "We are currently busy with a world-record hole of 1,420 m deep at 4.6-m diameter that has to be directionally drilled. We have completed more than 65% of the pilot hole for this project."

The company also has some new projects under way in West Africa, mainly Ghana, for AngloGold Ashanti and Newmont.

Technological innovation and development remain a key pillar of Master Drilling's focus and a significant business differentiator. The company recently introduced a Remote Drilling feature for its rigs. The first unit was successfully commissioned 3 km underground at the world's deepest mine: AngloGold Ashanti's Mponeng. Remote drilling enables operation of an automated drill rig from a remote location and, at Mponeng, the rig was successfully operated from the contractor's site office on the surface.

The Remote Drilling system is a proprietary "plug and play" control and display module that connects to the drill rig's local control module through the mine's underground and shaft communication network. Master Drilling said by removing all personnel from the underground environment, this self-driven mechanism has improved production time and confirms that autonomous drilling technology is at the core of safer mining operations.

Having completed testing, the Remote Drilling module has since been rolled out to sites in Mexico and Peru as well.

Focus on Efficiency

"In our experience the most important thing in raiseboring is efficiency," said Bruce Matheson, sales and marketing director, Terratec. "There is a tendency in the industry to go larger, but this leads to inefficiencies as larger raises needs larger machines, which are difficult to move around. We are trying to see how we can increase the size or length of the raise without increasing the physical footprint of the machines, such as with our TR2000+, which has increased capacity over the 2000 model without an increase in the footprint."

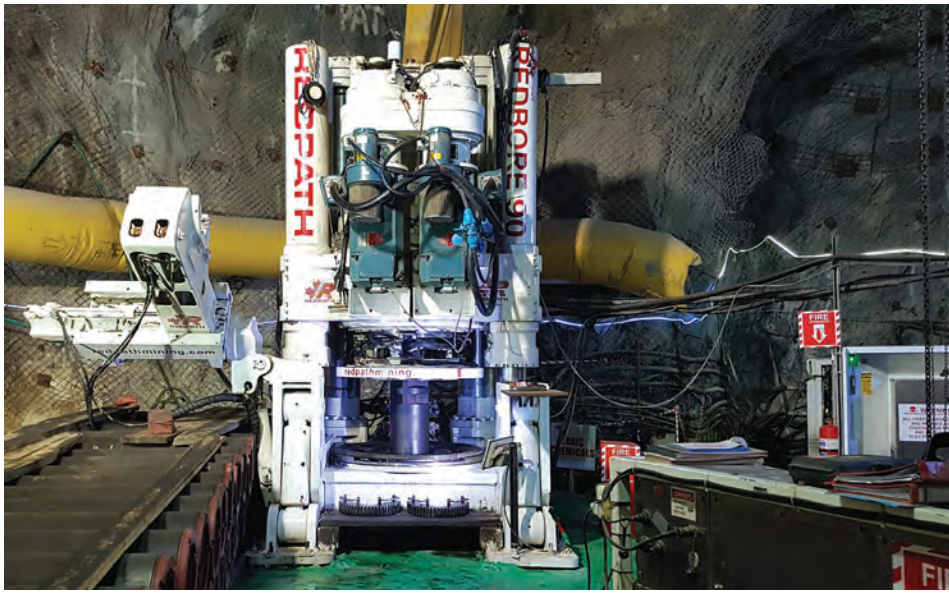
Terratec offers a full range of products from box hole, through down-reaming machines to traditional raise borers. It also has a multipurpose machine known as the Universal Borer that can perform all of these duties and be quickly re-tasked underground.

"The continued upswing in gold certainly has not hurt us," Matheson said. "In late 2019, Terratec celebrated the completion of a 300-m deep, 4.1-m diameter, ventilation shaft at Continental Gold's flagship Buriticá mine development project in Colombia.

Peruvian mining contractor INCIMMET deployed a custom-built TR2000+ raise boring machine to excavate the shaft in challenging ground conditions, which consist largely of andesite-porphyry, diorites and monzodiorites with intrusive hydrothermal gaps within the volcanic and sedimentary sequences.

Terratec said the mixed and fractured conditions provided a challenge both to the integrity of the reamer and the capability of this robust machine.

"Not all raiseboring equipment is capable of working with such robustness in these conditions," Terratec Regional Raise Boring Operations Manager John Alejos commented on announcing the milestone. "Without doubt, this changing terrain is almost impossible to drill at such depths and such diameters. Only a team as strong as this, with the technical support of our on-site staff, is able to carry out such a task successfully and not without difficulties."



Redpath's Raisebore 90. Raiseboring projects are currently engaging the majority of the company's fleet and workforce.

The TR2000+ was custom manufactured at Terratec's workshop in Tasmania, Australia. It can comfortably execute raises of up to 500 m at 2.4 m diameter and larger ones up to 4.1 m diameter (of shorter depths). It has a maximum pilot drilling torque of 42,000 Nm, a reaming torque of up to 209,000 Nm and breakout to 236,000 Nm. The maximum down

thrust force is 665 kN with up thrust being 4,150 kN. The total installed power on the machine is 360 kW.

Terratec has erred on the side of caution when it comes to digitizing its rigs. As Matheson put it: "contractors need reliable rigs that can 'take a lickin and keep on tickin," so systems have been kept as simple as possible to allow quick repairs and easy sourcing of parts — features that are particularly appreciated at remote sites and in production drilling when time is of the essence.

A good example of this durability comes from the UB1000-R16 Universal Box-Hole Borer. The unit was delivered to a mining contractor for use in the Western Australian Gold Fields in 2014. The unit was specifically developed to meet industry requests for a 1.06-m-diameter box hole boring machine that would meet all Australian mine safety standards, plus be low profile, and could also be quickly switched to operate as a conventional raise borer, capable of pulling up to 3-m-diameter holes.

The UB1000-R16 went into service in late 2014, working in a narrow-vein gold mine, and was used to produce box-holed stope slots and escape ways, along with some larger, conventionally raise bored, ventilation shafts.

A number of improvements were made to the machine in 2015, and it went on to operate almost continuously for more than two years, with no major downtime or repair interventions. In late 2017, the machine was taken out of the mine for some derrick maintenance work, plus a gearbox rebuild. Even though the gear box was well past its recommended hours between services, it was found to be in excellent condition.

Recent discussions between Terratec personnel and mine managers where the rig is operating indicate a high degree of satisfaction with the machine's capabilities.

"They highlighted its ruggedness, reliability and especially its flexibility. They are particularly happy to have a single machine on site that can perform box holes and medium-sized conventional holes, rather than having to maintain and schedule two different machines," Matheson added. "Also, the ability to switch from box-hole to conventional mode very quickly gives the mine managers more flexibility to change their sequencing of holes later in the production schedule."

Safety is Paramount

Safety is paramount to any mining project, and this is an area in which Epiroc has been particularly focusing its efforts.

"Safety is always high up on our customers' agenda and is Epiroc's number one priority," said Marcus Eklind, global business line manager, mechanical rock excavation, with Epiroc's Underground Division.

"Safety concerns both the operators, the service personnel but also relates to the application. The raise needs to be completed in a way that is safe for the people involved but also for the expensive equipment used to do the raise. This pushes us to develop equipment that is soft on the drill string and the tools, yet productive, equipment that is safe to service and that can be monitored so that problems can be detected before they become catastrophic."

Epiroc's range of equipment includes models for both conventional raiseboring, boxhole boring as well as down reaming and covers diameters from 0.5 m up to more than 6 m.

"We also offer the complete range of drilling tools such as drill-string compo-

nents, reamers and cutters; we are a one-stop-shop serving raiseboring customers around the world," Eklind added.

Epiroc recently released a new generation of its popular 90 series Robbins 92R. This is designed for power, flexibility and safety.

"With Epiroc's latest available technology added to our raiseboring machine, we have prepared the rig for autonomous and remote operation," Eklind said. "This model is now suitable for raises over 1,000 m long and diameters over 6 m while having the best size to power ratio of all raiseboring machines. With regard to tools, there is a continuous development to reduce downtime by reducing the need for lowering reamers for cutter change. This also greatly increases operator safety, since cutter changes are typically the only time operators are exposed to the open raise. Tracking product performance is made easier by having RFID tags installed in pipes and cutters. There is also the possibility to further develop live monitoring of the rock engaging products if the users value this kind of feedback."

Epiroc introduced its CAN-bus control system on the Robbins Raiseboring machines back in the early 2000s and it recently introduced the fifth generation (RCS 5) on its raiseboring machines.

"This has been a revolution for operators with a number of auto- and semi-automatic functions making it possible to accurately control the machine and the operation, thus increasing productivity without jeopardizing accuracy," Eklind explained. "In recent years, telematics solutions such as Epiroc's telematics system Certiq allow customers to remotely track and monitor the equipment. Other equipment used for the establishment of a raiseboring site, such as surveying tools etc., has of course developed a lot and this also allows for more accurate and precise set up of our equipment."

Epiroc's Easer L mobile raiseboring machine is currently being tested at LKAB's Konsuln mine as part of the Sustainable Underground Mining (SUM) project.

"There are two major trends in raiseboring. Longer and larger with the need for greater accuracy, and relatively short, small diameter raises driven by the need for an opening hole for blasting in large-scale mining methods. In the later one, mobility and setup time is key, and this is where the Easer raiseboring system shines," Eklind explained.

Since conventional raiseboring machines stay around for many years, much of the development work done to meet these trends are on the rock engaging part of the raiseboring system. Epiroc has also been investigating ways to help smaller machines cater to the need for longer, larger raises.

Eklind said to do this, there are just a few parameters to work with, as the amount of torque and thrust that can be transmitted from the machine down through the drill string is given.

"Reducing the number of cutters required to dress a reamer increases the available load per cutter leading to more efficient breaking of the rock, even if the raiseboring system lacks capacity," he explained. "This is where the six-row Magnum cutter comes to the rescue. With its 1-1/2-in. (38 mm) spacing and ability to run single coverage, larger and longer raises are now less stressful for the mine designers and raiseboring operators."

Data and Design Drive OTR Tire Improvements

Mines can take advantage of improved tire monitoring and management systems, along with new tire design features, to plan a course for reduced running costs

By Russell A. Carter, Contributing Editor

Michelin and Komatsu America Corp. recently announce a joint program to provide Michelin's MEMS 4 Earthmover Management System as a factory-installed option on select electric-drive trucks manufactured at the Komatsu facility in Peoria, Illinois. The system is integrated with the truck's electronic display panel at the factory and Michelin coordinates installation of the sensors in the tires at the customer's site.

Mine tires are designed to fight constant skirmishes with rock, ruts and berms on haul roads, pit floors and dumps, but it's never a fair contest: Rock has no rules, while the giant OTR tires used on trucks, loaders and other mobile equipment must obey the laws of chemistry, physics and economics. Rock always wins, eventually, but improved tire compounds and designs, advanced tire management strategies and operator training can significantly prolong the battle.

Tires are customarily high on the list of mine operating expenses, and optimizing the useful life of consumable items that can cost anywhere from $40K to $60K each is essential for budget control, even when supply isn't an issue. OTR market surveys published throughout 2019 indicated that giant-tire supply and demand levels have settled into a balanced state largely devoid of significant regional or product shortages, but it remains to be seen what effect the COVID-19 pandemic will have on future supply, as Bridgestone, Goodyear, Yokohama — and possibly other major OTR suppliers after this issue goes to press — announced production shutdowns to ensure worker safety.

What isn't uncertain, however, is that OTR builders have been exploring new production arrangements, innovative use of non-traditional materials in tire fabrication and expanded tire management concepts. They're increasingly moving areas of their raw materials supply in-house. For example, India's Balkrishna Industries Ltd. (BKT) is ramping up production at a new carbon black plant located at its Bhuj production facility and expects to use half the plant's output for its own tire production needs and sell the rest on the open market. Both BKT and Continental Tire are exploring the use of natural rubber obtained from a specific Russian dandelion species that can grow in nontropical environments, offering the possibility that manufacturers could obtain their rubber supply from nearby locations, eliminating the high costs of raising and transporting the material from distant regions and smoothing out supply variations.

And recently, U.S.-based Cabot Corp., a global specialty chemicals producer, launched its Engineered Elastomer Composites (E2C) solutions including the first E2C product, DX9730, part of a new Durability series. Using proprietary technology for mixing reinforcing agents into elastomers, E2C solutions are premixed composite solutions designed to help tire manufacturers unlock superior performance sustainably and economically. The company said its E2C solutions have been shown to break critical trade-offs in OTR earthmover tire design by both lowering operating temperatures and extending tire life, enabling an average mine to increase haulage capacity, boost output, and reduce annual downtime for tire changes leading to a potential benefit up to $150 million per year, and noted that E2C solutions can be formulated for specific OTR/earthmover applications to deliver maximum performance benefit.

Cabot said E2C solutions can be integrated into current production methods without additional capital investment. They also require fewer mixing stages, lower mixing temperatures and shorter mixing cycles than conventional products, thus reducing operating costs and enabling additional production capacity. Cabot also previously reported that it intends to spend about $120 million on two new carbon black plants in Indonesia by 2021.

Tires, Telling All

Tire manufacturers serving the giant OTR market have traditionally banked largely on physical improvements to their products to meet the rising demands of mining customers, and tread design, stronger internal fabrics and cord materials, and refined fabrication methods will continue to be important factors in boosting tire perform-

Cabot Corp.'s first E²C elastomer composite, DX9730, is part of a new series of products designed to offer improvements in cut, chip and chunk resistance, and reduce the risk of catastrophic tire failures and unplanned vehicle downtime.

ance, but as the industry moves toward its connected-site goals these silent, massive objects will be expected to become much more talkative — letting equipment operators, maintenance teams and operations personnel know, preferably in real- or near-real time, what's happening on the ground and inside the carcass.

The concept of a more-intelligent tire has been gathering traction over the past several years as major suppliers introduced and refined their embedded Tire Pressure Monitoring Systems (TPMS) while keeping an eye on additional developments in Industrial Internet of Things (IIot) technologies to incorporate big-data class predictive-analytics capabilities into their product and service lines. OEM tire manufacturers and large mine-tire service companies are folding these capabilities into comprehensive tire management packages structured to shift customer focus from a "tires as a commodity" approach to a "tires as a service" concept.

Recognizing that rapidly evolving sensor and data collection technologies can be implemented to satisfy customer preferences for increased integration between tires, the vehicle they're mounted on, and supplier service and consultation options, OTR vendors are expanding the availability and scope of their systems. For example, late last year, Michelin and Komatsu America Corp. announced a joint program to offer the Michelin MEMS 4 Earthmover Management System as a factory-installed option on select electric-drive trucks manufactured at the Komatsu facility in Peoria, Illinois. Komatsu's 930E-5 mining truck was the first available model with MEMS4 as an option, with other models following. Komatsu is factory-installing the MEMS4 transceiver, antennas and related harnesses, integrating the system with the current existing electronic display panel. Michelin coordinates installation of the sensors in the tires at the customer's site.

Michelin said the factory-installed system captures real-time tire temperatures, pressures and mapping for proactive fleet management. Using GPS and accelerometers, a sensor installed in the tire sends critical tire-related data to alert operators online, via email or by SMS to laptops, tablets or smartphones. Each truck is geo-localized on a map in real time. A data-capture tool and mobile-device connection transfers information via Ethernet or 3G to cloud storage. Data are reported to dispatchers to provide tire performance and anomalies.

MEMS4 allows users to anticipate downtime and avoid disruptions through detection of critical events, according to Michelin. An inflation monitor compensates tire-pressure limits for ambient temperature. When tire temperatures change, operators can know immediately if there is an alert and change routes. Maintenance operations can be anticipated, and unnecessary stops can be avoided. Michelin also will continue to offer MEMS4 as an aftermarket offering for trucks already in operation.

Goodyear, which has offered its EMTrack tire and rim tracking and reporting system for several years, recently announced the availability of a new version that replaces the existing product, which will not be supported after June 30. Goodyear said it could work with customers to transition their OTR tire performance data to the updated version of EMTrack with no interruption to current tire management capabilities.

In practice, EMTrack works like this: Goodyear tire technicians survey the fleet, capturing tire inflation, tread depth and other critical measurements, as well as photos of each tire's condition. The data are then loaded into a password-protected, cloud-based platform for easy access. The information can then be downloaded into customizable reports. Fleet operators can use Goodyear's EMTrack app to view tire data and reports in real time, as well as tire performance data across their fleets. They can focus on specific tires to calculate cost-per-hour, cost-per-ton and other key metrics. The system, according to the company, minimizes the need for manual tire data entry, allowing the fleet operators to focus on keeping their fleets moving.

Beyond Basic Maintenance

Kal Tire offers a comprehensive tire management system that provides a variety of operational tire performance tracking capabilities including demand forecasting and stock management, equipment productivity and tire service downtime, tread monitoring, tire performance and benchmarking, tire failure analysis and wheel rim tracking. The Canadian company has been steadily expanding and refining this service, called TOMS (Tire Operations and Management System) since its introduction in 2018, and *E&MJ* recently spoke with Mark Goode, Kal Tire director, Business Insights, to get a clearer picture of the service's origin and features.

Goode explained that TOMS was conceived with two main objectives in mind: to help the company establish a baseline of tire maintenance standards and practices by using the data collected through TOMS to help customers improve productivity; and as a vehicle to transition the vast amount of data available through tire monitoring and management activities into actionable value for customers and other stakeholders.

Goode said Kal Tire currently provides tire services at 150 mine sites worldwide and 93 of those sites are using TOMS. The program is available to all Kal Tire mining customers, and the company's intent is to eventually migrate all of those customers to TOMS. It's a gradual procedure, Goode explained. "The process is protracted given the care taken to accurately map historical data to the 'common language' in TOMS, which is critical if we want to be able to benchmark performance."

He said TOMS gathers information via an application programming interface (API) from a customer's dispatch system, including productivity data to track tire performance in hours, distance and tons as well as truck TKPH. The program delivers its output directly and securely to a customer's servers for analytical purposes. If the customer provides permission, it can also send data to tire OEMs.

According to Goode, customers can begin to benefit quickly after incorporating TOMS, in terms of data visibility and the ability to see top level benchmarking comparisons such as tire performance, tire work MTBS and stock cover levels, for example. "The immediate benefit of TOMS' common language is the ability to draw on best practices to benefit all customers.

"This is incorporated into our Service Delivery reporting tools," he explained, and pointed out that "With three years-plus data in the system, we are starting to analyze and look for opportunities to extract value from the wide range of

operational data in TOMS. For example, can we answer questions such as 'What is the optimal number of spare tires required to run a fleet?' Or 'What is the most effective tire rotation strategy to maximize tire performance or to minimize truck downtime'? This work is ongoing. We envisage incorporating the answers as algorithms into TOMS to increase system intelligence."

At present, the company administers TOMS primarily as an integral tool for expanding its customer base as a contract service provider. "TOMS is simply the operational system Kal Tire uses to conduct its service contracts," Goode explained. "During this rollout phase, we are focusing on migrating existing Kal Tire mining customers. At a future stage, we will look at how best to make TOMS available as a potential standalone tool for customers who might today use Kal Tire as their service provider on some but not all of their properties and who might be interested in utilizing the system to manage and benchmark tire service across all their operations."

In the long term, Kal Tire will use and promote TOMS as a maintenance planning tool, Goode said. "The system enables our on-site service operations to be managed the same as any other maintenance function. This is a change management process for our teams as well as for how our customers might typically see tire service providers — moving on from managing and reporting on historical tire performance to the proactive management of wheel components on running equipment. This requires identified and planned tire work to be communicated effectively and fully integrated into maintenance planning cycles so as to maximize the amount of planned tire work with scheduled PMs or other planned maintenance work."

What's New

The most recent OTR model introductions have been construction- and quarry-class sizes, as OEMs unveiled new offerings in this market at the CONEXPO/CONAGG trade show held in February. However, there's been activity in the giant sizes as well: BKT appears to be following its announced roadmap for production of larger-size OTR tires and is planning to launch a new tire model in 2020. Rajiv Poddar, BKT joint managing director, told a tire-industry trade publication in November that the company was moving toward introduction of a 57-in. tire this year after receiving encouraging customer interest in its other earthmover OTR tires.

Maxam Tire expanded its Large Mining series, with three models featuring newly developed compounding and carcass construction. Its MS401, MS402 and MS403 tires are designed for haul trucks up to 320 tons. MAXAM said it offers three specific tread patterns available in multiple compounds based on site TKPH/TMPH to meet different surface mine application requirements. The MS401 features an aggressive tread design with heat-resistant under tread, for applications that require maximum traction and high site TKPH/TMPH. The MS402 features enhanced shoulder lugs and a solid centerline providing increased protection, traction and tread life in haulage applications. The MS403 integrates an advanced

Michelin's new XDR 3 OTR tire allows customers to select a benefit that best fits their needs: they can choose not to increase speed or load and expect a 10% increase in tire life, or to increase speed by 10% or increase load by 10% and achieve the same tire life as the previous generation.

tread design for flexibility in all applications, from smooth haul roads to rough and rocky terrain.

Maxam also noted that Caterpillar had recently validated and approved its 875/65R29 MS405 L4 tire for use on specific Cat 982M medium wheel loaders. The company said its MS405 "65 Series program" is engineered for high-torque harsh applications where extreme traction is required. Main features include a cut-resistant tread compound and deep undertread, and a design specifically intended to minimize vibration at haul speeds.

Last year, Michelin North America introduced the XDR 3 surface-mine haul tire in size 27.00R49, replacing its XDR 2 predecessor. The XDR 3 is intended for a range of rigid dump trucks with payload capacity up to 400 tons and features new compounds and a tread pattern that helps provide exceptional tire life. The use of corrosion-isolating cables in the tire architecture represents a significant upgrade as well, noted the company.

Michelin said these innovations allow customers to select the benefit that best fits their needs. Customers can choose not to increase speed or load and expect a 10% increase in tire life or to increase speed by 10% or increase load by 10% and achieve the same tire life as the previous generation. Michelin said the XDR3 is MEMS-ready and helps reduce rim slip through a new flat bead wire that strengthens the clamping force on the wheel and increases its contact surface with the rim.

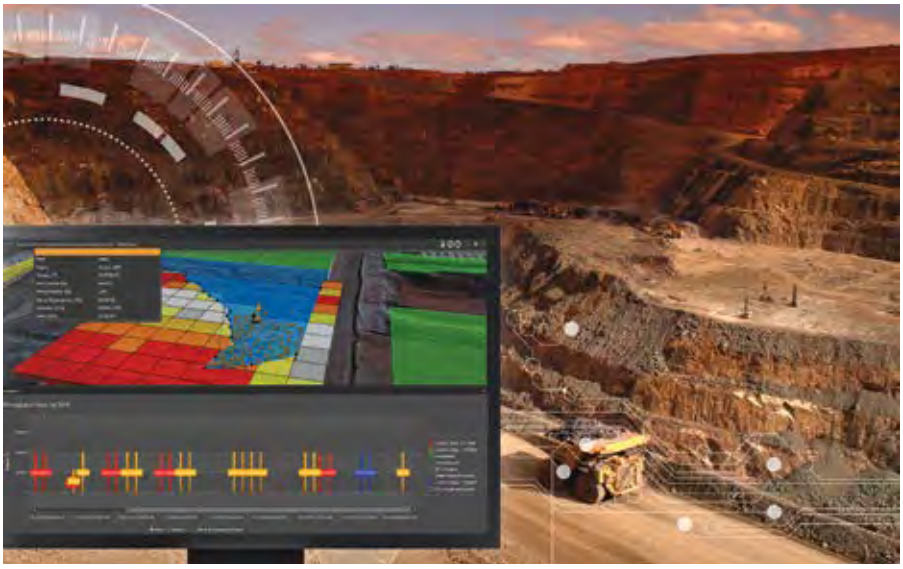
Other entries in the smaller size ranges include a bias-ply model from General Tire, a brand of Continental. The company's new TE188 is a multipurpose earthmoving tire for use on ADTs, RDTs, loaders and scrapers. General said its bi-directional pattern with massive bars provides gripping edges on soft and wet ground and the wide ground patch leads to even wear, good surface interaction and a long service life. It comes in one E3 size (16.00-25) and seven E3/L3 sizes (ranging from 20.5-25 to 37.25-35).

Dutch supplier Magna Tires extended its M-Terrain line-up, introducing the 20.5R25, a steel radial tire engineered for use on wheel loaders and ADTs. The tires have a non-directional E4 tread, which the company claims substantially enhances performance and traction, and as with other models in the M-Terrain range, heat buildup is significantly reduced by state-of-the-art casing construction.

Planning for Uncertainty

How technology is helping to optimize mine planning and add flexibility over the life of mine

By Carly Leonida, European Editor



In November 2019, RPMGlobal unveils several upgrades for its XECUTE short-term scheduling solution to help expand planning across the mine value chain. (Photo: RPMGlobal)

The main challenges faced in mine planning remain relatively unchanged from those of 20-30 years ago. The question still stands: how can we produce more metal from assets in a way that maximizes operational and financial efficiency over both the short and long term?

During this time, the tools available to mine planners have reached new levels of capability in terms of computing power and speed and, as one would expect, the accuracy of plans has improved accordingly. However, at the same time, the level of uncertainty that mining operations face at every stage of their lives has also risen; from exploiting increasingly lower grade, more complex mineral deposits, to rapidly changing operational environments, rising production costs, and unstable markets that face numerous challenges including, most recently, a pandemic-induced recession.

"Turbulence in the market in terms of revenues and ever-increasing operating costs creates lots of instability. It is difficult to make decisions about key items in mine planning and design, such as the size of ultimate pit and scale of operation," said Anoush Ebrahimi, principal mining engineer at SRK's office in Vancouver, Canada. "In our view, the biggest challenge is to plan for flexibility. Challenges could range from increased difficulty raising capital, to increased scrutiny on environmental and social impacts leading to changes in designs.

"Although modern mine planning tools allow planners to analyze more data, they must be able to focus in on practical solutions at all levels of the mine planning process and provide input on which plan is most effective."

To accomplish this, SRK relies heavily on practical experience in combination with high-level economic analysis to ensure that all necessary factors are taken into account.

"High-level economic analyses are included at every stage of project to provide guidance on how design changes affect the operation. By doing this, we help to lower risks and enable our clients make strategic decisions on time," Ebrahimi added.

It is worth noting that the fundamentals of planning are the same for both open-pit and underground operations — plans are created in sequences with economical assessments at each step. However, for underground design, information with higher resolution is required, which is time consuming and generally more expensive and, for the purpose of this article, it will focus mainly on open-pit operations.

Some analyses that SRK has found beneficial to its clients in planning open-pit operations include simulation of mining progress and equipment; pre-concentration of ore, prior to processing, and probability of failure geotechnical analyses on all pit designs, including interim phases. The team has also been working to develop techniques to better understand potential mining dilution, which usually is a source of reconciliation issues in mining operations. This helps to increase the level of accuracy for ore selection.

A Tailored Approach

SRK recently helped several mines to develop and apply sophisticated geo-metallurgical models in their designs and production schedules, resulting in higher profitability. Another project saw the company develop a novel approach to mine design that incorporated complex geotechnical design criteria into a model for a complex coal deposit.

Justin Smith, senior mining engineer with SRK Consulting's team in Reno, Nevada, elaborated: "Traditionally, design work in complex coal would be done in sections, however, this new methodology allowed for 3D modelling of the pit. Several trade-offs were then conducted in much less time than it would have taken to complete a single sectional design."

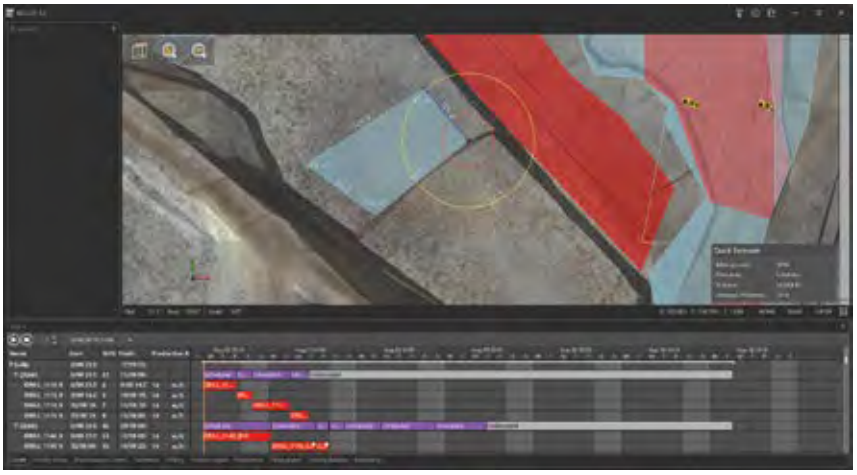
The rise in autonomous and remote-operated mining equipment is also challenging the norm in pit design.

"In 2019, we helped two major mines in Canada to review and model the impacts of new technologies on mine design," Ebrahimi told *E&MJ*. "New technologies such as autonomous trucks are changing the way we operate mines. This should be reflected in our designs. We helped the operations to explore the items that may need to be changed in mine design and assessed the impact of new technology implementation."

Another key focus reflects the enhanced scrutiny mining companies are under with regard to their environmental impact, particularly in tailings and waste management. Mines are often now designed with their end-of-life in mind to lower closure risks and costs wherever possible.

"The key to ensuring that a mine plan is profitable while minimizing the environmental impact and maintaining a social license is to look at all aspects of the mine plan and optimize it as a system, rather than just focusing on each individual component and piecing them together at the end," said Smith "This could be referred to as a holistic approach to mine planning. For environmental impacts, SRK has a concept in planning called 'design for closure.'

"At the beginning of the project planning stages, we include team members from all disciplines to review and challenge ideas. Armed with this wide range of information, our mine planners are able to develop a site-wide plan that considers how all factors interact with each other. Potential solutions and alternatives can be assessed, and compared to determine their effectiveness, practicality, and effects on profitability of the operation."



A CAD drawing from XECUTE 2.2. (Photo: RPMGlobal)

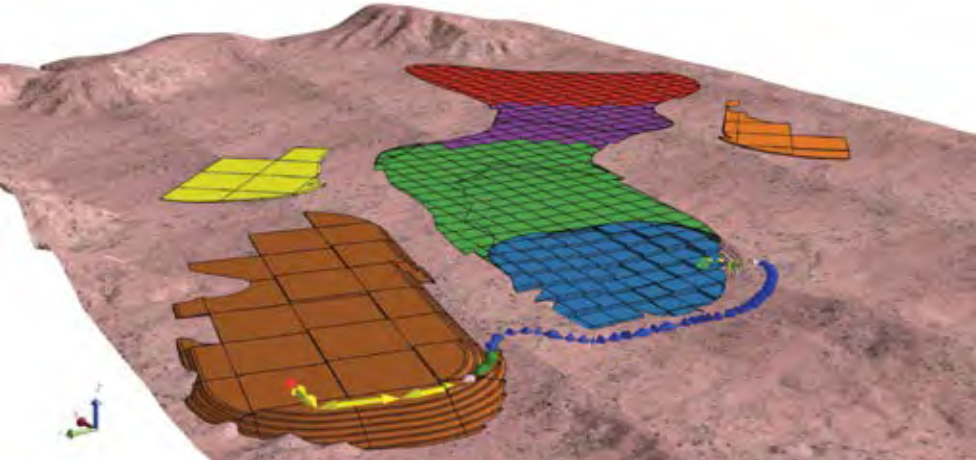
The Right Tools for the Job

Digital mines require digital tools to plan their operations, and the software available to mine planners today is far more powerful and sophisticated than predecessor versions. These packages can handle more iterations, scenarios and complete a higher level of analysis in a shorter time period. Items such as cycle times, volumetric calculations, dilution factors, and densities can be included with much higher granularity than was previously possible, and the simulation of results can also add significant value by decreasing risk for mining operations.

The accuracy of mine plans has risen in line with the amount of data available, but Smith pointed out that while data can bring opportunities to optimize, the sheer quantity can also create a challenge.

"Today, we are collecting, and analyzing, more data than has ever been available in the past," he said. "While this helps us to understand the unique challenges facing each mine, it can be quite overwhelming and difficult to manage. Being able to process huge amounts of data and sort out what is important is critical to successful mine planning today."

The extra data generated, for example, by more sophisticated geo-metallurgical models, higher resolution dilution calculations and more complex operating cost models, means that the number of variables that must be considered have also increased substantially.



Haulage costs form a major portion of mining costs in pits so accurate calculations are essential. (Photo: RPMGlobal)

"Mine planning tools are, for the most part, well equipped nowadays to handle this complexity," Smith said. "So, as the tools get better and more powerful, we are considering a much larger problem and, in some instances, it may take more time for preparation and analysis than in the past. The key reason being more complicated inputs and the demand for higher accuracy."

This is why flexibility in planning is so key. New startups must often stage their development to reduce preliminary capital costs, and fewer greenfield projects mean many operations must make costly adjustments to mine in previously disturbed areas. Lower grades are also driving companies to reduce costs, and significantly longer permitting timelines increase both the initial costs and the risk that operations may not be approved following large expenditures.

"Software advances have also increased the speed at which trade-off studies can be conducted, allowing companies to test several scenarios before committing to a final mine plan," noted Smith.

Advances in Software

Philippe Lebleu, principal mining engineer and open-pit manager at AMC Consultants in Vancouver, recently presented a webinar on the capabilities of modern mine planning software.

"Recent advances in open-pit strategic mine planning software enable the optimization of intricate mining problems associated with a complex and vast array of parameters and constraints," he said in the follow-up paper.

"These programs simultaneously optimize the mining sequence, cut-off grade

selection, amount of mining equipment needed and capital expenditure to maximize the net present value (NPV) of a project or deliver on corporate goals."

Lebleu explained that, typically, a mine plan is produced based on fixed cut-off grades and strives to achieve a primary goal, such as a target mill feed, while maintaining a smooth total material movement to simulate the operation of a predetermined mining fleet. The mine plan is then used to calculate equipment hours and numbers.

"The latter form the input into cost models that calculate mining costs and overall project value. The process is repeated with different assumptions for total material movement, sequencing or cut-off grades," he explained. "Once the mining engineer creating the plan is satisfied that an adequate number of scenarios have been evaluated, the best outcome is selected and used for the rest of the process such as waste dump and stockpile design."

However, this approach can be time-consuming and sub-optimal from a value perspective — especially when the operation being planned is complex. It is also heavily reliant on the mining engineer's understanding of the deposit and their experience — something that is becoming more difficult as experienced engineers retire and skills shortages hit home.

"That is why the use of advanced mine planning software is becoming more widespread among mining companies and consultancies," Lebleu said. "Mixed-integer linear programming processes and advanced algorithms allow rapid evaluation of complex problems and help engineers and management make educated decisions regarding the best mine development or optimization strategy to adopt."

Lebleu explained that the advantage of using advanced mine planning software lies in its ability to achieve multiple targets while respecting a variety of constraints. For example, by looking ahead to ensure that the choice of mine development made in the first year of production does not jeopardize its ability to achieve targets in subsequent years and achieve optimum value.

"Improving a project's NPV can be achieved by applying variable cut-off grades by scheduling period. This is accomplished by defining grade bins based on the spatial distribution of the ore and grade tonnage curves," he said. "Advanced mine planning software can define a 'high-grading' strategy that brings high-grade material to the processing facility earlier in the mine life while balancing the total material mined, and therefore the mining costs to do so. Following a high-grading strategy can typically result in a 15% higher NPV compared to directly processing run-of-mine ore."

The main issue with high grading is that mining more material requires additional equipment. The impact of that cost can be evaluated within the software by accounting for equipment hours as a variable in the model. Assigning a capital cost to a larger fleet allows the software to gauge whether and when to increase production capacity to optimize the project's NPV. Capital expenditure decisions are not limited to the mining fleet and can extend to evaluating the merits and best timing for increasing processing plant capacity or putting capital toward developing a new pit.

Lebleu concluded that, despite the advances in mine planning software, mining practicality still needs to be central to a development strategy.

"It is in the engineer's best interest to produce multiple scenarios to demonstrate the incremental value generated and help tell the story behind the decision-making process," he said.

Developing New Features

In order to delve a little deeper into software development, *E&MJ* turned to Sandeep Sandhu, general manager for North America at software specialist RPMGlobal.

"Not that long ago, generating and analyzing a single fairly basic scenario could be a challenging task. But now, users can evaluate dozens of alternatives and really start to understand the impact and sensitivity to key drivers," he said.

"Furthermore, software has shifted from highly customized, siloed, desktop applications to a more commercial off-the-shelf offering that supports product integration and data sharing. Planning software is producing more data than previously possible, and without being able to expose planning data to analytical systems, effectively comparing options becomes much more difficult."

Sandhu said that a common misconception is that software needs to be customized and scripted for a site.

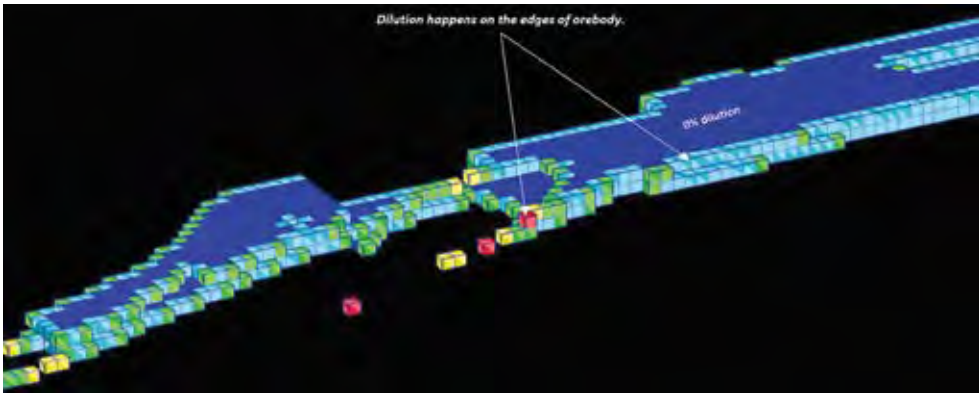
"We have had a lot of success deploying software, which requires no customization to get running, but merely configuration for a specific operation," he explained. "You no longer need to spend months to get new software up and running — it can be as little as a week and you no longer need a consultant on site full time providing support."

Another misconception Sandhu and his team often hear is that there is an "optimal plan."

"In reality, anything that is optimal from a value standpoint is probably unachievable from an operations standpoint," he said. "There really needs to be a focus on finding maximum value within an achievable framework."

RPMGlobal's XPAC Solutions are built for planning according to different commodities and mining methods. The last few releases have included new features to enhance modelling of haulage within open-pit mines.

"With haulage costs being a major portion of mining costs in pits, these enhancements have allowed for more accurate haulage calculations within the solutions," Sandhu said. "We have also expanded the range of design capabilities available in all our solutions."



The team at SRK is developing techniques to better understand potential dilution, which is a common source of reconciliation issues in mining operations. (Image: SRK Consulting)

In November 2019, RPMGlobal unveiled several upgrades for its XECUTE short-term scheduling solution to help expand planning across the mine value chain.

"The market reaction to the new release has been very positive," Sandhu enthused. "With more clients looking to move to remote operating strategies, and more companies pushing digital strategy agendas harder, XECUTE's offering as an enterprise mine planning application is filling a gap that other planning products cannot provide. Since the latest release in November, we have made our first sales of XECUTE into Indonesia and Russia and have gained further interest in Western Australia (Australia) and North America."

Sandhu said one of the most exciting aspects is the enthusiasm with which the industry is embracing new technologies.

"Mining has traditionally been a bit slow to the mark with these sorts of shifts but there is a large amount of activity focused on new technology," he told *E&MJ*. "Mining companies are now looking at things like better automation of tasks that have traditionally been very manual across the pit-to-port value chain.

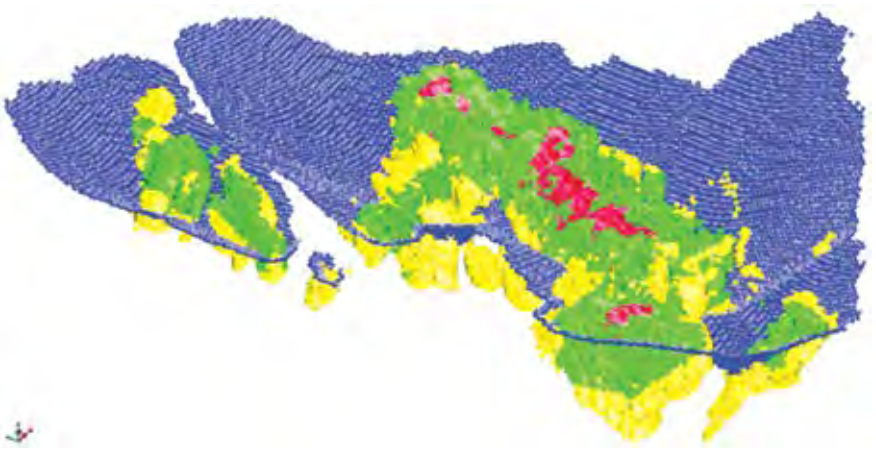
"The other big trend is the accessibility of the new software coming out to market. In the past, mining software was typically reserved for use by those with a high degree of skill in the software. However, with new technology, we are seeing the barrier to entry with new software being reduced."

Connecting the Dots

The team at the COSMO Stochastic Mine Planning Laboratory, based out of McGill University in Canada, is also looking at ways to optimize planning across the mineral value chain.

"Every few decades, we see a big focus on and new technologies for mine planning, production and scheduling for optimization," Roussos Dimitrakopoulos, director of the COSMO Lab, told *E&MJ*. "The current challenge is how to harness new digital technologies to produce more from mining assets that we currently have and those we discover in the future. This brings up the topic of connecting all parts of the mineral value chain, or mining complexes as we like to call them.

"We are developing ways to connect and simultaneously optimize all of the components within a mining complex — from mines to products — to produce more metal, more efficiently and to capitalize on synergies between those components. We are also investigating new ways to treat mine waste."



SRK has found the simulation of mining progress and equipment, pre-concentration, and probability of failure geotechnical analyses useful to its clients when planning open-pit operations. (Image: SRK Consulting)

Stochastic mine planning aims to take into account and generate models that describe the uncertainty of the materials in the ground, as well as uncertainty in operating environment and in the markets.

Dimitrakopoulos explained: "So we start, rather than by saying we have one possible scenario of what's in the ground, that we have several, to reflect the potential variability of the materials as well as quantify their uncertainty. When you understand what you are extracting, where it could flow and where it could end up, you create a different understanding of the supply of materials that comes from the whole setup."

"Conventional mine planning methods, although they are very advanced methods, don't allow for multiple scenarios of what might be in the ground. If you take mine planning software that is on the market, it generally uses what we call deterministic optimization — one input and one output — whereas stochastic optimization allows for multiple inputs to build up a framework that informs and simultaneously optimizes short and long-term mine asset planning. That kind of framework can accommodate uncertainty around what is in the ground and also in the markets, commodity prices, equipment availability… The stochastic framework has been shown to produce more from mining assets than conventional methods."

One of COSMO's current research projects is focused on harnessing the vast quantities of data generated by mining equipment and processes, as well as advanced software to create what the team call a "self-learning mining complex."

"Nowadays, sensors are applied to everything and they generate huge amounts of data. We are looking at ways to capitalize on that information and use it to automatically update models with information on what is in the ground to better inform weekly, daily and hourly planning activities," said Dimitrakopoulos.

The project uses artificial intelligence to create self-learning, deep neural networks that adapt production schedules in real time. Dimitrakopoulos believes we are only about five years or so away from the self-learning mining complex being a reality.

The COSMO team is also working to understand how stochastic mine planning techniques can be used to optimize the production of mine waste, with a view to better rehabilitating operations at the end-of-life, or even creating new streams of income through the repurposing of what were previously considered waste materials.

"We need to switch our thinking in this area," Dimitrakopoulos stressed. "Why can't we take the same technologies and techniques that we use to optimize the production of metals and apply them to engineer waste materials and ensure optimal outcomes in mine rehabilitation as well?

"Understanding how materials flow through mining complexes, and the characteristics of materials that we are sending to the processing plant will play a huge part in that. Metals are not the only products that a mine can produce. We should expand the tools and technologies that we have and apply them to tailings and waste as well."

An Essential Industry Supports Surrounding Communities

Mine operators make adjustments to support employees, suppliers and neighbors during difficult times

By Steve Fiscor, Editor-in-Chief

The updates from mining companies related to the coronavirus (COVID-19) were flooding *E&MJ*'s inbox as this edition was going to press. With the exception of a few country-wide mandates, the mines and mills throughout most of the world continue to operate, especially those in low-risk jurisdictions. Most report they are assessing operations while actively implementing programs to protect workers and the surrounding communities. Others have reduced or temporarily suspended production to slow the spread and comply with regional edicts.

The Mexican Federal Government joined Peru and South Africa and suspended all non-essential activities for 30 days. The suspension includes all mining activities from March 30 to April 30. Companies operating mines in the region announced they were safely ramping down operations and placing them on care and maintenance. The Peruvian Government extended its current state of emergency by an additional 13 days to April 12. Several mining companies suspended operations in the Canadian provinces of Quebec and Ontario.

Mines in the U.S. continue to operate. The U.S. Department of Homeland Security (DHS) has designated mining as critical to U.S. infrastructure. On its quarterly stakeholders' call, the U.S. Mine Safety and Health Administration advised all mines to follow the policies issued by the Centers for Disease Control (CDC). A couple of U.S. coal operators announced they were temporarily idling portions of their production, which were located in the eastern U.S.

The message from Australia was the same with a little twist. The mines were continuing to operate and some were hiring additional staff to support local communities. Recognizing their influence on local communities, they were making sure funds flowed through to them.

The situation for the poorest parts of the world is troubling and again mining companies were putting their best foot forward. Working closely with provincial governments of the North West and Gauteng in South Africa, AngloGold Ashanti made available two hospitals for their exclusive use to treat COVID-19 patients. Barrick Gold donated $500,000 to help Zambia. Vale purchased 5 million test kits and donated them to the Brazilian government.

BHP CEO Mike Henry meets with the team at Peak Downs while practicing social distancing to slow the spread of COVID-19.

BHP Makes a Bold Move

It didn't take long for the world's largest mining company to respond. BHP posted 1,500 open positions in March to support its workforce operating across Australia. The jobs will be offered as six-month contracts and cover a wide range of skills, from machinery operations to warehousing roles across its coal, iron ore and copper operations. BHP Acting Minerals Australia President Edgar Basto said supporting people, communities and partners, safely, is the highest priority. "As part of BHP's social distancing measures, we are introducing more small teams with critical skills to work dynamically across different shifts," he said. "The government has said that resources industry is vital in Australia's response to the global pandemic. We are stepping up and providing jobs and contracts. Our suppliers, large and small, play a critical role in supporting our operations. It is a tough time for our communities and the economy. We must look out for each other as we manage through this together."

"We know that our activity has a multiplying effect in employment and the national economy," Basto said. "Keeping our operations running is essential for the stability of the economy, especially in the face of the difficult times ahead. It is possible to manage the health crisis faced by

the country, as a priority, and at the same time ensure operational continuity."

The company said it would also establish a A$50 million Vital Resources Fund to help support regional Australian communities.

"BHP stands with the regional communities we operate in," BHP CEO Mike Henry said. "With those communities facing significant challenges, we are stepping up in establishing the Vital Resources Fund, which will provide support in a range of areas such as health services and resilience building during this difficult time."

Over the coming weeks and months, BHP said it would work with relevant leaders and groups to distribute funding according to local needs and in a manner aligned with government programs and initiatives.

The Importance of Mental Health

Henry also shared a message with BHP employees emphasizing that mental health is every bit as important as physical health. "Our employees and contracting partners have done a great job of putting into practice social distancing and hygiene measures in a very short space of time," Henry said. "COVID-19 shifted the way we work — from the practicalities of social distancing at our mine sites and off-shore oil platforms, to the challenges our office-based people face to stay connected to their colleagues while working remotely.

"COVID-19 doesn't stop outside of work either, with many concerned about theirs and their loved ones' lives and livelihoods, creating stress and anxiety," Henry said. "Mental health has been a priority for BHP for some time now. We have mental health, wellbeing and resilience tools in place to help our people. This includes our Employee Assistance Program (a free confidential counseling and support service), which is also available for immediate family members. We're updating these resources in a practical way for COVID-19."

South African Mines Contend With 21-day Shutdown

By Gavin du Venage, African Editor

CAPETOWN, South Africa, March 31, 2020—The South African mining sector ground to a halt at the end of March as the country went into lockdown in response to the coronavirus (COVID-19) pandemic. Prime Minister Cyril Ramaphosa declared a national disaster, and used the sweeping powers this brings to order businesses countrywide to shut down. Among these are all underground operations, with limited surface workings still permitted.

Coal mines that support the country's power stations will continue. Production at collieries that feed Sasol, the coal-to-oil producer, will also be issued with permits to operate. South Africa derives about a third of its diesel and gasoline from Sasol.

The shutdown is just the latest blow to a sector that has struggled with intermittent power supplies, regulatory uncertainty and demands from radical politicians that mines be nationalized. However, the industry response to the latest crisis it faces has generally been positive.

"We, as an industry, reiterate our support for the fight against this pandemic by making available facilities for quarantine and treatment of COVID-19 patients, in partnership with government," said Roger Baxter, CEO of representative body the Minerals Council of South Africa.

According to Baxter, the shutdown was preceded with extensive talks between industry and government. Operations will function under care and maintenance protocols, that allow mine sites to be kept safe and stable, with a view to a quick commencement of production when conditions improve.

Mining Minister Gwede Mantashe acknowledged the importance of maintaining value-adding mining infrastructure, especially refineries and smelters, which cannot easily be switched on and off. These operations will continue to operate at reduced levels, using stockpiled ores or lower levels of mining production, while ensuring that due care is taken with preventative and monitoring measures to protect the staff, Baxter said.

An agreement was also reached that internal essential services, including security, ventilation, cooling and pumping, refrigeration, tailings facilities and specialized maintenance may continue.

Many mines also provide local services to surrounding communities and employee residences, such as water. These would also continue.

The shutdown will significantly curtail production. Harmony, the country's third-largest gold producer, said it will lose up to 700 kg of bullion in the 21-day production halt.

Anglo American has also had to cancel diamond auctions through its subsidiary De Beers. The quarterly sales now held in Botswana, where a lockdown is also in force, were behind the decision, the company said. Major markets such as India and the UAE were also enforcing travel restrictions, making buyer attendance unlikely.

Platinum producers have collectively declared force majeure. "We are unable to supply [customers] with metal because now our operations have closed down, so we will have to declare force majeure," spokesman for Sibanye-Stillwater, James Wellsted, said.

For platinum producers, the enforced three-week production break may not be all bad. The price of the commodity fell to a little more than $200 per ounce (oz) during the March market rout, from around $880/oz to 570/oz. However, as realization set in that production would stop, platinum regained $100/oz.

South Africa produces 70% of the world's platinum, much of which goes into vehicle production where it is the essential raw material for catalytic converters that reduce harmful emissions. "The 21-day lockdown in South Africa, which would significantly reduce 2020 platinum group metals (PGM) production, should go a long way to offsetting the demand impact of the outbreak," Nedbank equity analyst, Arnold Van Graan, said, *Reuters* reported. "This should ensure that the market is not flooded with unwanted supply while demand is low. This would contribute significantly to keeping the PGM market fundamentals intact."

Mining related logistics has also been affected. Transnet, the state-run freight rail operator, said it would keep the lines that served coal plants open. It would also continue limited rail shipments to the Richards Bay Coal Terminal, the world's largest dedicated coal port.

Mines could apply for export permits on a shipment-by-shipment case and Transnet would accommodate them, according to capacity. Kumba Iron Ore meanwhile, a unit of Anglo American that has its own rail and port logistics infrastructure, said it expects exports to continue.

Elsewhere in the region, mining is slowing, too. The port of Walvis Bay in Namibia reported a 30% drop in ore shipments from the Democratic Republic of Congo. Production of copper and cobalt has slowed as the world's largest market China reduced commodity imports by up to 90%.

Henry also said he is inspired by the many ways and examples of people in BHP looking after their colleagues. Small acts of care and simply asking "Are you ok?" can make a huge difference to someone's sense of connectedness and well-being, he explained.

Barrick Steps Up

Multinational gold miner Barrick Gold said emergency response plans for dealing with the COVID-19 pandemic have been stepped up at all its sites and offices around the world, some of which are in the poorest parts of the world.

President and CEO Mark Bristow said the company was closely monitoring a very fluid situation. All non-essential business travel was suspended and non-essential projects were curtailed. In line with directives from host governments and the international health authorities, Barrick put measures in place to mitigate the risk of infection while ensuring a safe environment for operations to continue as usual.

"In addition to protecting our people, we have taken measures to support the sustainability of the business," Bristow said. "We have increased stock levels for key supplies and equipment to a minimum of three months, identified alternative suppliers and shipping routes, and put in place contingency plans for clearing and offloading. To date, placed and forecast orders are still intact and there have been no hold-ups in our supply chain."

In addition to everything else it was doing, Barrick Gold has donated significant sums of money to support African nations in combating the pandemic. The company's country manager for Zambia, Nathan Chishimba, presented officials with a check for $530,000. At the ceremony, he described the extensive measures Barrick is using to protect workers and their families living in and around its Lumwana mine against the virus.

Rio Tinto: We All Have to Play Our Part

Rio Tinto said that most of its assets continue to operate. Acknowledging that COVID-19 is a human tragedy, Rio Tinto Chief Executive J-S Jacques said, "We all have to play our part as the pandemic spreads. We have taken extensive measures across the business to help protect our people and communities, and have increased these as the pandemic spreads, in line with guidance or directives from governments and advice from international health organizations on best practice."

Rio Tinto has assembled business resilience teams (BRTs) at each site and region, including a global BRT under the leadership of Jacques. The aim of these teams is to keep operations running safely, to enable commercial supply chain continuity, and plan for future eventualities under various scenarios. Critical infrastructure at each of the operations has been assessed with a continuity plan in place, should it be required, the company said.

The company extended its $15 million Royal Flying Doctors partnership to support health for remote communities in Western Australia. To support global grassroots community COVID-19 preparedness and recovery, it has pledged a further $25 million. Rio Tinto said it continues to look for opportunities to share knowledge of response activities and to partner with others said it continues to find joint solutions to address and aid in the recovery.

Vale Donates Millions of Test Kits

Vale purchased 5 million COVID-19 rapid test kits to help the Brazilian government combat the spread of the illness in the country. The tests can provide results in 15 minutes. The company used its massive logistics operations to import the first 500,000 kits from China to Brazil on March 30. The remaining kits were expected to arrive by mid-April. The amount of test kits purchased by Vale represents half of the needs estimated by the Brazilian Ministry of Health at the moment.

"Vale offers this humanitarian help to Brazilian society in a moment which the country unites for the health and safety of its people," Vale CEO Eduardo Bartolomeo said. "We are making use of our logistics network in Asia to bring equipment to Brazil that may make a difference in the lives of people."

The company is also purchasing from its Chinese suppliers personal protective equipment such as goggles, gloves, and masks for doctors and nurses. The material will also be delivered to the federal government.

Vale also announced a series of support initiatives for its suppliers. The estimate is that, through these measures, the company will advance payments before the invoices are due to inject R$160 million ($30 million) into the Brazilian economy through small- and medium-sized companies.

"At a time when the country is experiencing great uncertainty, we will use our distribution network, our presence at the base of the production chain and our capacity of mobilization to help our suppliers face the impacts of this pandemic, always focusing on the health and safety of people," said Alexandre Pereira, Vale executive officer of Global Business Support.

Vale said it will also provide financial support to construction companies and workers allocated to projects, which have been temporarily suspended. They clarified there will be no impact on the work related to dam safety.

The first shipment of 500,000 COVID-19 test kits from China arrives at the Sao Paulo International Airport (Guarulhos) on March 30. (Photo: Vale)

E&MJ ENGINEERING AND MINING JOURNAL®

GBR GLOBAL BUSINESS REPORTS

Mining in Ontario and Toronto's Global Reach

Challenges and opportunities in Canada's biggest mineral producer

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Cover photo: Lake Gold project, Newfoundland and Labrador, courtesy of Marathon Gold.

A REPORT BY GBR FOR E&MJ

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Introduction

A global mining powerhouse facing competition

Ontario's position as one of the world's pre-eminent mining jurisdictions is demonstrated by a number of metrics. As Canada's leading producer of minerals, valued at C$10.1 billion in 2018, with the second largest number of mining companies headquartered in one city (Toronto is second to Vancouver) and as the traditional home of mining finance on Bay Street where the TSX is found, Ontario's influence reaches far beyond the borders of the province.

However, remaining competitive in a global market place cannot be maintained through reputation alone and, despite impressive production figures and a world-class mining ecosystem, there are signs that Ontario's traditional position of dominance has started to wane. The Fraser Institute's Mining Investment Attractiveness Index ranked Ontario number 16 in 2019, behind North American jurisdictions such as Utah (14), Saskatchewan (11), Idaho (8), and Alaska (4). Of course, none of these jurisdictions come close to matching Ontario's global influence, but even from a mining finance standpoint, the days of spending an afternoon on Bay Street to raise project finance are no longer.

High energy and labor costs and lengthy permitting processes are two of the main issues facing Ontario. Fortunately, the provincial government, led by Doug Ford's Progressive Conservative Party, elected on June 28, 2018, and a network of mining associations are cognizant of these challenges and have been proactive in attempting to establish a more favorable climate for mining investment.

In his interview with Global Business Reports, Greg Rickford, Minister of Energy, Northern Development, Mines and Indigenous Affairs from the Government of Ontario, emphasized a focus on key areas in order to position Ontario as the leading mining jurisdiction in Canada, including expediting regulatory processes for mine production, strengthening spaces for industry-wide dialogue and creating focused task groups to resolve a backlog of project-specific issues immediately. When asked what steps

Greg Rickford, minister of energy, Northern development, mines, and Indigenous affairs, Government of Ontario.

the Ontario government is taking to reduce red tape and streamline the mining process, Minister Rickford pointed to the four mining-related clauses in the "Better for People, Smarter for Business" project.

Firstly, creating certainty for proponents submitting a closure plan by creating a 45-day timeline for the ministry to make a decision; secondly, to streamline processes and lessen confusion by amending the regulatory framework; thirdly, amending the mining rehabilitation code to ensure that it refers to the most recent version of dam safety; and lastly, improvements to the land mass administration system to make it easier for stakeholders to merge individual claims. "The timeline to open a mine is not at the speed of business or commodity markets, and we are working to correct this," acknowledged Minister Rickford.

Record M&A activity sweeps the industry

2019 ended much the way it started, with a wave of high-profile M&A deals in the gold and PGM space as Impala Platinum acquired North American Palladium for C$1 billion in October, Kirkland Lake Gold stunned the market with its acquisition of Detour Gold for C$4.3 billion in November and China's Zijin Mining Group bought Continental Gold for US$1.3 billion in December. By mid-December 2019, 348 deals worth more than US$30.5 billion had been agreed, according to Refinitiv Eikon data. This figure is up from US$10.8 billion in 2018 and even surpasses the previous high of US$25.7 billion from 2010.

One of the most noticeable differences between the boom-time M&A surge in 2010 and the 2019 activity has been the lack of pre-

miums linked to the transactions, most notably Barrick's no-premium acquisition of Randgold, and the modest 18% premium paid by Newmont for Goldcorp. "The financial strategy we are seeing from companies is still very conservative," commented Daniel Ricica, partner of KPMG's energy and natural resources division, explaining that, despite the robust gold price, a seven-year downturn and previous misuse of capital are still fresh in the minds of investors: "The effects are still visible, and we see management and investors are still treading carefully."

At the Denver Gold Forum in September 2019, the month gold traded at a six-year high breaking the US$1,500/oz barrier, the main themes were the growing importance of ESG (Environmental, Social and Governance) to investors, and companies emphasizing their commitment to remain disciplined with capital allocation despite the rapid generation of free cash flow that flourishing precious metals prices were generating. This prudent approach from senior management is a legacy, you would like to think, of the numerous failed excesses of the previous upcycle. However, with gold approaching the US$1,700/oz threshold by the time the Prospectors and Developers Association of Canada (PDAC) took place in March 2020, will the buoyant mood foreshadow a more liberal outlay of capital in the coming months?

ESG moves to the forefront of strategy

Speaking at the Northern Miner's Progressive Mine Forum in Toronto, October 2019, Claudia Mueller, associate director of the Global Mining Management program at the Schulich School of Business, proclaimed that the next generation of mining leaders will arrive with a "tsunami" of ESG concerns.

Furthermore, the No. 1 consideration in EY's Top 10 business risks and opportunities in mining 2020 is license to operate (LTO), an issue that has evolved into something more than simply social license. "Looking at the list year-over-year, we have seen a big shift from the traditional corporate social responsibility approach towards adopting a holistic environmental, social and governance strategy," observed Theo Yameogo, co-leader of mining and metals Canada at EY.

On the environmental side, one of the key components of the increasing importance of ESG is water management. "I have seen the mining sector's views on water change a lot in a relatively short period of time," observed Kristin Pouw, principal consultant and water management specialist at SRK Consulting, noting that today there is a better appreciation of the resource, as both a liability and an asset. "Water management is becoming an important consideration for investors," she added, expanding: "Evidence of this increase in attention is that frameworks for disclosing information on water-related risks and financial and social penalties are being developed, and companies are developing and implementing internal standards for water management planning."

On the trend of regulatory changes requiring companies to understand, quantify and mitigate water impacts associated with mining, Pouw gave the example of a change to the federal Metal and Diamond Mining Effluent Regulations coming into effect in 2021, that will lower limits on some metals and impose a new limit on un-ionized ammonia for effluent discharges at all mines in Canada. "My advice to project developers is to look at, and plan, water management early on. This will give you the best chance of avoiding risks and successfully tackling issues," suggested Pouw, highlighting the benefits of looking at water management at an integration level – combining water, waste, and mining. "If you do not have the necessary internal capabilities, seek expert help to develop a water management strategy appropriate to the site's climate, geology, geography and regulatory framework. This will help you to avoid poor decisions that initially seemed appealing from an economic perspective and to ensure that your project goals remain deliverable," she advised.

Mining 2.0 downloading! ESG transitioning to action

By: **Dean McPherson,** Head, Business Development, Global Mining, Toronto Stock Exchange & TSX Venture Exchange

Two years ago the global mining sector started a slow climb out of a historically long downcycle. Plagued by historic volatility and uncertainty brought on by successive global crises, the sector's recovery has been inconsistent at best -- yet market optimism remains persistent.

Even through moments of uncertainty, the second half of 2019 saw a noted pickup in global mining financings, as well as mergers and acquisitions (M&A) activity. With a strong recovery in precious metals prices being added to the mix, we entered the new year with optimism all around.

Today, we're seeing strong underlying fundamentals (supply/demand imbalances) for base metals, as well as technological developments driving increased demand for battery metals in the medium-to-long-term.

Heading into PDAC 2020, we noted an increased sense of discipline on the part of mining investors. There is now a persistent bias in the sector, with investors seeking projects within relatively "safe" jurisdictions with minimal regulatory risks. Investors are looking for trusted management teams with a proven track record of growing stakeholder value. From exploration to production, the paradigm is shifting and stakeholder value has now supplanted shareholder value.

The previously mentioned pickup in M&A is driven in part by increased investor demand for efficiencies (often through economies of scales) to enhance shareholder return. This focus on shareholder return will no doubt continue in the near term, and perhaps extend down to more exploration companies. However, there is another component of this more disciplined investment approach.

Mining companies must now engage investors and stakeholders with detailed, informed and proactive environmental, social and governance (ESG) strategies. This is now also a key investment decision factor.

ESG transitioning to implementation and disclosure

To help mining companies listed on our Exchanges, we have developed an ESG portal. Issuers are able to access the site to help them navigate the complexities of ESG reporting, ratings and data collection. www.tsx.com/learning/esg

Two years ago we flagged the emergence and need for a "Mining 2.0" era; a new age of responsible and innovation-based mining. This concept has evolved and is now established under the umbrella of ESG and is in full implementation phase.

This year, we note from VRIC/Roundup to Africa Mining Indaba to PDAC, focus has been on innovation and positive change to restore the image of the sector in the eyes of investors and the public. Moving ESG from advocacy to disclosure and implementation is the key here.

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Toronto: the Home of Mining Finance

The challenge of attracting investment

Toronto remains the global investment engine of the mining industry through its stock exchanges, mining-focused financial services, consultants, legal advisors and banks that have a long history of financing projects from early stage exploration through to production. With almost twice the number of mining companies listed on the TSX and TSX.V (approximately 1,200) compared to its nearest competitor, the ASX, even companies that have never had or will likely never have operations in Canada choose to be headquartered in Toronto for its access to capital.

Michael White, president and CEO, IBK Capital.

Dean McPherson, Head, Business Development, Global Mining, Toronto Stock Exchange & TSX Venture Exchange

In October 2019, the TSX30 program was launched to highlight the top 30 performers on the main exchange over the last three years based on dividend adjusted share price appreciation. Considering the challenging market conditions in that time period, it is a welcome surprise that eight of the companies on the list are in the mining sector, five of which are headquartered in Toronto, with Kirkland Lake Gold being the fourth best performer overall with over 600% return. "The program showcases that investors can still receive great returns in the mining market," commented Dean McPherson, head of business development – global mining at the TMX Group, noting the significant role that management and jurisdiction play in encouraging investor appetite.

Although these success stories are encouraging, they do not paint the full picture. While the incredible performance of a small section of the industry is an encouraging sign moving forward and should elicit some investor confidence, a lack of new listings and the continued struggles of the junior community to attract finance have created a chasm between those who produce, and those who explore. A clear illustration of the challenging financial climate facing the industry came from Triple Flag Precious Metals Corp, which decided to pull the plug on its planned C$360 million IPO in December 2019, citing difficult market conditions and a lacklustre demand for new mining issues.

"In terms of new listings and financings, 2019 has been a bit volatile, not only for the mining sector but across the board," acknowledged McPherson, before noting that this is truly a global issue, as the number of new listings on TMX Group's equity exchanges in 2019 still outweighed those of its major competitors combined.

In such a context, companies need to cast their nets wide when sourcing capital, and a roadshow that includes the United States, Europe and Asia requires juniors to demonstrate more than just promising drill results. "My theory is that there has been a renaissance in mining, whereby a lot more is demanded from companies as the sector in general has matured. The companies, the environment and investors have all changed, demanding greater ROI," reflected McPherson.

Despite the struggles of the junior market, the outlook for metal demand is robust, and the fact remains that mines need to be discovered, financed and put into production – a process that does not happen overnight. A distressed market also presents opportunities, and the disparity between bullish precious metals prices and declining junior share prices is not sustainable. "There is now the opportunity for longer term investors to look at the undervalued juniors and take advantage of the current market," observed Ryan Matthiesen, managing director of investment banking at Haywood Securities, adding: "If you have the ability and patience to analyze and evaluate assets and teams, you will find great opportunities."

Raising finance in 2020: What are investors looking for?

With further M&A activity expected between the precious-metals mid-tiers and "cannabis 2.0" on the horizon as edibles, beverages and vaping products enter the Canadian market, the competition for investment dollars looks set to remain stiff in 2020. How, then, can the downtrodden junior community stand out from the crowd?

"What I like about an early bull market is that it separates the good from the bad," stated Michael White, president and CEO of IBK Capital, the private investment firm that has helped to raise finance for the likes of Great Bear Resources (GBR) – the standout junior stock of 2019. "Management has to be very convincing in order to obtain capital. There must be a strong vision that is backed with historical data and reliable results, as well as a tested team that can be trusted to deliver results," explained White, noting that investors will be put off if due diligence and planning are not prioritized in the rush to drill. "There is a lot of competition for funding. Being thorough with a strategy and prepared for execution is far more attractive than rushing to get results," he added.

From the point of view of the investor, what should exploration companies focus on to impress the market, and are there indications that a stock may have reached its peak? "A comment that applies to any exploration discovery is that continuous exploration and expansion of a deposit are important for the company's market valuation," said White, pointing to the success of GBR's strategy to continually step-out and add new mineralization at its Dixie project. "If a company's sole focus turns to infill drilling, converting inferred resource to indicated or measured, this might be an indication that the stock has reached its limits," he concluded.

Keith Spence, president and CEO of Global Mining Capital, echoed the sentiment that preparation is key, suggesting that junior companies often go public too hastily: "If a company remains private, puts its house in order, gets rid of some of the risks and then goes public, it will have a better product to offer the market."

Noting a significant structural change in mining industry financing, Spence explained that a strong retail base had made Toronto into a global financial center for mining, but as the amount of institutional money grew, eventually the retail market disappeared: "Many investors have left the mining space after losing huge amounts of money due to major financial disasters and scandals during the last 20 years, such as the massive gold mining fraud by Bre-X Minerals."

A reoccurring theme in Global Business Reports' research and interviews was the growing importance of team and jurisdiction. Terry Harbort, president and CEO of Talisker Resources and VP exploration for Sable Resources, related how, over the last 10 years, there have been approximately 200,000 drill holes drilled in the global mining industry, yet only 38,000 of these drill holes actually made a significant intercept. "The discovery rate in the industry is 0.6%, so investors want to invest in the 0.6% of the industry that has actually found something," said Harbort, noting that Sable Resources' team has been responsible for discovering approximately 40 million oz globally.

Ryan Matthiesen commented that advanced projects in the right location with a clear path to production, backed by a good management team and strong investor base, will attract interest: "Capital is migrating to more secure jurisdictions and investors are willing to pay a premium for stability; a factor that is more important than it was a few years ago."

Tellingly, for the first time ever, no Canadian jurisdictions were included in the top 10 of the Fraser Institute's Investment Attractiveness Index in 2019. Improving the climate for investment will be key to maintaining a healthy project pipeline in the years to come.

Mining Production in Ontario

Majors streamline operations after mergers

In the wake of the two super mergers concluded in early 2019, there was uncertainty surrounding how the world's two largest gold miners, Newmont and Barrick Gold, would deal with their assets in Ontario. Would Newmont manage to sell its Red Lake mine? Would it begin operations at the new Borden mine in 2019? Would Barrick maintain its headquarters in Toronto despite its CEO being based abroad? Would Barrick's Hemlo mine survive the cut as the company decided to sell off non-core assets?

Crucially for the Ontario mining industry, the answer to all of the above was a resounding yes. The common theme in the restructuring decisions taken by both companies has been to focus on top-tier assets, trimming the fat to reduce costs and optimize operations.

Mark Bristow, Barrick's president and CEO, spoke on the reasoning behind the merger with Randgold: "Through the merger we obtained the possibility of having six or seven of the top 10 assets in the world. If you have an asset portfolio like this, you can create a standout business. If you want to be dominant in the gold mining industry, it is not about size, but about value and the quality of the assets," he stated.

Bristow commented that Barrick's success in 2019 was due to a focus on youth, praising his new management team for closing four big deals in 10 months: the Barrick-Randgold merger, the Nevada consolidation, the acquisition of Acacia Mining and the sale of KCGM. "One of the things we were focused on during the merger was to create a more agile, fit for purpose and modern corporate structure. You can have the best assets in the world, but without the right people they are useless," elaborated Bristow, who likened the previous incarnation of Barrick to a "patient in intensive care" when discussing a possible merger with John Thornton in 2015, emphasizing how the new generation of young talent brought in has re-energized the company.

This philosophy has been applied to Barrick's Hemlo operation in Thunder Bay. The project has undergone a modernization process to reduce an average employee age, which sat at 57 before the restructuring. "During our due diligence on Hemlo, we did not have a consensus on whether it was a good or bad operation, but it was clearly old fashioned," reflected Bristow, noting that a voluntary separation package offered to many of the mine workers had been accepted by all. "The next steps at the mine will be to phase out the open pit operation and move to an underground contract mining model, with the objective to upgrade Hemlo to a Barrick Tier 2 asset and extend its Life of Mine well into the future," he explained, concluding that Hemlo today is a more lean, agile, modern and profitable mine.

A major milestone for the Ontario mining industry was celebrated on October 1, 2019, as Newmont's new Borden "mine of the future" entered into commercial production. Located near Chapleau, under 200 km from Timmins, the Borden mine sits under the umbrella of Newmont's Porcupine Gold Mines operations, which also include the Hoyle Pond underground mine and the Hollinger open pit mine. The three operations combined should deliver approximately 300,000 gold oz/y, according to Marc Lauzier, Porcupine Gold Mines' general manager, who commented that Borden is expected to produce approximately 1,800 mt/d at about 6 grams of gold per metric ton (mt). "Borden's digital mining technologies, low carbon-energy vehicles and modern health and safety controls position it as one of the world's most technologically advanced mining operations," stated Lauzier, who expects Borden to be fully electric by 2021.

The Canadian and Ontario governments each provided Newmont with C$5 million for the electrification of the mine, which can be seen as a model of modern resource development from both environmental and cost standpoints: "Through the use of electric vehicles, we will be able to reduce 7,000 mt of greenhouse gas emissions and associated maintenance costs, as well as save the consumption of 2 million liters of diesel and 1 million liters of propane," explained Lauzier.

A golden age for Ontario mid-tiers

The darling of the Canadian mining industry over the last four years has been, without a doubt, Kirkland Lake Gold (KL Gold), with a remarkable rise that saw its stock increase from under C$3 in January 2016 to a high of almost C$65 in Q3 2019 as its market cap broke the C$12 billion threshold. KL Gold's serene progress was – at least temporarily – halted on November 25th, as the market reacted in shock to the company's all-share acquisition of Detour Gold Corp for C$4.9 billion, a 24% premium to its valuation at the time.

When questioned about initial market skepticism towards the Detour transaction, KL Gold president and CEO Tony Makuch spoke of the value he sees in adding a third high quality asset to the KL portfolio with a large reserve to support mining for over 20 years.


Mark Bristow, president and CEO, Barrick Gold Corp.


Anthony Makuch, president and CEO, Kirkland Lake Gold.


Duncan Middlemiss, president and CEO, Wesdome Gold Mines.

"We have already taken two "under-loved" assets at Macassa and Fosterville, and turned them into industry leading mines through investments in exploration, infrastructure, equipment and development," he stated, continuing: "Detour is in our back yard in north-eastern Ontario, we know the geology here well, and bring a lot of synergies."

Another low-cost, high-grade gold producer from Ontario that enjoyed a tremendous 2019 was Wesdome Gold Mines, having enjoyed exploration and production success at its Eagle River mine in Ontario and at a second high potential asset, its Kiena mine in Québec. Before becoming Wesdome Gold Mines' president and CEO in 2016, Duncan Middlemiss was instrumental in the growth of St. Andrew Goldfields prior to its acquisition by Kirkland Lake Gold. Under his leadership, Wesdome's stock has risen from under C$2 in July 2016 to over C$10 dollars in December 2019, and shows no sign of slowing down. "Wesdome has a crystal clear strategy about building Canada's next mid-tier gold producer," stated Middlemiss, before going on explain how Wesdome's exploration and production success at Eagle River – producing at 21 g/mt in 2019 – has allowed the company to accelerate the investment program into the complex: "This includes enhancing the tailings capacity, improving the mill by adding a Falcon gravity concentrator and developing the proper drilling platforms within the mine."

Success at the Eagle River mine has also funded the C$27 million advanced exploration program at Wesdome's Kiena project in Québec, with a PEA expected to be released in April 2020. "The advantage Wesdome has is that this project is a fully built, fully permitted mine, and the resources that we have been able to explore and define better are incredibly high grade – almost 18 g/mt in the indicated and 15 g/mt in an inferred resource," said Middlemiss.

Canadian Exploration

A suffering junior market waits for the tide to turn

Major Drilling's specialized drilling teams use a CP50 core rig for deep core hole with directional drilling at a copper exploration project. Photo courtesy of Major Drilling.

Despite robust metals prices and gold breaking the US$1,600/oz threshold for the first time since 2013, funding has been harder than ever to come by for Canadian exploration companies. The cannabis hysteria and cryptocurrency boom have died down, but generalist investment has yet to return to the exploration sector, preferring to invest in low-cost producers showing free cash flow. "The funds are seeing generalist money coming into the large and mid-caps and, from their perspective, it is riskier to pick a micro-cap that could double when some of these intermediates have been doubling," explained Ryan Matthiesen, managing director of investment banking at Haywood Securities. "This has created a large valuation gap as bigger companies have been trading at much better multiples," he added.

The discrepancy between the producers and juniors is, however, not sustainable, as depleting reserves and declining ore grades incrementally increase the necessity for new discoveries to be funded, developed and brought into production.

In his interview with Global Business Reports, Barrick president and CEO Mark Bristow named Canada as a "standout jurisdiction for finding big mines," pointing to the opening up of big gold/copper porphyries in British Columbia and the potential of the older regions in Ontario and Québec to be reinvented through creative and penetrative exploration. "Archean rocks produce surprises, and I believe in Canada there are still great opportunities that lie within the ground," reflected Bristow.

Golden opportunities at Red Lake

Red Lake in Northwestern Ontario has been a hive of activity in 2019, as Newmont sold its Red Lake mine to Australian company Evolution Mining for US$375 million in November, Pure Gold Mining began construction at its Madsen Gold mine in September and a host of juniors ramped up exploration at the historic mining camp.

The best performing junior stock of Q4 2018 made further strides in 2019, as extensive exploration of Great Bear Resources' (GBR) Dixie project at Red Lake produced spectacular result after spectacular result, seeing the Vancouver-based junior's share price rise from C$2 in January to a high of C$9 in September.

"Approximately 12 months ago, we only had two zones discovered, but we have now increased this to seven discovered zones," stated Chris Taylor, GBR's president and CEO, who elaborated on how, through regional drilling and the use of government data, GBR discovered a new zone of shallow high-grade gold associated with silicification of host rocks related to a crustal-scale structure, called the LP fault. "The fault marks a contact between mafic and felsic/intermediate rocks and is spatially associated with an 80 m to 200 m wide quartz sericite zone associated with highly anomalous to high-grade gold mineralization," explained Taylor. "The Dixie project has transformed from another high-grade gold in quartz vein story, to being something entirely different now," he continued, likening

the deposit to Hemlo as the mineralization is more disseminated in the rock, rather than in veins, with intercepts of high-grade gold mineralization going right to surface.

Palladium reaches all-time highs

When producing the previous version of this report in December 2018, palladium's remarkable performance was one of the key talking points, headlined by the now-acquired North American Palladium's Lac des Iles mine near Thunder Bay. While the outlook for 2019 was bullish, few would have predicted just how well the platinum group metals (PGM) would perform as rising demand from the hybrid automobile industry combined with a continued eight year deficit drove up the price by 83% for the year. On December 17, for the first time in history, palladium broke the US$2,000/oz threshold, becoming more valuable than gold has ever been (US$1,917/oz in 2011). By February 2020, palladium had reached a staggering US$2,600/oz.

Jamie Levy, president and CEO, Generation Mining.

How then did Toronto-based junior Generation Mining manage to acquire a 51% interest in the Marathon palladium project in Ontario from Sibanye Stillwater in 2019 for a total consideration of under US$6 million, considering that Stillwater had acquired the project in 2010 for US$118 million when palladium was worth less than US$1,000/oz? Jamie Levy, Generation Mining's president, CEO and director, expanded on how the project had been abandoned due to Stillwater's inability to raise money and its financial outlay with the US$450 million acquisition of Peregrine Metals. "There were management changes and Stillwater was sold to Sibanye. The merger was for US$2.2 billion, and the purchase was primarily motivated by Stillwater's assets in Montana," explained Levy, elaborating: "When we approached them, they had no interest in developing the property in Ontario. Sibanye's focus is in production rather than in developing the mines. For this reason, we managed to get the asset under very favorable conditions."

"The Generation Mining team negotiated an outstanding deal for their shareholders," affirmed Ryan Matthiesen, managing director for investment banking at Haywood Securities, the sole bookrunner on the financing.

Generation Mining can increase its interest in the Marathon palladium project to 80% by spending C$10 million and preparing a PEA within four years.

Generating an Ontario nickel play

In December 2019, Toronto-based project generator Noble Mineral Exploration announced the completion of the Crawford Nickel-Cobalt project property transfer to Canada Nickel for C$2 million in cash and 12 million shares of the new Ontario junior. "An important part of the transaction was the negotiation with the royalty holder to reduce the royalty from a 5% NSR to a 2% NSR," explained Vance White, Noble Mineral Exploration's president and CEO, noting that this reduction is going to make the project attractive to more participants, such as majors and mid-tiers.

Noble's Project 81 asset is a contiguous parcel of land covering all or parts of 14 townships adjacent to the Kidd Creek mine complex, which has been in production for 53 years and has produced


Jose Vizquerra, president, CEO and director, O3 Mining.


Terry Harbort, president, director and CEO, Talisker Resources.


Vance White, president and CEO, Noble Mineral Exploration.

160 million mt. Expanding on the potential of the land package, White commented that by taking out all of the early stage risks of airborne geophysics and data compilation, Noble has created drill-ready opportunities to be picked up by third parties. "The Canada Nickel deal is tangible proof of the potential of our land package, and we intend to continue developing projects into 2020 and beyond," stated White, adding: "We are looking at anywhere between a C$15 and C$20 million spend over the next 36 months with 8-10 partners."

Québec: a world-class mining jurisdiction

The first incarnation of Osisko Mining defined a new style of mineralization in Archean aged gold-only porphyries, ultimately discovering over 10 million oz of gold at Canadian Malartic. In recent years, no group has performed as much exploration in Canada as the second incarnation of the company, reaching a staggering 1 million meters of drilling in September 2019 in only four years.

Now, O3 Mining, the third iteration of the Osisko Mining Group, has been created with the intention of adding significant value to the Garrison and Marban assets in Ontario and Québec, according to Jose Vizquerra, O3's president, CEO and director. In July 2019, O3 Mining completed an RTO with Chantrell Ventures, transferring a portfolio of exploration projects including Marban and Garrison. Additionally, a portfolio of selected securities was transferred by Osisko, which ended with just over 53% of O3 Mining's outstanding shares.

Despite challenging conditions for juniors, O3 Mining has shown that the right projects with the right backing can make quick progress, as the company has raised over C$28 million to advance its exploration projects and acquired properties for a total value of roughly C$50 million to consolidate its portfolio in Québec. "These initiatives allow us to move closer to our goal of becoming a multi-million ounce, high-growth company, with over 61,000 ha of prospective ground," stated Vizquerra, adding: "O3 Mining's properties hold 3.6 million oz of measured and indicated resources at 1.26 g/mt of gold and 1.5 million oz of inferred resources at 2.14 g/mt of gold, positioning us as a Tier 1 company in the junior mining space."

Another well-funded, Québec-focused junior is Troilus Gold, which acquired the past-producing Troilus gold mine in Northern Québec in 2016 and worked privately on the asset before going public in January 2018. The Troilus mine was previously operated by Inmet Mining, which produced approximately 2 million oz of gold and 70,000 mt of copper in a US$300/oz gold environment when it first entered production and operated profitably for the next 14 years.

Having raised almost US$50 million in under two years and maintained a tight share structure, Troilus aims to start a PFS toward the end of 2020 with the goal of moving towards a production decision in 2021. "Troilus Gold has over US$400 million in inherited infrastructure and over 6 million oz in resources, having added more oz in the last two years than any gold company in the world," affirmed Reid.

A new greenstone belt and "the crown jewel of Canadian mining" in British Columbia

At Roundup 2020 in January, the Association for Mineral Exploration (AME) awarded its 2019 Celebration of Excellence H.H. "Spud" Huestis Award for significant contributions to enhancing the mineral resources of BC and/or Yukon to Peter Fischl of Westhaven Ventures. Fischl was recognized for his role in the discovery and ongoing definition of the South Zone high-grade epithermal gold-silver

deposit at Westhaven's Shovelnose project in the newly emergent Spences Bridge Gold Belt (SBGB) in southern British Columbia.

Toronto-based junior Talisker Resources was able to gain control of 85% of this new gold belt in the largest single staking in B.C. history, staking nearly 190,000 hectares in a six hour period, according to president and CEO Terry Harbort. "During the 2019 field season, we conducted an aggressive exploration campaign with 22 geologists in the field collecting approximately 2,500 silt fraction first order stream sediment samples resulting in over 100 new anomalies and, to date, 10 defined drill targets," he said, adding that a planned budget of C$3.6 million has been allocated to continue the exploration at Spences Bridge in 2020, with Talisker's specialized greenfields team, in parallel to its program at the newly acquired Bralorne Gold Camp.


Alistair Ross, president and CEO, Rockcliff Metals Corp.

"The crown jewel of Canadian mining" was how Harbort described Talisker's Bralorne Gold asset in British Columbia, and the market seemed to agree, with the company's share price doubling in the wake of the November 2019 acquisition. The Bralorne Gold Camp is the source of the prolific Fraser River alluvial gold rush of the 1860's, producing 4.2 million oz of gold at 17.7 g/mt for over 50 years. Two of the mines in the camp, Pioneer and King, were closed in the mid 1960s, whereas the Bralorne mine continued until the early 1970s. "The gold price then was US$35/oz; that's about US$220/oz in today's dollars. I doubt there would be many mines today economic at US$220/oz gold," observed Harbort, adding: "With a highway right to it, a camp, a mine and tailings permit, and being connected to grid power with a hydro plant several kilometers away, we view Bralorne as a world class opportunity."

A path to near-term copper production in Manitoba

Gold miners made hay while the sun was shining in 2019, as expectations of U.S. Federal Reserve rate cuts and geopolitical tension mounted between the United States and China to create the perfect storm for the safe haven precious metal. Copper, on the other hand, suffered as trade tensions threatened demand outlook from China, which accounted for 49% of global refined copper consumption in 2018. When the US and China signed a "phase one" trade agreement on January 15th, copper reached a seven-month high of US$2.88/lb. However, a Chinese dynamic of a different kind conspired to send the red metal crashing to a low of US$2.50lb by the end of the month, a 13% drop in merely two weeks in reaction to the escalating coronavirus outbreak.

While China's overwhelming influence on the copper price is worrying, the current dip seems like an artificial low. Indeed, copper is "poised for liftoff" in 2020, according to Jefferies analyst Christopher LaFemina, who pointed to low copper inventories, high short positions, supply constraints and better demand creating conditions for the metal to rally, in a note to clients. This optimism is matched by the likes of Goldman Sachs, Morgan Stanley, Bank of America and Citi, which see copper rising with an improving global economy.

In May 2019, a three-way tie up between private equity investor Greenstone Resources, capital merchant bank Norvista and the Rockcliff exploration company run by Ken Lapierre came together with a clear strategy of moving into copper production, according to Alistair Ross, president and CEO of Rockcliff Metals Corp. "The initial work is to bring three of the company's resources, Tower, Talbot and Rail, to an indicated level of between 3% and 4% copper equivalent, with a target size of approximately 2.5 million mt each," revealed Ross, discussing the company's asset portfolio in the Flin Flon-Snow Lake district in Manitoba near on the Saskatchewan border.

Ross explained how Rockcliff is taking an innovative approach to change the way people see narrow veined, steeply dipping ore bodies, with the aim of mining a lot more on a daily basis than would traditionally be expected: "This is thanks to the adoption of a digital mine site design from the onset and from combining technologies that have not been used in unison before," he said, elaborating: "We conducted a peer-reviewed study of our conceptual method and gained agreement that it could be possible to produce at a mining rate of 2,000 mt/d. This is more than double the traditional rate and would turn the seven-year project into a three-year project."

With this timeframe, the project would rely on power generators instead of traditional hydro lines, be less intrusive to the environment and leave a minimized footprint.

Toronto's Global Reach

Mine the mines abroad, mine the markets in Toronto

"I always say asset quality overrides jurisdiction," professed Barrick chief Mark Bristow, a philosophy clearly shared by many mining companies headquartered in Toronto. From the biggest fish down to the micro-cap juniors, Canada is awash with companies headquartered in the home of mining, but with operations abroad.

Access to the capital markets and financial institutions, a wealth of mining expertise and a diverse international community all make Toronto an ideal hub for deal making and orchestrating financial support. As the home of the PDAC convention, which hosted attendees from 132 countries in 2019, what happens in Toronto invariably reverberates around the mining world.

Stephen G. Roman, president and CEO, Global Atomic Corp.

On that note, Global Business Reports' annual guide to the Ontario mining industry would not be complete without an investigation into a variety of Toronto-based mining players plying their trade in countries with better coffee than Tim Hortons. Although jurisdictional stability has grown in importance in the eyes of investors in recent years, the tantalizing combination of underexplored and highly mineralized land with low operating costs continues to attract mining entrepreneurs.

Diverse opportunities across Africa

London and Australia form natural hubs for Africa-focused mining companies, and China's growing influence in the region is apparent from its control of the cobalt supply chain in the DRC to its strategic infrastructure investments in East Africa. However, there are a number of success stories from the Toronto mining community active in Africa, with Teranga Gold being one of the standout performers in 2019.

"It has been a year of highlights for Teranga Gold," enthused Richard Young, president and CEO, who, in early December, announced plans to acquire the Massawa gold project from Barrick Gold. A non-core asset for Barrick, Massawa is ideally located right next door to Teranga's flagship Sabodala gold operation in Senegal and within 30 km of its plant. "As one of the highest-grade undeveloped open-pit gold reserves in Africa, the addition of Massawa is a game changing event for Teranga," Young stated, commenting that the acquisition is set to accelerate the repositioning of Teranga into a low-cost, mid-tier gold producer.

Additionally, Teranga's newest mine, Wahgnion, located in southeast Burkina Faso, achieved commercial production C$15 million below budget and two months ahead of schedule in August 2019. "We are really pleased with the work of our team and contractors throughout this project and in particular with the fact that it was completed with no lost time incidents over 5.3 million hours worked," added Young.

In the neighboring Republic of Niger, Global Atomic Corporation is advancing its large, high-grade, DASA uranium deposit with a resource of 250 million pounds and located in the middle of three existing plants. In contrast to the majority of junior companies, Global Atomic benefits from a positive cash flow from the significant dividend stream generated by its share in the Befesa Silvermet zinc concentrate production facility in Turkey, which was upgraded in 2019 and forecast to double throughput in 2020.

Stephen G. Roman, Global Atomic's president and CEO, would like to have the mining permit process complete by the end of 2020, so that the company can move ahead with construction of the DASA mine. Elaborating on the outlook for uranium, Roman said: "From an environmental standpoint, compare the amount of resources needed and footprint left by a large-scale solar or wind power installation to nuclear alternatives, such as a small modular reactor (SMR), and you will realize uranium's sustainable value to our future."

Trigon Metals is a Toronto-based junior focused on African copper, with projects in Namibia and Morocco. Elaborating on the company's decision to focus on a low-capex restart at its flagship past-producing Kombat mine asset in Namibia, Jed Richardson, president and CEO, underlined the importance of looking at what is properly financeable in today's market: "Country risk is what it is; the real risk is the next dollar," he reflected, continuing: "If I come to you and say I need US$100 million and I only raise US$50 million, then I am in trouble because a half built mine is worth nothing. Too often mines have been built on excel spreadsheets without taking practical realities and the myriad of

risks associated with development into consideration. In a sense, the market is a little smarter now and companies need to work harder to prove their value."

Gold production and innovation in Mexico

While populist rhetoric from the President of the United States continues to stoke the price of gold and depress the price of copper, further south, the election of a populist of a different leaning, Andrés Manuel López Obrador (also known as AMLO), sparked fears that Mexico's government could interfere with a myriad of mining projects, many of which belong to Canada-based companies. Fortunately, AMLO announced that he will not interfere with current mining concessions. On the other hand, good luck getting new ones: "We will maintain these concessions, and we are not going to cancel them, but now we are also not going to continue issuing new mining concessions, because a lot have been handed out," the Mexican president declared in a press conference in Zacatecas state in August 2019.

Fred Stanford, president and CEO, Torex Gold Resources.

For those with concessions in hand, Mexico remains an excellent jurisdiction. One of the established Toronto-based mid-tiers active in Mexico is Torex Gold Resources (TXG), which saw its share price double from 2018 to 2019, a reflection of the transition of the company's El Limón Guajes mine to steady operation following the resolution to an illegal blockade in early-2018. "Since then, the mine has lived up to its potential, delivering record gold production in Q3 2019, following a record quarter in Q2 2019," clarified Fred Stafford, TXG's president and CEO. Operational performance combined with a resurgent gold price has allowed Torex to generate strong cash flow, which has been directed towards strengthening the company's balance sheet, de-risking its Media Luna project and advancing its proprietary Muckahi Mining System. The first blast of TXG's innovative Muckahi Mining System (pronounced "Muck-ah-high") took place in April 2019 and has been garnering attention from mine operators looking to reduce costs and optimize production. "If there is the potential of reducing costs by 30%, making an all-electric mine without any greenhouse gasses and producing less waste rock that must come to surface, you are going to attract interest from industry," remarked Stanford, who believes that once the integrated Muckahi system is demonstrated, it will become one of the cornerstones of TXG's growth strategy.

Mongolia ramps up mining development

Mongolia's mining minister, Dolgorsürengiin Sumyaabazar, reassured Rio Tinto in November by declaring that the company's US$7 billion expansion of the Oyu Tolgoi underground copper-gold mine, the second largest copper deposit in the world, will not be stopped. The minister's words eased fears that the government could try to renegotiate contractual agreements after the Mongolian parliament backed a petition to revise documents related to the asset's development. "The government understands that mining is a major contributor to the GDP and pays the vast majority of taxes in the country," observed Ali Haji, CEO of Mongolian lithium-focused exploration company Ion Energy. The company plans to go public in 2020, backed by a board of directors from the Steppe Gold management team.

In March 2020, Steppe Gold announced the commencement of ore processing at its 100%-owned ATO Gold Mine in Mongolia. Aneel Waraich, Steppe's executive vice president, explained how the company's projected sustaining costs going into 2020 are approximately US$650/oz including refining and royalties: "In Mongolia there is a skilled labor force at a cheaper cost than anywhere else in the world. This means that we were able to build our mine cheaper than anywhere else. We had equipment coming in from China, which meant that logistical lead times were quite quick and the costs were also relatively cheap."

Underlining Steppe Gold's focus on becoming a mid-tier Mongolian precious metals company, Waraich gave his outlook for 2020: "Steppe Gold will be in commercial production and at full run rate at the company's heap leach operation. We will also have completed strong exploration programs on our ATO, Mungu and UK projects."

Additionally, Erdene Resource Development Corp becoming the first company to be dual-listed in Mongolia and the TSX. "A landmark move for the country which demonstrates the government's interest in seeing its citizens – the ultimate beneficiaries of the natural resources of the country – share the risk and reward of mining projects via stock ownership," commented consultant Bayar Baatar.

The Battery Metal Supply Chain

North American collaboration in the effort to catch up with China

Although the United States and China announced a preliminary "phase one" trade agreement in December 2019, the future of their economic relationship remains uncertain. A defining feature of the Trump administration's economic policies has been its embrace of international trade protection and, while the United States holds the upper hand in most markets, China's dominance in the battery metals supply chain is indisputable. Electric vehicle (EV) sales grew to more than two million units globally in 2018: an increase of 63% on a year-on-year basis. Comparing the 2019 adoption rates for EVs, China leads comfortably with 6%, compared to 2.6% in Europe and North America, and 2.2% for the rest of the world. However, adoption rates are less of a cause for concern than the fact that China currently dictates the supply dynamics for the majority of metals used in the production of EVs and batteries.

Donald S. Bubar, president and CEO, Avalon Advanced Materials.

The fact that Tesla chose Shanghai as the location of its Gigafactory, built the plant in less than one year in 2019, and quickly raised an additional US$1.6 billion (through a consortium of state-backed Chinese lenders) in December for a plant expansion, is emblematic of the speed and assertiveness being shown by the Chinese in the battery race. The new plant is expected to double production capacity of Tesla's Model 3 sedan, will be the company's first manufacturing site outside the US, and China's first vehicle plant wholly owned by a foreign company.

On January 9, 2020, Prime Minister Trudeau and President Trump announced the Canada-US Joint Action Plan on Critical Minerals Collaboration had been finalized, aimed to advance the countries' mutual interest in securing supply chains. Canada is already a leading producer of nickel and cobalt and has another 70 advanced projects for both metals, according to a July 2019 presentation by Hilary Morgan, director of international affairs at Natural Resources Canada. Additionally, Canada is home to 16 advanced rare earths projects and 17 advanced and near-stage lithium projects.

"Governments are now recognizing the need to create critical minerals supply chains outside of China," reflected Don Bubar, president and CEO of Avalon Advanced Materials and one of the leading North American voices in the field of rare metals and critical minerals. "There is more urgency for other countries to develop their own critical minerals supply chains due to the risk of China restricting supply," he added, continuing: "We have all of these minerals in the ground in Canada and the time has come for us to take advantage of the opportunity by extracting these minerals and creating the value-added in Canada."

Mark Warner, lawyer at Pilot Law, suggested that Canada has the potential to be one of the countries to benefit from the current trade war by becoming a reliable alternative supplier for the United States, but such a context depends on the Canadian mining industry actually being able to get resources out of the ground. "The trade war has shown the need for a counter point to China. The demand and need is definitely there, but the question is if there is political will from North America, including Canada, to take advantage of this opportunity," said Warner, adding that Canada has seen a significant amount of mining investment coming from China, which could create challenges in the development of a North American supply chain.

Janice Zinck, director of green mining innovation at CanmetMINING, part of Natural Resources Canada, commented that China's dominance in the critical mineral space started 30 years ago and their long-term strategy allowed them to overtake competitors: "At that time, everybody was comfortable allowing China to supply products. Our resource strategies are not nearly as long term in the Western world as they are in China," she remarked.

"Canada is well-positioned to occupy a greater space in the value chain, but we need to be more strategic and invest in developing those resources," added Zinck, commenting that Canada is rich in mineral resources and has the necessary expertise, but needs to accelerate the pace at which it is advancing projects. "We have to look at supply-chains and value-chains in terms of what is driving the development. Instead of driving development from the resource, it should be driven from the magnet, battery or end product."

Innovation

The risk of standing still

Operational costs are rising, mines are getting deeper, ore grades are declining, exploration success is decreasing and environmental regulations are becoming stricter. All of these factors are underpinned by a seven-year downturn that has seen investment leave the mining sector. When looked at from a macro perspective, the climate is ripe for new innovations to dramatically reduce the cost of production, improve exploration success and reduce environmental impact. In such a context, innovation should be a necessity, rather than an option.

However, the mining industry's adoption rate for implementing new technologies lags behind other heavy industry such as the chemical, automotive and oil and gas sectors. "Having worked in other industries, when you approach a company with a new technology, if they realize it will optimize performance and cut costs, they are willing to be first-adopters. Mining companies, on the other hand, almost always ask "who else has this in their mines?" observed Nadine Miller, strategic advisor at the Awz HLS Fund and director of Wesdome Gold Mines.

"When I entered the industry in the 1970s, there were significant changes taking place," said Alex Henderson, president of Alex Henderson Consulting, who mentioned that a high degree of everything the industry does today was developed during this period. "I often ask clients to show me what is different in the new mine they are developing from previous mines that have been built. They usually answer that there is nothing different," he added.

There are reasons for this caution. Mining is an inherently risky business, from early stage exploration that raises vast sums of money to invest in ventures statistically unlikely to be developed, through to the complicated and dangerous process of extracting ore in a remote location at depth. By the time a mine is ready to go into production, tried and tested methods are often more attractive to operators looking to guarantee output for management and shareholders. Jeff More, president and CEO of MineSense Technologies, touched on the practical reality mines have to deal with: "By definition, mines have a lot more complexity than other industries. For example, when your industrial processes are inside of one building you have more flexibility to try new things in comparison to the mass scale in a mine," he reflected, noting however, that the rate of adoption for new technologies in mining is starting to accelerate.

Chrysalix Venture Capital, a global technology venture capital fund that specializes in transformational industrial innovation, was one of the companies to have funded MineSense Technologies. Charlie Haythornthwaite, senior partner at Chrysalix, suggested that the various pressures facing the mining industry are starting to force companies to change their approach: "Generally, there is renewed recognition that sustaining incremental innovation may no longer be enough and there is an ever greater need for step-change solutions."

This sentiment was echoed by Ryan McEachern, managing director of the Mining Suppliers Trade Association (MSTA) Canada, who acknowledged that the industry knows that it has to change: "After the last downturn, there has been a focus on what we must do in order to survive moving forward," he said, explaining that this encompasses two aspects: having a social license to operate, and integrating technology more efficiently. "I still see companies struggling on the second aspect. I think both the understanding of the need and the will are there at a corporate level but operationalizing those changes has been more challenging. The difficulty comes in integrating new technologies into an already established system," remarked McEachern.

For Douglas Morrison, president and CEO of the Centre for Excellence in Mining Innovation (CEMI), economic pressure will be the driving factor for the implementation of technology that significantly reduces the costs for metals needed to achieve electrification of the economy. "Climate change will soon begin to threaten coastal infrastructure on a scale which most economies will not be able to tolerate," stated Morrison, warning that if the demand for metals means the price of copper, nickel and lead increases, it will be harder to drive lower-cost carbon out of the economy and the trends in climate change will continue.

Morrison insists that we need to see greater volumes of base metal production, but at a lower price point, and this cost reduction must come not only from prospective mines which may not come into production within a decade, but from current mines as well. "If we change the cost of production significantly, we change the cut-off grade of ore, expand the volume of mineable ore and increase the life of mine," he explained, adding: "This requires us to implement whole-scale change in metal mining operations globally within the next decade. The innovation imperative for mining globally is to achieve a radical increase in the electrification of the economy; the consequences of failing are not trivial."

SMEs and start-ups: the lifeblood of innovation

Although there are mining companies at the forefront of innovation, such as Torex Gold Resources, Dundee Precious Metals and Newmont, the small and medium enterprises (SMEs) whose sole business is to create and develop mining technologies are often the real agents of change. Across Canada there are a number of world-leading mining-tech hubs, most notably in Sudbury, Val-d'Or, Toronto, Vancouver and Montreal.

The Sudbury and North Bay area in Northern Ontario is the home of the largest mining service sector hub in Canada. Although steeped in mining tradition, the modern day Sudbury Basin region is far from old-fashioned, with a high-tech ecosystem of companies producing ground-breaking technologies.

One such company is SafeSight Exploration, which celebrated its one-year anniversary of an underground drone program with Newmont in 2019. "This rugged utility drone integrates the latest LiDAR technology with an open platform flight controller and has the ability to go anywhere that a human should not go. The time for collecting data is also significantly reduced with the DB3 product being able to do a complete scan in approximately 15 mins," explained Mike Campigotto, president of SafeSight, who commented that his company is evolving to become more than just an underground drone specialist: "We are becoming a company that solves problems with innovative technologies rather than limiting ourselves to one type of technology. We can essentially become the technology extension of an innovation manager in a mine."

On the subject of new-technology implementation, Campigotto acknowledged that the majority of mining companies do not want to be first-adopters, but having a high-profile partnership can lead to further collaborations once the innovation has been proven, as has been the case with SafeSight which built upon its work with Newmont to collaborate with Redpath Mining, Wesdome Gold Mines and Barrick. "After just under three years in the field, SafeSight has already flown over 100 operational missions, so despite bringing innovation into a conservative industry, we have tangible proof that the best technologies can be adopted," he concluded.

Another Sudbury-based company to have had considerable success disseminating its technology is Maestro Digital Mine, which now supplies solutions to over 130 mines worldwide, according to Michael Gribbons, co-founder and vice president. Maestro launched its Zephyr AQS solution in May 2019, a low-cost air quality monitoring station for underground mines, after studying market data to find out what its users were buying and designing a product to fit a profile that matched 75% of these buyers. "The flaw of many technology companies is to hang on to a product and fail to innovate, and the innovation cycle is slow," observed Gribbons.

When asked which factor seemed to be top of the agenda of mining companies in 2019, Gribbons replied unequivocally that productivity has been the number one focus. "A 10% reduction in energy use does not have the same impact as a 10% increase in production," he said, underlining the importance of understanding the operating principles of a mine and how mine managers are being compensated. "The primary focus is on tonnage feeding the mill and second is health and safety. Energy is important but it is nowhere near those two parameters," he added, noting that Maestro's solutions can help dramatically in all three areas.

When it comes to step-change technology, the potential to reduce the cost of material movement from US$3.27 to US$0.16 per tonne is the type of impact that mining companies cannot afford to ignore, or perhaps, may find hard to believe, according to Jim Fisk, executive chairman of Rail-Veyor. Rail-Veyor's conveyor belt ore transportation technology has been implemented in mines across four continents, including Agnico Eagle's Goldex mine in Val-d'Or. Although the technology has gained traction through high-profile collaborations, Fisk commented that a resistance to change is still apparent when one does not have an engaged audience willing to consider a new process. "Many companies just look at the capital cost and forget about the operating cost, but in my experience mines shut down because of high operating costs, not because of high capex," he said.

While some innovations change or reinvent processes that have been in place for years, others enhance what is already in use. This is the case of Deep Cryogenics International, the Halifax-based start-up which addresses abrasive wear problems for mining tools and components. "Making items last longer is the eternal engineering challenge and this is what the Deep Cryogenics process does," stated Jack Cahn, founder and president, who explained how the deep cryogenics process takes the nitrogen in the air, separates and chills it to -196 C before warming it back up and imparting a permanent wear resistance to the metals. "The process uses no chemicals, leaves no waste, causes no harm, is not dangerous, is environmentally neutral, infinitely renewable and recyclable," he added.

Ok Tedi Opts-in for Workforce Optimization Technology

Papua New Guinea's Ok Tedi mine implements Immersive Technologies' Operator Performance Analytics program to improve safety and encourage machine care among its operators.

Ok Tedi Mining Ltd. operates the longest-running open-pit copper, gold and silver mine in Papua New Guinea. From the start of operations in 1984 to the end of 2018, Ok Tedi produced 4.83 million metric tons (mt) of copper, 14.8 million ounces (oz) of gold and 32.7 million oz of silver. Safety and environment are high on the list of company priorities, and there is ongoing management focus on operator safety. A recent announcement from mining equipment simulation-system provider Immersive Technologies reported that as part of that commitment, the mining company has established a fully integrated Immersive Technologies Operator Performance Analytics (OPA) system. The mine is using this workforce optimization technology to drive improvements in workforce development.

Immersive described OPA as a business improvement service providing site stakeholders with accurate, timely intelligence on operator performance variability and training needs analysis. The service is structured to deliver immediate analysis across multiple data systems, and critical information is presented in a dashboard format tailored to stakeholder needs.

Following years of ontinuous improvement projects and Managed Services by Immersive, OK Tedi opted to establish the OPA installation on-site with the dual goals of improving safety and machine care among its operators. Immersive said that by using the OPA electronic operator scorecard, the customer was able to drill down to individual operator performance indicators, which can be used to see how an operator compares with peers or is trending over time. Ranking of all operators additionally provided an opportunity to motivate personal ownership of safety statistics and performance, while giving management an effective tool to identify training needs to improve overall mine site productivity.

Operator Performance Analytics (OPA) dashboard samples.

OPA data, according to Immersive, can also be filtered to show machine errors, performance on different machines, performance over time and training history in order to locate the root cause of a performance trend. The customer analyzed an initial dataset containing six months of field-based machine operational data along with simulator data and used the results to identify outlier operators in terms of risk rating or performance against key metrics (such as spot time, average speed loaded and average tons per km/h).

With multiple operational data sources integrated within OPA, Immersive said OK Tedi easily identified an elevated incidence of "high-peak frame bias" events and was able to prioritize simulator training for operators contributing the highest error counts. Once underperforming operator groups or individuals are identified, these can be selected and assigned to a training needs analysis report. Simulator training can then be conducted and training data is automatically sent to OPA without manual intervention. Typical training scenarios for errors could require operators to navigate loaded trucks over rough road conditions or involve loading and dumping using correct procedures. In turn, this can be used for assessment of training retention and impact.

"Operator Performance Analytics has enabled quicker analysis of mine operator performance to identify trends or patterns to mitigate risk relating to equipment reliability and operator productivity metrics. We now have a reliable operator data platform that gives real comprehensive data view to approach our operators and discuss training development needs or for reward and recognition for the outstanding performance based on both risk and productivity criteria," said Masket Siune, superintendent, mine business improvement and training at OK Tedi.

"At OK Tedi, analysis that previously took days or weeks now take minutes, integrating disparate data systems with simulator generated data provides a single, powerful platform for workforce development planning," said Alex Da Silva, global professional services manager at Immersive Technologies.

Immersive said OK Tedi plans to extend the use of OPA to additional machines types to further support its operations.

New Trailer Suspension Gives 'Big Iron' Smoother Ride

Moving large mining equipment such as bulldozers, loaders, graders and even bigger units that can be broken down into highway-transportable components can be an expensive process. Combine the loss of production while equipment is out of service with the costs of transportation and the result can be a delicate dance between expense, machine and worker safety, speed and in some cases, availability. The appropriate lowboy trailer for a specific type and weight of a mining machine might not be readily obtainable. Use of the wrong trailer or one with a suspension not capable of coping with super-heavy loads can result in sudden calamity or delayed damage from undetected stress during transport.

Link Manufacturing, a leader in specialty engineered suspensions, presented a new suspension design at the recent CONEXPO-CON/AGG trade show that could make future heavy-equipment transport less dicey. The company introduced its TR50-HDT heavy-duty off-highway air-ride suspension at the show, mounting three of the 50K suspensions in a tri-axle configuration on a 100-ton-capacity mining trailer for display.

According to Link, until now heavy-haul, off-highway trailer manufacturers had few choices when it came to suspensions. They could outfit a trailer with a tri-axle walking-beam suspension, possibly exposing the trailer and its cargo to jounce, rebound and other significant dynamic stresses when encountering uneven terrain. To improve ride quality, manufacturers could also choose lower-capacity air-ride suspensions, but in the quad configuration required to bear heavier loads, these imposed their own stress-inducing forces associated with wheel drag or scrubbing.

With the introduction of the TR50-HDT heavy-duty off-highway air-ride suspension, Link claims trailer manufacturers now have a more effective and efficient way to equip their heavy-haul trailers for severe-duty environments. The TR50-HDT, in its tri-axle configuration, gives trailer OEMs the ability to achieve the higher load capacities they seek, while maintaining the superior ride characteristics of an air-ride suspension, without the added weight and scrubbing issues associated with a quad.

"The TR50-HDT was engineered specifically for off-highway and mining trailer applications and was designed to reduce axle and trailer stress, overall weight and maintenance costs," said Greg Hulstein, director of engineering for Link.

Link says its new TR50-HDT trailer suspension will give trailer OEMs the ability to achieve higher load capacities while maintaining superior ride characteristics.

The company said the TR50-HDT offers trailer OEMs the highest capacity and range of articulation available in any air suspension. Designed for a standard 17-in. (43-cm) ride height with +/- 4 in. of travel, the suspension is also available in other ride heights upon request. The TR50-HDT's maximum axle spread is 60 in. (1.5 m) at its 50 K capacity, and it can operate at up to 40 mph (65 kmph) even over rugged terrain, according to the company.

Each TR50-HDT features three high-capacity air springs, plus heavy-duty ride shocks. The shocks help mitigate the dynamic forces that can damage trailers, axles and wheel ends, and the system is flexibly designed to allow additional shocks to be added if desired.

Link said the TR50-HDT can be configured to fit the majority of heavy-haul trailers with 17-in. ride height, and further customization is available. Two-axle A train, three-axle B train and super B train axle configurations can all be accommodated by the TR50-HDT.

Each TR50-HDT is fully integrated with a 6-in. solid round KGI axle. The 92.8-in.-axle track utilizes 14R 25-in. wheel ends and 18-in. drum brakes.

Epiroc, ASI to Automate Roy Hill Truck Fleet

Senior leaders from Hancock Prospecting, Marubeni, POSCO, Roy Hill, Epiroc and ASI Mining celebrate the contract signing to automate Roy Hill's haul truck fleet. (Photo: Roy Hill, Epiroc, ASI)

Iron ore mine Roy Hill, in the Pilbara in Western Australia, contracted Epiroc and ASI Mining to convert their fleet of 77 haul trucks for autonomous usage. The suppliers will work with Hitachi and Wencomine on truck conversion and integration of Roy Hill's existing Wenco fleet management system.

The solution will have the ability to expand to other mining vehicle types and manufacturers, as well as the capability to integrate with existing and future Roy Hill systems, the partnership reported.

The project has a phased implementation, with testing and production verification of up to eight trucks undertaken in the initial phase prior to the second phase of full fleet expansion from mid-2021, the partnership reported.

The mine plans to reskill and redeploy personnel to assist with the transition.

Roy Hill leadership said the mine is well-positioned to transition to automation. "Our teams on site and in our Remote Operations Centre in Perth have demonstrated a clear capacity to deliver complex projects, sustainable change and operational excellence with the recent success of the autonomous drill program and fleet optimization initiatives," Roy Hill CEO Barry Fitzgerald said.

Epiroc said the company is proud to partner on the fleet automation project. "This is a very strong example of how automation will take a mining company's operation to the next level," Helena Hedblom, senior executive vice president, mining and infrastructure, said.

Perenti Reports Solid Book of Business

Perenti announced its Surface Mining Industry Sector Group has been awarded $155.5 million in new and extended contracts.

The company is working on a three-year contract for production drilling services at the Boggabri mine in New South Wales; three-year contract extension for reverse circulation and grade control at a Western Australian iron ore operation; 12-month contract extension with Consolidated Minerals to support current mining operations and regional expansion projects; the expansion of services for a major mining contractor in Queensland; 12-month extension to existing work at Gold Fields' St. Ives and Granny Smith projects, which involves land and lake rigs for air core, reverse circulation and diamond drilling; and an equipment hire agreement with E&P at Gold Fields' Damang mine in Ghana.

Perenti reported that subsidiary Barminco was awarded a three-year $200 million contract by Panoramic Resources for mine development production and haulage to include a new fleet at the underground nickel-copper-cobalt Savannah Project. The project is expected to employ 170 people. Barminco and Panoramic will develop a mobilization plan, and contract mining was calendared to begin in late Q1 2020.

Management at the mine reported execution of the contract represents a significant step. "With Barminco's proven expertise, we are confident that underground mining productivities at Savannah are set to improve significantly over the coming months," Victor Rajasooriar, managing director and CEO, Panoramic, said.

Metso Fullfilling Contract in Chile

Metso reported it is delivering on a significant performance solutions contract at Sierra Gorda SCM Copper & Molybdenum mine in Chile. The services provided include preventative maintenance and calibration of Sierra Gorda's eight on-stream analyzers.

Metso's contract at Sierra Gorda in Chile, above, includes preventative maintenance and calibration of eight on-stream analyzers. (Photo: Sierra Gorda)

President of Minerals Consumables, Metso, Sami Takaluoma cuts the ribbon at the opening of the new foundry. (Photo: Metso)

Metso's responsibilities include performing maintenance of the sample handling system, and maintenance and calibration of the analyzers.

The two-year contract commenced in February 2019 and includes daily, weekly and monthly taks.

The mine's leadership said the service provided by the Metso team demonstrates true professionalism, collaboration and teamwork. "We are really satisfied with the work Metso has delivered and look forward to our continued partnership," Edgardo Chiappa, plant manager, Sierra Gorda SCM, said.

Separately, Metso announced a foundry project in Vadodara, India, which would supply castings for the company, had achieved first pour.

The new $27 million foundry uses Lean principles, which will enable strong on-time delivery performance, shorter lead times, and world-class quality of finished products, Metso reported.

Leadership at Metso reported the foundry will have a strong role in the company's global foundry network. "The new facility with its modern and efficient production processes increases our product availability with reduced lead times," Sami Takaluoma, president, minerals consumables, Metso, said.

India's NALCO Taps Outotec for Filtration Tech

India's National Aluminum Co. Ltd. (NALCO) tapped Outotec for the delivery of technology and services for NALCO's alumina refinery expansion in Damanjodi, Odisha, India. The contract is valued at $16 million.

The scope of delivery covers the engineering of two alumina calciners and hydrate filtration plants, supply of key equipment, and advisory services for installation and commissioning, with deliveries taking place in 2021. The new plants will increase NALCO's annual alumina production by 1 million metric tons (mt), Outotec reported.

Outotec reported the company has previously delivered three process lines for NALCO's existing calcination and hydrate filtration plant, the first two of which have been in operation since 1987. "We are excited about the continued cooperation with NALCO and the delivery of our latest technology improvements for their expansion project," Kalle Härkki, head of Outotec's metals refining business, said.

FLSmidth Sells Separation Tech in Belarus

CITIC Construction Co. contracted FLSmidth for equipment for Slavkaliy's new potassium mining and processing facility in Nezhinksy, Belarus. The contract is valued at $51.5 million and covers the delivery of liquid-solid separation equipment islands.

The separation equipment includes a large number of thickeners and clarifies, pan and horizontal belt filter packages, FLSmidth reported. All equipment islands come with a full automation package.

The delivery will begin at the end of 2020 and is expected to be completed in 2021.

FLSmidth leadership said the equipment would enable the miner to run a cutting-edge operation with a strong focus on productivity, efficiency and sustainability. "This significant level of automation and digitalization, in combination with our equipment, will mean the lowest possible on-site energy consumption," Manfred Schaffer, president, mining, FLSmidth, said.

The new mining and processing complex will have an output capacity of between 1.1 million to 2 million mt/y of potassium chloride. The complex is expected to open in Q4 2023.

Rolls-Royce, ASI Sign MOU on Autonomous Engines

Rolls-Royce and Autonomous Solutions Inc. (ASI) signed a Memorandum of Understanding enabling the former to offer autonomous-compatible, Mobius-ready MTU engine solutions for equipment in a range of mining applications. Offerings will include engine solutions that are compatible with ASI's vehicle automation software to help optimize vehicle power performance and efficiency, the partners reported.

Customers could retrofit the power system on existing haul trucks and convert them to autonomous operation. Such would improve performance and enable savings on operating costs, the partnership reported.

Rolls-Royce said the partnership would offer integrated future-oriented autonomous solutions. "This agreement may help mining operators save big on operational costs and at the same time reduce their environmental footprint by cutting emissions," Scott Woodruff, global director, mining and oil and gas, Rolls-Royce Power Systems, said.

ASI leadership said the development is "another testament to the interoperability of Mobius and real value it adds to our mining customers."

Rolls-Royce and ASI partner to make some of the former's mining-class engines autonomous-ready. Above, the MTU Series 4000 Mining. (Photo: Rolls-Royce)

Zyfra, COSAPI Install FMS at Peru Mine

Zyfra Mining and CT Power implemented a fleet management and monitoring system for COSAPI Mineria at the Shougang Hierro mine, near Marcona, Ica region, Peru. All trucks, electro-hydraulic and diesel shovels, and drilling platforms were equipped with sensors, and a high-speed MESH WiFi network was installed.

The system provides information on the operation of machinery to operators and managers, Zyfra reported. Truck operators and electro-hydraulic shovels can visualize data in real time on intelligent panels inside the cabins of their vehicles. The dynamic optimization module automatically adjusts the best routes depending on the actual situation in the mine.

COSAPI reported the system will allow full monitoring of operations. It will increase productivity and safety by offering real-time equipment monitoring, automatic truck assignment using intelligent ad-hoc algorithms, high precision selectivity in loading, and high precision drilling guidance.

Zyfra said the joint project demonstrated the advantages and competitiveness of its technologies in Latin America. "In this project we have used best practices, proven in India and Morocco, as well as our technologies in the field of the internet of things and artificial intelligence," Pavel Rastopshin, managing director, Zyfra, said.

COSAPI Minería is a construction and engineering contractor for the open-pit operation.

Partnership on Mine Monitoring Solution

Machine health monitoring and cloud technology company sensemetrics partnered with Yieldpoint, an instrumentation company, to bring to the Americas and Australasian markets a joint solution.

Under the agreement, Yieldpoint's d-Tech line of digital sensors were integrated with the sensemetrics cloud platform to enable underground mine operators to rapidly respond to changing conditions, sensemetrics reported. Expected benefits include the ability to: accurately predict and prevent risk, improve safety conditions, save thousands of hours of high-value engineering time and reduce overall operational costs.

Shougang Hierro mine in Peru adopts a fleet management system for its trucks, shovels and drills. The system was implemented by Zyfra Mining and CT Power. (Photo: Zyfra Mining)

Sensemetrics reported the partnership will bring together cutting-edge expertise and a track record of breakthrough impact. "We are excited to see how we will be able to transform operational performance and deliver step-change productivity improvements across the entire mine lifecycle," Cory Baldwin, president, sensemetrics, said. "Combining these smart sensors with the sensemetrics cloud-based platform results in one of today's most innovative approaches to underground mining instrumentation."

Simmons Taps Fabick Mining as Distributer

Simmons Equipment Co. announced a comprehensive distribution and service agreement with Fabick Mining Inc., a division of Fabick CAT, for the Midwest region.

Simmons reported the development would enable the company to better serve customers in the region. "Their team has tremendous industry experience and a reputation of serving their customers well," Matt Simmons, president, Simmons Equipment, said. "We feel it's a real win for the customer."

Simmons Equipment is an OEM manufacturer of underground mining equipment, including battery and diesel scoops, battery powered haulage vehicles, and longwall shield haulers. Fabick Mining is an independent equipment dealership focused exclusively on supporting underground coal, lead and gypsum customers, and an ISO90001 certified manufacturer of equipment and components for several OEMs.

Partnership on Permanent Magnet Motor

Electrification company Equipmake partnered with additive manufacturer HiETA to develop what the partnership is calling the world's most dense permanent magnet electric motor.

The partnership, named AMPERE, is arranged to produce a lightweight, efficient motor with peak power density of more than 20 kW per kg, more than four times as power dense as a conventional electric motor.

AMPERE is expected to have a peak power of 220 kW at 30,000 rpm and a weight of less than 10 kg.

The first AMPERE prototypes will be operational in a year, the partnership reported.

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Pipeline Expansion Barrels Bring Benefits to Oil Sands Miner

Trelleborg pipeline expansion barrels are flexible in all directions to compensate for thermal expansion and lateral deflection in a pipeline system.

Trelleborg Group's marine and infrastructure operation, a part of its Industrial Solutions business area, has supplied rubber-lined expansion barrels to an unidentified customer in Fort McMurray in Alberta, Canada, described as one of the largest integrated combined oil sands mining and refinery facilities in the world. According to Trelleborg, the installation of its expansion barrels has significantly increased productivity at the mine while reducing downtime.

At large operations such as this, oil sands slurry and sediments are pumped long distances through the mine's pipeline system. Accordingly, the mine specified Trelleborg's expansion barrels to facilitate the slurry's extended travel during highly variable temperatures at the site. The expansion barrels, which were tested over a four-year period at the mine, are flexible in all directions to compensate for thermal expansion and lateral deflection in a pipe system.

Richard Hepworth, president of Trelleborg's marine and infrastructure operation, noted that testing at the mine site proved that the barrels allowed as much as 24,000 hours of slurry transfer in the system without maintenance, equating to approximately three years — in comparison with about 4,000 hours typically delivered by non-expanding barrels.

Trelleborg's barrel design can operate in temperatures from -46°C to 90°C and has an expansion/compression range of 910 m. The barrel also provides an installation hydraulic ram as a feature for simpler maintenance and rotation.

IsaMill Update: Smaller Footprint and New Model

Glencore Technology announced two significant developments in its line of IsaMill fine-grinding mills. According to the company, the product line has been redesigned to reduce civil infrastructure costs up to 28%, and a new 1,600-2,200-kW M7500 has been introduced to fill a gap between the M5000 and the M10000 models.

Engineering Manager Nick van Heerden said, "Several changes incrementally saved 22%-28% of costs to the client through a reduction in steel and concrete." The new, smaller plant configuration was achieved by lowering the IsaMill 2 m for an M3000/M5000 and 3 m for an M10000. The media hopper was moved from under the IsaMill to the side. Due to the backpressure created from the rotor, it was possible to utilize this to pump media out of the IsaMill during its maintenance shutdown sequence rather than drop it to the hopper below. In addition, tying gland and IsaCharger water directly into the plant water eliminated the need for separate tanks and their corresponding pumps.

The company said the new design allows the mill and access footprints of equivalently specified IsaMill and HIG

Design changes to Glencore Technology's IsaMill product line provide significant reductions in plant footprint space requirements and associated costs, the company says.

mills to be the same, while the IsaMill is roughly a third the height of the HIG mill.

Glencore Technology Lead Mike Hourn called the new M7500 "a significant option" for operations that require 1,600-2,200 kW of power yet prefer the availability, safety and product consistency of an IsaMill.

"These are huge wins for operations and for engineering firms wanting to specify the best fit. We've already installed the smaller configuration in Minsur and Woodlawn, but the new M7500 mill has only just been made available now. And like all our IsaMills, the M7500 is guaranteed to scale-up with 100% accuracy. We certainly look forward to installing our first."

New Bio-based Solution for Metals Extraction

Finnish companies Outotec and Neste Corp. announced they have jointly verified the viability of applying Neste's MY Renewable Isoalkane as a fully bio-based diluent for extracting metals in hydrometallurgical processes. The diluent is based on Neste's NEXBTL technology and produced entirely from bio-based waste and residue raw materials. Neste is a major producer of renewable diesel refined from waste and residues, as well as other refined oil products.

Outotec reported that laboratory studies and pilot trials at its research center in Pori, Finland, and Neste's technology center in Porvoo, Finland, confirmed high-level performance of the product for solvent extraction of copper, and that it can be also used for other base metals.

Because of its renewable origin and biodegradability, the bio-based diluent reduces environmental risk and has a remarkably smaller carbon footprint over its life cycle when compared to fossil equivalents, according to the two companies. In addition, Neste MY Renewable Isoalkane evaporates at a lower rate, which improves copper extraction efficiency and safety due to significantly reduced volatile organic compounds (VOCs), the company said.

Neste MY Renewable Isoalkane is claimed to be fully compatible with conventional fossil diluents at solvent extraction plants and can be introduced into the extraction process without any downtime.

"This cooperation with Neste is part of our continuous innovation efforts of improving the environmental performance of our technologies and helping our customers to meet their sustainability goals," Outotec Chief Technology OfficerKari Knuutila said. "In this project, experts from two industries discovered synergies and co-created a new application for Neste's bio-based product."

"Collaboration with Outotec provides us with a great opportunity to introduce Neste MY Renewable Isoalkane as a new 100% bio-based solution to metals extraction. Using Neste MY Renewable Isoalkane as a replacement to fossil diluents provides significant ecological benefits, while simultaneously improving the efficiency, economy and safety of metals extraction processes," said Mercedes Alonso, executive vice president, Renewable Polymers and Chemicals at Neste.

To introduce Neste MY Renewable Isoalkane to metal producers, Outotec will provide technical industry expertise, and Neste will handle production, sales and deliveries of the bio-based diluent to the solvent extraction sites globally.

Rig Drills 11-m Hole on Single Pass

Epiroc introduced the DM30 II SP (single pass), which the company described as a rotary blasthole drill for small mining operations. The crawler-mounted, hydraulic tophead-drive rig offers faster hole-to-hole drilling and a lower cost per ton through single-pass capability, the company reported.

The rig uses the same platform as the DM45 and DML blasthole drill rigs. It can achieve a clean hole depth of 11 m for single-pass applications, the company reported. It is easy to maneuver on tight benches and simple to transport in the pit and over the road.

The DM30 II SP is designed to handle 4- to 6.5-in. drill pipe and offers a pull-down of up to 30,000 lbf-ft and a hole diameter of almost 7.875 in., the company reported. A 36-ft single-pass tower option increases productivity for 29- to 36-ft drilling conditions by eliminating the need to add a second drill steel. Customers can choose a low- or high-pressure compressor, depending on their needs.

www.epiroc.com

Updated LHD Range Ready for Remote

Paus reported its entire LHD loader range has been revised. Models within the range are available in diesel, electric and ready for remote. The loaders are optimized for special conditions and enable highly efficient extraction, even in room-and-pillar mining, the company reported.

Payload capacity ranges between 1.5 metric tons (mt) for the PFL 8 and 6 mt for the PFL 30. The articulated vehicles have an optimized turning radius. The smallest loader, the PFL 8, has an inside radius of 2 m and an outside turning radius of 4.5 m.

The articulated oscillating axle steering on the PFL 20 and 30, and the articulated oscillating steering on the PFL 8 and 10, compensate for rough roads and provide optimal operator comfort, Paus reported. All controls can be reached from the driver's seat and are highly visible. The lateral seat arrangement provides the driver with good visibility when driving forwards and backwards.

The PFL 8 to 30 are delivered with Deutz engines. The PFL 10 and 20 are available with Cummins engines. The engines meet the various emission standards, the company reported.

The PFL 8 and PFL 20 are available in a battery-operated version. Mines wired for 400 to 1,000 volts (V) and 50 or 60 hertz, can adopt the PFL 15 E with tethered power supply.

www.paus.de

Hydraulic Power Source Offers 13.5-kWh Output

American Eagle released the 30P-E compressor, described as an an electrically driven air compressor. The reciprocating compressor is driven by a 48-V electric motor and controller. It is designed to be paired with work trucks that are built on an electric-hybrid chassis platform.

The compressor's small footprint, along with its weight of 225 lb, makes it a great addition to a hybrid work truck where higher air consumption is needed, the company reported. It produces a maximum air output of 30 cubic feet per minute (cfm) and up to 150 psi.

The company also released the 40P compressor, a lightweight hydraulically driven air compressor. The reciprocating compressor weighs 240 lb and produces a maximum air output of 40 cfm and up to 150 psi.

American Eagle also reported it added six new aluminum lube skids to its LubeMate Lube Systems line. The new skids include the V90, V120 and V160 Mobile and Permanent models, which are more than 30% lighter than their steel counterparts.

The weight savings offers operators the ability to add a lube system to their service truck without giving up valuable payload availability. The skids' aluminum construction provides not only significant

weight savings, but also superior corrosion resistance for lower maintenance and longer equipment life, the company reported.

The skids come standard with 5:1 new oil pumps, the 1-in. diaphragm pump with four-way valve, 0.5-in. by 50-ft new oil reels, and the 1-in. by 25-ft oil reel with quick coupler.

The company also introduced the Hybrid Power Source (HPS), a self-contained hydraulic power source that utilizes automotive-grade lithium-ion technology to provide a system that is low-voltage, anti-idle compliant and quiet during operation. It offers up to eight hours of run time, 13.5 kWh of output and more than 10 years of life.

americaneagleacc.com

Mobile Screen for Large-scale Aggregates

Metso showcased the latest addition to its mobile screens range, the Lokotrack ST4.10. The unit, recently launched in North America, is the largest mobile screen in the Lokotrack range, making it ideal for large-scale aggregates production, the company reported.

The ST4.10 has a 9 m^2 screen area. It features an extended feed hopper and adjustable side conveyors, making it compatible with large-scale crushing plants, such as the Lokotrack LT120 or the LT300HP. The unit is equipped with a diverter chute that enables the mixing of products from different decks. It is easy to set up, Metso reported.

The mobile screen is powered by a 106-kW engine. It is also available with an optional Bi-Power feature enabling it to be plugged to an external electric network or into a hybrid Lokotrack crusher equipped with an onboard diesel generator, such as the Lokotrack LT120E.

The ST4.10 can be equipped with the optional Metso IC process control system, which offers a safe single-button startup and the option to interlock the unit with other equipment. Metso IC can be leveraged by Metso Metrics data visualization service.

The screens were released in Europe in 2019.

Cleveland Brothers purchased the screen due to its closed circuit capabilities with the current LT300HP mobile cone crushing plant, Metso reported. The ST4.10 can communicate with the cone plant via an interlocking cable to ensure maximum production. Cleveland Brothers reported the large screening area was ideal. The ST4.10 can be moved in a single transportation load, it reported.

www.metso.com

3 Corrosion-resistant Pumps

Weir Minerals announced three new models in its Lewis range of pumps: the VL Axial Pump, the Horizontal Process Pump and the Vertical High Pressure Molten Salt Pump. The pumps are designed to maximize wear life in some of the world's most corrosive industrial applications while simplifying maintenance, the company reported.

The single stage, end suction Horizontal Process Pump combines long-lasting corrosion and wear resistance with the robust performance, efficiency and ease of maintenance associated with centrifugal pumps, Weir reported. The VL Axial Flow Pump offers heavy-duty construction ideal for use in corrosive, high temperature chemical processing applications. Its design can be customized to suit a wide variety of industrial applications, while its low component count makes servicing quicker and easier, Weir reported. The molten salt pump is for the solar industry.

All three pumps are constructed with Weir's Lewmet alloys, which incorporate highly specialized metallurgy designed to survive in the most corrosive industrial applications involving sulphur, sulphuric and phosphoric acids, the company reported.

The pumps are now available worldwide.

www.global.weir

Rugged Phone for Extreme Work Environments

RugGear released the RG170, which the company described as an ultra-rugged 4G smart-feature phone designed for professional use in extreme working conditions. With the push-to-talk-over-cellular function via a button, the phone enables completely encrypted and tap-proof communication.

Weighing 197 grams, the telephone has a 2.4-in. capacitive RGB display that supports the industry standard IP69 and is protected against high pressure and steam jets, RugGear reported. It meets the U.S. military standard MIL-STD 810H, and is protected against all types of liquids, dust, oil mist, vibrations, shocks and falls from up to 1.5 m.

The microphone as well as a 1.5-watt loudspeaker ensures smooth and easily understandable communication via LTE or a push-to-talk app, even in very noisy working environments, the company reported. The phone can be equipped with a SOS button, which can be used to automatically make emergency calls.

The extra-large keyboard is easy to operate with dirty hands or gloves. It supports 4G connectivity, Wi-Fi and essential industrial applications. The battery is available in two sizes, 2,800 mAh and 3,120 mAh.

ruggear.com

Gyro Option Orients Mapping Probe

Carlson reported the Gyro option on the C-ALS laser system, which offers mapping capabilities for underground cavities, gives greater navigational capability. It ensures the probe's position along the borehole can be determined without relying on the mechanical alignment of deployment rods or a magnetic compass.

The C-ALS probe is dropped into boreholes on cable or wires, or is pushed through them on rods or a boom. The system provides a detailed visual record of the subsurface environment, Carlson reported. It enables laser scanning of air-filled voids to create geo-referenced 3D models of subsurface conditions.

For the Gyro option, the probe is fitted with a miniaturized MEMS IMU, which contains a three-axis gyro that monitors the probe's heading and accelerometers that determine the inclination. Prior to deployment, the heading for the C-ALS Gyro probe is established in relation to the mine's grid system, which gives the reference orientation for the rest of the deployment. The software automatically identifies the gyro and offers controls.

The rods or cables by which the probe is typically moved or suspended are no longer used for the purpose of mechanically aligning the probe, Carlson reported. They may still be used to move the probe along through the hole.

www.carlsonsw.com

AutoMine Enables Autonomous Haulage

Sandvik reported its AutoMine for Trucks enables autonomous haulage, turning intelligent mining trucks into unmanned robots that keep running.

AutoMine for Trucks enables autonomous ramp haulage, and leverages smart handover technology that allows trucks to switch from underground to surface navigation mode in real time, Sandvik reported. This allows trucks to continue through the ramp portal seamlessly to the surface to complete the dumping cycle.

Field results show AutoMine reduces equipment damage and repair work, while adding the highest levels of efficiency and fleet utilization, giving a lower cost per ton, the company reported. The solution is scalable and can be supervised from remote applications.

AutoMine connects to Sandvik OptiMine, enabling efficient production planning and automatic dispatch of tasks to AutoMine for production execution, Sandvik reported. The progress of production tasks are reported back to OptiMine, giving mines real-time visibility of their automated and manual operations, and enabling them to make informed decisions on their operation

www.rocktechnology.sandvik

Fleet Management System

Stellar Industries introduced Stellar Telematics, which the company said will help customers optimize their fleet and increase uptime. The system consists of Fleet View for fleet managers and Stellar E-Link Mobile for operators.

The Fleet View online dashboard helps fleet managers maintain a productive and efficient fleet by giving them access to real-time and historical data on equipment, Stellar Industries said. It offers the ability to monitor data on load trends and compressor usage. Data from Fleet View allows fleet managers to right-size their fleet application and location, to better understand operator behavior, and to anticipate upcoming preventive maintenance needs.

E-Link Mobile gives operators the ability to control equipment, access real-time diagnostics, and view upcoming preventive maintenance needs, all from a mobile device, Stellar Industries reported. It lets operators access technical manuals and reach customer service with the touch of a button.

www.stellarindustries.com

Potassium Measurement System for Potash

Berthold released the LB474, a potassium (and radioactive isotope K-40) content-measurement system for the potash industry. The system uses three different types of detectors, depending on the

process conditions and mechanical arrangement, the company reported. It is non-contacting, almost eliminating maintenance and downtime.

Benefits include outstanding sensitivity, proven technology, real-time measurement, and easy installation, the company reported. The system features an online display, enhanced diagnostics, an event log, NRTL approval, and optionality with a HART connection.

www.berthold.com

Digital Meter for Harsh Environments

Simpson released the Eagle, described as a programmable digital meter with a reinforced fiberglass enclosure for extreme environment applications. The meter is programmable to measure AC/DC voltage, AC current or frequency.

The user programs the Eagle by computer via a USB port and cable. The user can program for bar graphs and pre-set alarms that alert operators when an established parameter is out of range. The meter offers a configurable backlighting that colors the screen white, red or green to instantly indicate the state of the system being monitored. The screen incorporates a message board that displays four-character custom messages, alarms and annunciators that keep the operator informed as to the state of the meter and the system it is monitoring.

The Eagle runs on 100 to 240 V AC. It can interact with other equipment using control relays, and is available with or without those relays.

The fiberglass enclosure face measures 7.31 by 7.31 in. It is 4.92 in. deep. Designed to be wall-mounted, it is rated NEMA 3, 3R, 3S, 4, 4X, 12 and 13, IP68, and the meter is CE, UL and RoHS certified.

www.simpsonelectric.com

Extra Extended Warranty on Engines

Cummins Inc. introduced the ENCOMPASS Extra extended warranty program for its latest F3.8, B4.5, B6.7 and L9 Performance Series engines.

Cummins standard engine warranty is 2 years or 2,000 hours, whichever occurs first; or 1 year with unlimited hours if the 2,000 hours is exceeded in the first year. The new ENCOMPASS Extra program provides a range of engine coverage options up to 5 years with unlimited hours. It can cover parts and labor; or parts, labor and travel depending on customer needs. Additional coverage is also available for the Cummins aftertreatment to provide the same protection level as with the engine.

www.cummins.com

Machine Tracking System Gives 3D Representation

Propeller Aerobotics announced a beta program for DirtMate, described by the company as a machine tracking system that delivers survey-grade progress and productivity data whenever needed.

DirtMate sensors fill in blind spots that occur between surveys with real-time data. After a wireless installation, the solar-powered sensors collect RTK GPS and IMU information. The sensors can also be wired to the machine.

The data stream feeds the Propeller Platform, which converts the data into live 3D surfaces. Worksites can use this information to generate cut and fill heatmaps, utilization graphs, and progress-to-design measurements, Propeller reported.

www.propelleraero.com

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Metal Prices Decline Amid Uncertainty

By Steve Fiscor, Editor-in-Chief

For months, this column has speculated on the possible impacts of the coronavirus (COVID-19) on the demand for mined commodities. During March, the disruptive forces aligned and the market began to see the results in reduced metal prices. Also during the month, the Russians broke rank with the Organization of the Petroleum Exporting Countries (OPEC) and oil prices began to decline. Their timing could not have been worse. COVID-19 would further weaken demand for oil. With a glut on the market, prices briefly plummeted below $20 per barrel. This situation caused panic selling by investors. They sold positions in everything, including equities, bonds and precious metals. At a time when gold prices should sky-rocket as a safe haven, they didn't. Investors moved toward cash positions across the board.

Compared to the other precious metals, gold held its ground. It lost $30 per ounce (oz) during March, settling at $1,610.20/oz as this edition was going to press. Silver fell from $17.19/oz to as low as $12/oz (-30%) before recovering to $14.48/oz (-16%). As far as platinum group metals, platinum and palladium lost 16% and 10%, respectively. Palladium prices dropped from $2,510/oz to $2,255/oz (-10%) and platinum dropped from $863/oz to $726/oz (-16%). Similar to silver, both dropped significantly during mid-March and then regained ground. Palladium prices fell to a low of $1,570/oz (-37%) and platinum fell to a low of $609/oz (-29%).

Of the non-ferrous base metals, aluminum was hit the hardest, dropping 15.1% from $1,706 per metric ton (mt) to $1,448.50/mt, or $0.78/lb to $0.66/lb. Copper declined from 14.9% from $5,668/mt ($2.58/lb) to $4,821.50/mt ($2.19/lb). Tin prices fell 13.1% from $16,750/mt to $14,550/mt. Prices for lead and nickel fell by 11.3% and 10.9%, respectively. At 7.1%, zinc managed to avoid a double-digit percent decline. Iron ore lost $5.41/dmt, falling from $87.14/dmt to $81.73/dmt.

Discussing the $12/oz sliver price, Refinitiv (formerly GFMS), which recently published the *Silver Market Review 2019*, explained that it got caught up in a broader market sell-off. "We expect prices to recover from current lows, driven by bargain hunting, before moving higher later in the year once the market hysteria calms down and safe haven demand kicks in, taking the silver price to an annual average of $15.75/oz this year, down by 3% year-on-year," said Cameron Alexander, manager of precious metals research for Refinitiv.

Total physical demand for silver was down by 2% last year to 1.035 billion oz (32,196 mt). Industrial fabrication fell by 4% to an estimated 555 million oz (17,259 mt), as demand was dragged down by a slowdown in the global economy.

On the supply side, mine production declined by less than 1% to an estimated 853.7 million oz (26,552 mt) in 2019.

E&MJ PRICES INDEX

(April 2, 2020)

Precious Metals ($/oz)		Base Metals ($/mt)		Minor Metals ($/mt)		Exchange Rates (U.S.$ Equivalent)	
Gold	$1,610.20	Aluminum	$1,448.50	Molybdenum	$17,995	Euro (€)	1.086
Silver	$14.48	Copper	$4,821.50	Cobalt	$29,500	U.K. (£)	1.237
Platinum	$726.00	Lead	$1,684.50			Canada ($)	0.708
Palladium	$2,255.00	Nickel	$11,185.00	Iron Ore ($/dmt)		Australia ($)	0.605
Rhodium	$10,000.00	Tin	$14,550.00	Fe CFR China	$81.73	South Africa (Rand)	0.054
Ruthenium	$260.00	Zinc	$1,845.00			China (¥)	0.141

Gold and silver prices provided by KITCO Bullion dealers (www.kitco.com). Platinum group metals prices provided by Johnson Matthey (www.platinum.matthey.com). Non-ferrous base and minor metal prices provided by London Metal Exchange (www.lme.co.uk). Iron ore prices provided by Platts Iron Ore Index. Currency exchange rates were provided by www.xe.com.

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