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This month, E&MJ reviews the improvements some of the manufacturers have made with new models of hydraulic shovels. (Cover photo: Komatsu Mining)

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Steve Fiscor
Publisher & Editor-in-Chief

Return to Normal or Not?

Throughout the news section in this edition, readers will see examples of miners doing the right thing. This should come as no surprise, especially to those who have worked for or worked with mining companies. They genuinely care for local communities and vice versa. Readers should also note that many of the countries that imposed lockdowns to stop the spread of the coronavirus (COVID-19) have reclassified mining as essential and allowed them to reopen. In return, the mines are demonstrating that they can provide a healthy work environment.

As more governments lift COVID-19 lockdowns and businesses start to rebuild, they will begin to take stock of the damage. Already, the blame game has started with several countries threatening to take actions against China. Supply chains have been disrupted and it will take months to re-establish manufacturing processes. Some businesses will never recover, but opportunities will open for new ones as the world looks to diversify.

The metals demand shock created by COVID-19 already appears to be passing in China. Only time will tell if a second phase of the virus will return. For now, disrupted supply (ore production at the mines) is affecting the smelters in China. They consume most of the concentrate (refined ore) that mining companies produce today to smelt the metals consumed in manufacturing processes. Soon things will return to normal. Or will they?

One of the lessons COVID-19 taught the world is that they are hopelessly dependent on China for just about everything. Yes, of course, everyone knew it, but once supplies dried up and businesses could not move product, they felt it. They were, in a sense, whistling as they walked past the graveyard for a generation.

Industry often talks about diversification and sustainability, but it's usually in the context of environmental, social and corporate governance (ES&G). Maybe businesses will now consider diversifying supply lines to make themselves more sustainable. Before they can do that, they must move away from the race to zero approach or buying supplies at the lowest cost. This topic is discussed in the blockchain article (See p. 48). When a manufacturer is buying tin or cobalt, for example, the transparency provided by blockchain would show them the value of paying a premium from a reputable source. Blockchain purchases will support mining companies that are abiding by ES&G principles.

Much of the world does not realize how we ended up in this position. By implementing strict environmental standards, resource-rich countries exported smelting and refining activities and the associated pollution to China and other Asian countries during the 1980s and 1990s. Perhaps it's time for mining companies and their host countries to consider vertical integration, build modern smelters that meet today's environmental standards, and remove the middleman. For that to happen, however, business and society would have to accept a fair price for the final product.

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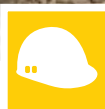
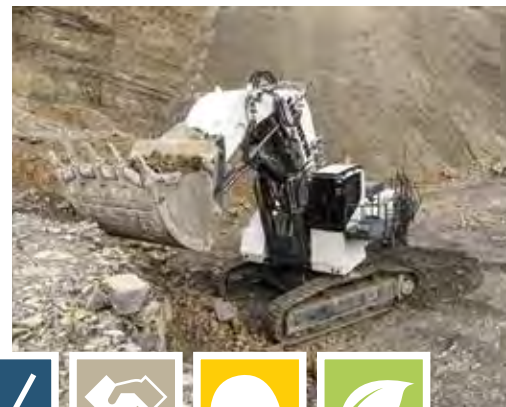
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Miners Fight to Stop Spread of COVID-19



From Moranbah to Newman to Escondida, BHP miners, its contractors and suppliers are adapting the way they work.

As the first quarter drew to a close, many mining companies were reporting their results and the coronavirus (COVID-19) and its effect on markets and operations were at the forefront of those discussions.

“We have operated safely for the quarter and have achieved another strong operational performance,” BHP CEO Mike Henry said. “We have implemented extensive measures across our operations to keep our people and communities safe from COVID-19. Working closely with relevant authorities and medical experts, strict travel and working practice arrangements have been established, including deferral of non-critical activity on our operating sites to support social distancing, revised rosters to reduce people travelling to site, more intensive site cleaning and health checks. I am encouraged to know that the small number of colleagues from our 72,000-strong global workforce who have tested positive for the virus have recovered or are recovering well.”

Henry said BHP delivered strong performance across its portfolio despite COVID-19, the impacts of planned maintenance and wet weather in Australia. He said Western Australia Iron Ore achieved record year-to-date production, while Escondida production also increased supported by record concentrator throughput.

“While demand in China has strengthened in recent weeks, we expect other major economies, including the U.S., Europe and India, to contract sharply in the June 2020 quarter,” Henry said.

Similarly, Anglo American Chief Executive Mark Cutifani said that most of Anglo’s sites around the world are continuing to operate, with an emphasis on safety reflected through appropriate health, hygiene and distancing measures. “We are taking all necessary steps to ensure the securi-

ty and integrity of our assets for the long term, preserving our ability to swiftly return affected operations to normal levels of production when appropriate,” Cutifani said.

The South African lockdown has significantly impacted diamond production at De Beers, production will likely be 7 million carats less than expected. At the company’s copper operations in Chile, Los Bronces and Collahuasi, production is at normal levels despite the workforce being reduced, by 50% and 40%, respectively, to ensure adequate de-densification and health screening measures. Overall performance for platinum group metals is improving and Anglo expects to achieve full production by year-end. Kumba iron ore in South Africa is operating at 50% capacity. The company’s metallurgical coal operations in Australia are continuing at normal levels despite revised rotations to manage social distancing and the impact of interstate travel restrictions. Thermal coal exports in South Africa continue with half the workforce. Production expected to progressively increase through May and June. El Cerrejón in Colombia has been placed on temporary care and maintenance. The Barro Alto nickel operation in Brazil is continuing at normal levels with appropriate protocols in place to ensure social distancing.

Anglo has implemented an extensive health awareness and support program called “WeCare,” specifically to protect the health and wellbeing of its employees and



In South Africa, Kumba Iron Ore delivers two filled Jojo tanks with tap stations to the Mapoteng informal settlement as well as two water bowsers and more than 2,000 bars of soap to the Tsantsabane informal settlements.

full-time contractors, and also measures in support of host communities. As part of this program, they are helping colleagues better understand how to protect themselves and others from catching the virus, monitoring their health to pick up early symptoms, and to manage their health if they test positive for COVID-19.

Russia's biggest metal and mining company Norilsk Nickel recently donated \$143 million to combat the spread of COVID-19 and to protect the health of its workers. The funds will provide medical equipment, medicine and personal protective gear for local healthcare facilities, the company's operating sites and employees, as well as extend additional support to employees and to small- and medium-sized enterprises (SMEs) in Norilsk's regions of operation.

"Norilsk Nickel is dealing with this crisis with a sufficient safety margin to ensure the maximum possible protection for our workers and all residents of the cities hosting our enterprises," said Vladimir Potanin, Norilsk Nickel president and Russia's wealthiest businessman. "Viruses, no matter how dangerous, come and pass, but we must never lose sight of our main asset: our talented people. I have ordered additional measures to support our workers and residents in our cities. I am certain that together with our employees, the residents of our cities, as well as with the whole country, we will overcome this challenge successfully."

Quebec Allows Mines to Reopen

On Monday, April 13, the government of Quebec added mining operations to the list of priority activities and services that are permitted to operate while the province responds to the coronavirus (COVID-19) pandemic. Mining activities are now starting to resume in a gradual and supervised manner.

Agnico Eagle Mines (AEM) reported it is taking steps to resume its operations in Quebec's Abitibi region, which includes the LaRonde Complex, the Goldex mine and the Canadian Malartic mine (50% AEM, 50% Yamana Gold), in an orderly fashion while ensuring the safety of employees. At each of these operations, AEM will implement health, hygiene and physical distancing measures that meet or exceed the government's requirements. The company also said it will communicate with the government of Quebec to ensure ongoing compliance.

Eldorado Gold Corp. restarted operations at Lamaque. The company said it has safety protocols in place to address COVID-19 at all its sites, including La-

maque, such as temperature screening, compliance with additional hygiene measures and task observation to ensure that all work is performed respecting physical

Silvercorp Will Buy Guyana Goldfields

Silvercorp Metals plans to acquire Guyana Goldfields in a cash and share transaction valued at C\$105 million (US\$75.48 million). Silvercorp said the move would further diversify the company, which already has two profitable underground silver mining operations in China, by adding a gold mining operation in Guyana, the Aurora gold mine.

At the same time, Silvercorp and Guyana Goldfields have also entered into a loan agreement, whereby Silvercorp will lend Guyana Goldfields up to US\$15 million. The funds from the interim loan were designated for ongoing operations at the Aurora gold mine.

"With the addition of Aurora to our growing asset portfolio, we believe this is a rare opportunity to leverage our underground mining expertise and strong balance sheet to unlock value for all shareholders through the development of the Aurora Underground Project as well as aggressive exploration programs in a proven gold district," Silvercorp Chairman and CEO Rui Feng said.

Last year, the Aurora operation produced 124,200 ounces (oz) of gold, a 17% decrease from 150,400 oz in

2018. The Aurora mill's throughput for 2019 averaged 7,300 metric tons per day (mt/d), up 4.3% from 7,000 mt/d in 2018. They processed more rock to produce less gold. The Aurora open-pit mine fell behind on waste stripping. Guyana Gold tried to use smaller mining benches and implement a pushback in two phases, one directly above the other. The plan didn't work and the company temporarily suspended waste stripping in favor of ore production from the bottom of the pit.

Guyana Gold knew ore production would be interrupted for four and six months in 2020. Toward the end of 2019, it became clear it would need additional funding to cover the cost of the waste stripping for the open-pit mine and development of the underground mine. They began to explore alternatives.

The deal has been unanimously approved by the Guyana Board of Directors, who recommends that Guyana shareholders vote in favor of the transaction. The combined entity will continue to be headquartered in Vancouver and detailed integration plans will be finalized over the next few months.



The Aurora mill (above) averages 7,300 mt/d for 2019, up 4.3% from 7,000 mt/d in 2018.

distancing, and the use of appropriate personal protective equipment.

Freeport Adjusts Plans to Compensate for Metal Prices

Freeport-McMoRan (FCX) has revised operating plans in response to the global COVID-19 pandemic and resulting negative impact on the global economy. The company, as *E&MJ* previously reported, has proactively implemented operating protocols at its operating sites to contain and mitigate the risk of spread of COVID-19. These actions included, among others, physical distancing, travel restrictions, sanitizing, and frequent health screening and monitoring. FCX is also incorporating testing procedures administered by medical providers at many of its facilities.

The revised FCX plan calls for reducing 2020 copper sales 11% to 3.1 billion lb from the 3.5 billion lb originally projected in January. Gold sales will increase slightly (1%) to 780,000 ounces (oz) from 775,000 oz. Molybdenum sales will decrease 9% to 80 million lb from 88 million lb. These projections are based on \$2.30/lb copper while the original plan was based on copper at \$2.85/lb. Capital expenditures for 2020 will decrease 29% to \$2 billion from \$2.8 billion projected at the beginning of the year.

FCX President and CEO Richard C. Adkerson said, "The prudent steps we are taking to safeguard our business, address costs and capital spending, and preserve our strong liquidity position are necessary to protect long-term asset values in the current weak and uncertain economic environment and to position us to ramp up and resume normal operations safely and quickly as health and economic conditions improve."

The company has suspended operations at the Chino copper mine in New Mexico because of the spread of COVID-19 among a limited number of employees. They continue to monitor, assess and update its COVID-19 related response, as needed.

Last year, FCX announced Innovation Initiatives at its North and South American operations. Capital projects, which were expected to total \$150 million for the year and were projected to add approximately 200 million lb per year (lb/y) of copper beginning in 2022, have been suspended.

Freeport operates seven open-pit copper mines in North America. Mining and milling rates for 2020 have been reduced by approximately 20%, resulting in a



Freeport's Lone Star operation in Arizona begins stacking copper ore on the leach pad.

projected 12% decline in North America copper sales for 2020. The plans take into account the impact of currently suspended operations at the Chino mine.

FCX elected to complete the initial phase of the Lone Star copper leach project with a remaining investment of approximately \$100 million in 2020. First production is expected during the second half of 2020. Initial production from the Lone Star copper leach project following a ramp-up period is expected to average approximately 200 million lb/y of copper, with the potential for future expansion options.

In April, FCX entered into forward sales contracts for 150 million lb of copper. The forward sales provide fixed pricing of \$2.34/lb of copper on approximately 60% of North America's projected sales volumes for May and June 2020.

Freeport operates two copper mines in South America, Cerro Verde in Peru (in which FCX owns a 53.56%) and El Abra in Chile (in which FCX owns a 51%). Peru has extended its national emergency declaration through May 10. Cerro Verde has been placed on a care and maintenance. Compared with the January estimates, Cerro Verde's mining and milling rates have been reduced by 13%, resulting in a decline in projected copper sales of approximately 130 million lb in 2020. Operating plans at El Abra have also been revised to incorporate lower mining rates, operating costs and capital spending.

In Indonesia, FCX has a 48.76% ownership interest in PT-FI and manages its mining operations. PT-FI has been successful in maintaining the health of its underground workforce. During first-quarter 2020, PT-FI achieved additional progress

in increasing mining rates by adding a total of 49 new drawbells at the Deep Mill Level Zone (DMLZ) and Grasberg Block Cave underground mines to build scale. Combined average daily production from the DMLZ and Grasberg Block Cave underground mines averaged approximately 37,500 metric tons per day (mt/d) of ore, slightly above forecast and 44% above the fourth-quarter 2019 average. PT-FI remains on track to continue to ramp-up production rates and expects 2021 production of 1.4 billion lb of copper (more than 75% above the current April 2020 estimate) and 1.4 million oz of gold (70% above the current April 2020 estimate).

The company is currently discussing with the Indonesian government a deferred schedule for the new Indonesian smelter.

FCX intends to reduce production from the Climax open-pit mine in Colorado by approximately 50% for the remainder of 2020. The Climax mine produced 17 million lb of molybdenum in 2019.

Exploration expenditures are being reduced by approximately 60% in 2020 (from the January estimate of \$70 million to approximately \$30 million) and activities will focus on analyzing and incorporating data from historical drilling programs.

Dominion Diamond Files for Insolvency Protection

Dominion Diamond Mines has filed for insolvency protection under the Companies' Creditors Arrangement Act (CCAA) and obtained an order from the Alberta Court of Queen's Bench granting Dominion protection.

(Continued on p. 22)



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Cleveland-Cliffs Idles Northshore Mining, Tilden Mine



Based on current projections, Northshore (above) will restart by August.

Based on current market conditions, Cleveland-Cliffs Inc. has decided to temporarily idle production at two of its iron ore mining operations, Northshore Mining in Minnesota and Tilden mine in Michigan. Cleveland-Cliffs said it will work down current inventory levels from these two operations and will continue to ship iron ore to fulfill its commercial agreements with steel customers.

Chairman, President and CEO Lourenco Goncalves said, "We have evaluated market conditions and the extraordinary disruptions in manufacturing and steel production in North America due to the impact of the COVID-19 market shock. As our steel customers rationalize their operations' capacities, we made the decision to adjust our iron ore production during the first half of the year and not continue to build additional iron ore inventory until market conditions improve."

Once the North American steel market improves, Cleveland-Cliffs will quickly restart and ramp up production, he added.

Cleveland-Cliffs temporarily idled production at Northshore mine in mid-April with a planned restart by August. The Tilden mine was temporarily idled by the end of April with a planned restart in July.

Black Butte Receives Positive Record of Decision

The Montana Department of Environmental Quality (DEQ) has released a positive Record of Decision (ROD) to grant a Mine Operating Permit (MOP) for Sandfire Resources' Black Butte copper project in

Montana. All required permitting is now in place for its 85% owned project, according to Sandfire. Granting of the MOP to Sandfire Resources America's subsidiary, Tintina Montana, represents the final permitting milestone required to allow development and underground mining of the Johnny Lee deposit at the Black Butte copper project to proceed.

Sandfire Managing Director and CEO Karl Simich said the completion of project permitting at Black Butte represents an exciting milestone on the company's pathway to develop a new, showcase underground copper mine in North America.

"We continue to tick important boxes as part of our long-term strategy to deliver a new, state-of-the-art copper mine at Black Butte, and the receipt of a positive RoD is a major achievement which marks the culmination of many years of patience and hard work," Simich said.

The Montana DEQ needs to finalize a financial bond calculation within 40 days to issue the MOP.

Tintina concurrently received its preliminary Air Quality Permit and a Montana Pollution Discharge Elimination System (PDES) permit.

The Johnny Lee deposit represents one of the highest copper grade undeveloped projects in the world with a measured and indicated resource of 10.9 million metric tons (mt) at 2.9% copper for 311,000 mt of contained copper, including a Lower Copper Zone with a copper grade of 6.8%, plus an Inferred Resource of 2.7 million mt at 3% copper for 80,000 mt of

contained copper, at a 1% copper cut-off, according to the company.

Black Butte's mine design is for a relatively shallow underground mine to be accessed by a 1,700-meter decline to access the Upper copper zone (60-200 m deep) first, followed by additional development to reach the Lower copper zone (300-500 m deep), the company said.

New Gold Restarts Rainy River

The Rainy River mine in Ontario, Canada, has begun a systematic ramp-up of operations following the completion of a voluntary 14-day suspension to adhere to provincial and federal COVID-19 guidelines related to out-of-country travel that impacted a significant portion of the local workforce. Operations will steadily ramp up over the coming weeks with the overarching priority of providing the safest possible environment for employees, New Gold said. Mine management will continue to work with surrounding indigenous and local communities to implement and coordinate actions that will reduce the risk of the spread of COVID-19, it said.

New Gold said it will initially use the local workforce during the progressive ramp-up of operations. This initial phase will be followed by the gradual reintroduction of the rotational workforce. To ensure the safety of its workforce and the local communities, the company has implemented extra measures in accordance with the recommendations of the Ontario Department of Public Health that will be overseen by the on-site nurse practitioner.

Feasibility Study Supports Ascot's Gold Projects

Ascot Resources has reported robust results from a feasibility study of its Premier and Red Mountain gold projects near Stewart, British Columbia. The study outlines a low-capital restart plan for the previously mined properties, with ore produced by underground mining of four deposits — Silver Coin, Big Missouri, and Premier on the Premier property and Red Mountain on the Red Mountain property.

Mining will be sequenced over an eight-year period to initially produce 1.1 million ounces (oz) of gold and 3 million oz of silver. The existing Premier mill will be refurbished to process 2,500 metric tons per day (mt/d).

Red Mountain is located approximately 23 kilometers (km) southeast of the existing Premier mill.

Initial capital expenditures to develop the projects are estimated at C\$147 million, including a 9% contingency and 22% indirect costs. The base case for the feasibility study considers mining of proven and probable reserves totaling 6.2 million mt at an average grade of 5.9 grams per metric ton (g/mt) gold and 19.7 g/mt silver. Life-of-mine all-in sustaining costs are estimated at \$769/oz of payable gold produced.

Ascot President and CEO Derek White said, "Completion of this feasibility study marks an important milestone for Ascot in the progression of restarting these projects. The current strong gold price environment, robust projected economics, and quick payback create an attractive opportunity to build our mines ...

"Management believes that future underground drilling will help to improve conversion of some of the remaining inferred resources and improve annual production rates. Next steps will be focused on advancing this exceptional gold project with all our stakeholders, while continuing to grow our mineral resources and reserves to enhance value through further drilling and delivering a number of identified opportunities."

Mining will begin on the Silver Coin and Big Missouri deposits, followed by the Red Mountain deposit in year three and then the Premier deposit. Access for production in the four operations will be through both new and existing adits, utilizing a combination of new ramp development and refurbishment of existing underground infrastructure.

This sequencing will allow mobile mining equipment and some fixed assets (electrical and ventilation) to be remobilized and reused at different deposits as dictated by mine schedules.

The feasibility study assumes a lease-to-own cost for the mobile mining equipment, which primarily consists of two scissor lifts, three jumbo drills, five haul trucks, five load-haul-dump machines, 15 ventilation fans, and several other smaller supporting pieces of equipment.

Mining methods will largely consist of long-hole stoping for most of the ore, with limited use of inclined undercut long-hole, room-and-pillar, and cut-and-fill mining in specific shallow or flat-lying stopes. Ore will be trucked to the processing facility, and mining waste will be used underground as a combination of rockfill and cemented rockfill.

The existing processing facility will be refurbished within a construction period of approximately 40 weeks. The plant will utilize conventional crushing, grinding, and gravity circuits followed by a standard carbon-in-leach process to produce doré bars.

The original Premier underground mine opened in 1918 and produced 2 million oz of gold and 45 million oz of silver prior to its closure in 1952.

BLM Approves Bell Mountain Mine

The Bureau of Land Management (BLM) has given the nod to Eros Resource Corp's Bell Mountain mine project. It will consist of open-pit mining and heap-leach processing located in Churchill County, Nevada, and will mine for gold and silver.

The project includes one new right-of-way for a water conveyance pipeline and use of the existing Earthquake Fault Road. This project will encompass approximately 180 acres of new disturbance on BLM-administered lands.

In the fourth quarter of 2018, Eros received notice that the Bell Mountain mining claims were no longer subject to a moratorium from the U.S. Navy, confirming that the Bell Mountain property will not be encumbered by the Fallon Naval Air Station expansion. The company has been aggressively pursuing the permitting of Bell.

Eros President and CEO Ron Netolitzky said, "Given the delays that the company faced when the Navy proposed to expropriate the property, the speed with which we have advanced through the permitting process has been key to ensuring the success of Bell Mountain. Eros wishes to thank our technical team in Nevada, along with our consultants, for their tireless efforts in this process."

Netolitzky said the company believes the scale of Bell Mountain can be significantly increased with additional exploration work on the property.

A preliminary economic assessment includes a four-year mine life, with total

production of 60,056 ounces (oz) of gold and 408,498 oz of silver, before expansion based on renewed exploration.

Cameco Suspends Uranium Production at Cigar Lake

Due to the increasing challenges associated with the Coronavirus (COVID-19), Cameco announced on March 23 that the Cigar Lake uranium mine in northern Saskatchewan would be placed on care and maintenance for four weeks, during which time they would assess the situation and decide whether to restart the mine or extend the production suspension. They have since decided to extend the suspension.

Cigar Lake ore is processed at Orano Canada Inc.'s McClean Lake mill, which is also presently in care and maintenance. Orano has also decided to extend the temporary production suspension at its McClean Lake mill.

"The proactive decisions we have made to protect our employees and to help slow down the spread of the COVID-19 virus are necessary decisions and they are consistent with our values," Cameco's president and CEO Tim Gitzel said.

Cameco has also placed the UF6 plant at the Port Hope Conversion Facility on temporary safe shutdown state for approximately four weeks and, where possible, maintenance work scheduled for the summer will be advanced.

Production at the Blind River Refinery was also suspended as most of the UO3 it produced is used to produce UF6 at the conversion facility. While production at the refinery is temporarily suspended, the operation will remain open to receive uranium concentrate deliveries.

USFS Updates Schedule for the Stibnite Gold Project

The U.S. Forest Service (USFS), along with other regulators working on the project, released an updated permitting schedule for the Stibnite Gold Project. In the updated schedule, the USFS has committed to releasing the draft Environmental Impact Statement (EIS) for the community to review and comment on in the third quarter of 2020.

"The team at the USFS updated the schedule after a comprehensive internal review by federal and state regulators identified areas for improvement to make the draft EIS more user accessible," Vice President of External Affairs for Midas

Gold McKinsey Lyon said. “To meet this objective and maintain the schedule, the USFS is dedicating additional resources to undertake the final review and release of the draft EIS.”

“A number of key milestones have been built into the updated timeline to keep everyone working on the project on track and on schedule,” Lyon said. “[We] hope that the additional time will make the document easier for the public to review, understand and provide feedback. We also feel confident the updated schedule will ultimately support a complete and robust record of decision at the conclusion of the NEPA process in 2021.”

She also said the updated timeline takes into account the evolving situation around the COVID-19 pandemic, as far as can be determined.

TMAC PFS Supports Doubling Hope Bay Production Rate

TMAC Resources has announced results of a preliminary feasibility study (PFS) of expansion of mine production from 2,000 metric tons per day (mt/d) to 4,000 mt/d at its Hope Bay operations in Nunavut, Canada, including development of a new 4,000-mt/d processing plant and development of underground mines on the property’s Madrid and Boston deposits.

The PFS suggests that 16.9 million mt of ore containing an estimated 3.5 million ounces (oz) of gold at an average grade of 6.5 grams/mt could be processed over a 15-year operating life. Total recovered gold is estimated at 3.1 million oz. Life-of-mine cash costs are estimated at \$841/oz, and all-in sustaining cost are estimated at \$986/oz.

Expansion capital expenditures for 2020 to 2023 are estimated at C\$683 million, including C\$184 million for a new processing plant.

The TMAC announcement cautions that the PFS does not take into account potential significant delays relating to the spread of the Covid-19 virus, including being able to order long-lead items or to complete critical test work, analysis, and engineering necessary to maintain the schedules presented in the PFS.

Underground mining at Hope Bay will incorporate long-hole mining methods in order to address deposit geometries and anticipated ground conditions. Mining will take place in permafrost where the mineralization is located away from wa-

ter bodies and also in unfrozen ground, known as talik, situated adjacent to and under lakes.

The deposits will be accessed by ramps from surface. The ramps will also be used for ore and waste haulage from the underground operations. The Doris deposit is currently in production, with an existing decline reaching active mining areas. Mining will continue as per current methods until depletion. Transverse and longitudinal long-hole mining are planned for Doris.

Madrid North and Boston will be mined using long-hole stoping methods, with sub-levels placed at 20-m vertical intervals. Both longitudinal and transverse accesses will be used, depending on the width of the ore zones. Madrid South, where ore zones are much narrower, will be mined using the long-hole stoping method, with sub-levels placed at 16-m intervals. The majority of stopes at Madrid South will have longitudinal accesses.

The new processing plant will recover gold from the ore through conventional crushing, grinding, and cyanide leaching.

Mine waste rock produced from underground mining will be temporarily stored on surface before being used as mine backfill. No mine waste rock will remain on surface post mining activities. Final closure activities are planned to ensure affected areas remain chemically and physically stable.

Marathon Advances Valentine Gold Project in Newfoundland

Marathon Gold Corp. has reported results of a prefeasibility study (PFS) of its Valentine gold project in Central Newfoundland. The study supports an open-pit mining operation, with low initial capital cost of C\$272 million and a high rate of return over a 12-year mine life. Gold production would average 175,000 ounces per year (oz/y) in years 1 through 9 from processing high-grade mill feed and 54,000 oz/y in years 10 through 12 from processing a low-grade stockpile.

Mill capacity is planned at 6,800 metric tons per day (mt/d) during years 1 through 3 based on gravity-leaching, expanding to 11,000 mt/d in year 4 based on gravity-flotation-leaching, with life-of-mine average gold recovery of 93%.

Proven and probable mineral reserves total 1.87 million oz of gold in 41.05 million mt at a grade of 1.41 grams (g) per mt.



Life-of-mine total cash costs are estimated at US\$633/oz, and all-in sustaining costs are estimated at US\$739/oz. After-tax payback is estimated at 1.8 years.

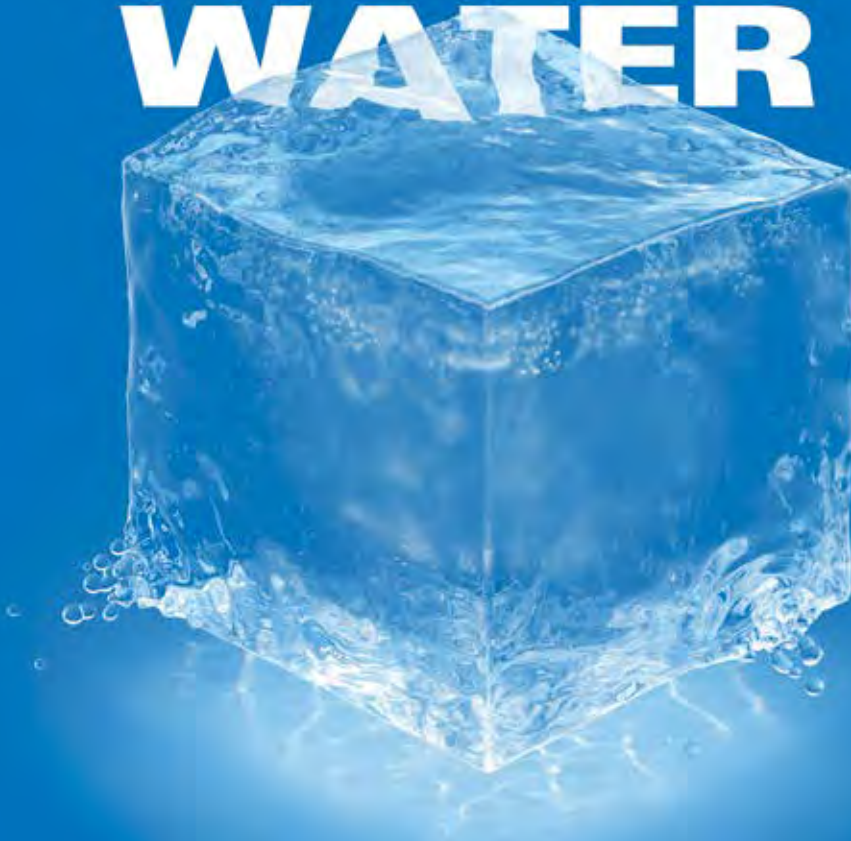
Marathon is targeting completion of a feasibility study of the Valentine project in the first half of 2021, completion of the Environmental Assessment and Ministerial Approval by mid-2021, and commencement of site-specific permitting thereafter. Ground-breaking for site construction is scheduled for January 1, 2022, followed by an 18-month construction period and first gold production by mid-2023.

The Valentine project PFS contemplates open-pit mining from the Marathon and Leprechaun deposits only. Ore with a cut-off grade of 0.70 g/mt gold will be prioritized for mill processing, initially at 6,800 mt/d and then at 11,000 mt/d. Ore between 0.70 g/mt and 0.33 g/mt gold will be stockpiled for processing at the end of the mine life.

Each deposit will be developed in three phases, with the Marathon pit achieving maximum dimensions of 1,250 m by 700 m by 294 m deep and the Leprechaun pit achieving maximum dimensions of 1,050 m by 650 m by 306 m deep. Life-of-mine strip ratios will be 6.7 at Marathon, 9.1 at Leprechaun and 7.6 overall.

Mining will be by conventional drill-blast-load-haul methods on 6-m bench heights with 8-m-wide berms every third bench. Dual-lane haul road allowances will support a diesel-powered mining fleet that will include 32 90-mt-payload trucks operating between the two open pits.

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Tony Giardini

Trilogy Metals Inc. appointed **Tony Giardini** as president and CEO, effective June 1. Giardini has been a director of the company since 2012. Previously, Giardini was president of Ivanhoe Mines Ltd. and as CFO at Kinross Gold Corp. **James "Jim" Gowans** will continue in his role as interim president and CEO until May 31. Gowans remains in his role as a director of the company and he will continue as a member of the Board of Ambler Metals LLC, overseeing the company's interests in its joint venture with South32 Ltd.



Jacques Perron

Pretivm Resources Inc. appointed **Jacques Perron** as president and CEO. Most recently, Perron was president, CEO and director of Thompson Creek Metals Co. Inc. until it was acquired by Centerra Gold Inc in 2016. Perron succeeds **Joseph Ovsenek**, who was Pretivm's president and CEO since 2017.

Outokumpu appointed **Heikki Malinen** as president and CEO and the chairman of the leadership team. He joined the company on May 1 and will assume his role as the CEO on May 16.



Heikki Malinen



Scott Davis

Golden Predator Mining Corp. appointed **Scott Davis** as CFO. Davis is a partner of Cross Davis & Co. LLP Chartered Professional Accountants. Davis has served as the CFO of several companies and his past experience consists of senior management positions, including four years at Appleby as an assistant financial controller. Davis has replaced **Greg Hayes**.



Rob Henderson

Great Panther Mining Ltd. announced changes to the board of directors and senior management team. **Rob Henderson** has been appointed president and CEO. Most recently, Henderson was president and CEO of Amerigo Resources Ltd. **David Garofalo** has been appointed as incoming board chair. Garofalo, **Joseph Gallucci** and **Alan Hair** will join the board effective immediately.

Newcrest announced a successor as chief legal, risk and compliance officer and company secretary for **Francesca Lee**, who will retire from Newcrest on July 18. **Maria "Ria" Sanz Perez**, currently the executive vice president, group counsel, commercial and company secretary AngloGold Ashanti Ltd., will commence with Newcrest on July 1.



Maria "Ria" Sanz Perez

Aura Minerals Inc. appointed **Fabio Ribeiro** to the Board of Directors.

Orosur Mining Inc. announced that CEO **Ignacio Salazar** will leave the company on July 17 to take up a new position as CEO of Highfield Resources Ltd. A search for his replacement has commenced.

Copper Lake Resources Ltd. appointed **Naomi Johnson** to the board of directors. Johnson is a lawyer with more than 12 years of experience working in the mineral industry as a global corporate social responsibility executive, primarily in a community relations role both domestically and internationally. From 2008 to 2017, Johnson worked for Barrick Gold Corp.

New Pacific Metals Corp. announced that **Dr. Rui Feng**, founder and CEO, has stepped down as CEO. **Dr. Mark Cruise**, COO, is appointed CEO, effective immediately. Dr. Feng will remain as a director of the company.



Dr. Mark Cruise

Bunker Hill Mining Corp. announced that **Sam Ash** has been appointed as president and CEO to replace **John Ryan**. Ryan will continue to serve as a member of the board of directors. Previously, Ash worked with Barrick Gold in various roles including general support manager for the Cortez mine in Nevada.



Peter Grönholm

Peter Grönholm has been appointed managing director of *ALLU Finland*.

Tenova hired **Roberto Pancaldi** as CEO. Previously, he was CEO of the Metals Division, while **Andrea Lovato**, the former Tenova CEO, will assume the role of TAKRAF CEO.



Roberto Pancaldi



Lukas Guenthardt



Andrew "Drew" Hobert

Eriez appointed **Lukas Guenthardt** to the position of president and CEO. Eriez selected Guenthardt to fill this leadership role when **Timothy Shuttleworth** retired. Guenthardt joined the Eriez Board of Directors in 2011 and was named executive vice president of global strategy and development in 2014. Eriez Flotation announced the promotion of **Andrew**

"Drew" Hobert to USA operations director. Hobert joined Eriez Flotation in 2014 as a process engineer and served most recently as technical services manager.



Iain Humphreys

Black & Veatch has named **Iain Humphreys** as the new water mining business line director and head of the company's regional office in Santiago, Chile.

MacLean Engineering hired **Jari Tuorila** as chief. Tuorila comes to MacLean from previous senior management roles with underground mining vehicle manufacturers out of Perth, Brisbane, and Sydney, as well as Singapore, Shanghai, Hanoi, and Ho Chi Minh City. He has 30-plus years in the mining and tunneling sectors.



Jari Tuorila



Jason Fisher

MineWare CEO and founder **Andrew Jessett** has stepped down from his role at the company to pursue new opportunities. Jessett founded MineWare in 2005, after independently creating and commercializing Pegasys. **Jason Fisher**, formerly MineWare regional vice president for Australasia, will now act as CEO, supported by the company's long-standing senior leadership team.



Otto Preiss

Rolls-Royce Power Systems appointed **Otto Preiss** as COO.



Larry Perino

The *National Mining Association (NMA)* recognized **Larry Perino** with the NMA Lifetime Environmental Achievement Award. Perino retired recently after more than four decades in mining, where he consistently made environmental stewardship a top priority. Perino has been instrumental in a variety of projects that have received national and local recognition including: 2019 AEMA (American Exploration and Mining Association) Environmental Excellence Award (Sunnsyde Mine); 2011 Bureau of Land Management (BLM) National Hardrock Mineral Environmental Award (Mineral Hill Mine); 2009 BLM National Hardrock Mineral Environmental Award (DeLamar Mine); and the 1994 Mined Land Reclamation Board Award, from the Mined Land Reclamation Board, Colorado Mining Association and the Colorado Rock Products Association (Sunnsyde Mine). He worked for Sunnsyde Gold Corp. (SGC) for more than four decades. He also worked for Kinross Gold.

allmineral employees mourn the loss of **Dr.-Ing. Heribert Breuer**. The long-time managing director died at the end of February at the age of 69 after a serious illness. Breuer co-founded allmineral Aufbereitungstechnik GmbH & Co. in March 1988 and was managing director of the company until 2016. The plant manufacturer from Düsseldorf has established itself worldwide as a specialist in the processing of ore, coal, gravel and sand as well as other primary and secondary raw materials. Breuer was a consultant to the company until his death.



Dr. Heribert Breuer



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JENNMAR has been the innovative leader in ground control for the mining industry for more than forty years. Over the past decade, our growth has led us to structural support in tunneling and civil construction projects, implementing the same vigor and detailed processes. Our JENNMAR Civil arch systems, lattice girders, and liner plates, as well as other products are made in the U.S.A. and backed by experienced engineers and technicians who are with you every step of the way, from initial consultation to qualified instruction and on-going technical support. We support and are dedicated to rebuilding America's infrastructure.



Barrick Acquires Interest in El Quevar

Barrick Gold has entered into an earn-in agreement with Golden Minerals to acquire a 70% interest in the El Quevar project located in the Salta Province of Argentina. As part of the agreement, Barrick will purchase US\$1 million of Golden Minerals shares pursuant to a private placement transaction at a price of \$0.21 per share.

Under the agreement, the Canadian company will have to invest \$10 million in exploration over a period of eight years. Disbursements will be organized as follows: \$ 500,000 in the first and second year; \$1 million in the third and fourth year; and \$2 million in the sixth, seventh, and eighth years. “The amounts can be spent sooner than required,” the statement said.

Last year, Barrick submitted the “NI 43-101 compliant prefeasibility study that describes a potentially profitable operation with mineral resources of not less than 2 million ounces of gold equivalent.”

El Quevar is a silver project that started in 2004 and is located 90 kilometers from the town of San Antonio de los Cobres, in the Puna de Salta. The total project area reaches almost 70,000 hectares (14 hectares for exploitation and 6 for exploration) and it is located more than 5,000 meters above sea level.

Mining Activity Gradually Resumes in Argentina

In Argentina, the government of San Juan, the chambers of the sector and the unions have agreed that the two main mining ventures in the province can start up again, after mining was declared an essential activity.

In response to this, 25% of mining workers have started at the Veladero and Gualcamayo gold mines, located in the border departments of Iglesia and Jáchal, for rotating periods of 14 days. About 500 workers will return to Veladero de Barrick and at least 100 to Gualcamayo de Yamana Gold, applying the biosecurity measures established in a resolution by the local mining authority.

“We have established the return to work in each of the enterprises gradually, and we began to outline the first steps to follow for the reactivation,” San Juan Minister of Mining Carlos Astudillo said.

Centaurus Completes Acquisition of Jaguar Nickel

Centaurus Metals has completed the acquisition of the Jaguar Nickel Sulphide Project in Brazil’s Carajás Mining District from Vale, the company said.

The agreement was announced back in August 2019. The consideration payable to Vale on closing for 100% acquisition of the Jaguar Project was a small upfront cash payment of US\$250,000 and the transfer of the company’s greenfield Salobo West tenure. All closing steps have now been completed including the payment of the initial cash consideration and the transfer of the Salobo West tenure. The main component of the cash consideration is deferred and contingent on successful production from the project, which demonstrates Vale’s comfort in Centaurus’ technical skills and sustainable approach in Brazil to further explore and develop the Project, the company said.

Following the commencement of drilling in November 2019, Centaurus has already completed more than 8,500 meters (45 drill holes) of in-fill and extensional resource drilling along with some exploratory drilling.

Centaurus Managing Director Darren Gordon said the completion of the Jaguar transaction with Vale marked a historic milestone for the company on its growth trajectory to become a substantial international nickel sulphide developer.

Feasibility Study Supports INV’s Loma Larga Project

INV Metals has announced positive results from an independent, updated feasibility study of its 100% owned Loma Larga gold-copper-silver project in south-central Ecuador, about 480 kilometers (km) south of Quito. Life-of-mine production of payable metals in separate gold pyrite and gold-copper concentrates over a 12-year mine life is forecast at 1.61 million ounces (oz) of gold, 8.87 million oz of silver, and 58.84 million lb of copper.

The feasibility study identifies Loma Larga as a low-cost operation, with expected life-of-mine all-in sustaining costs of \$627/oz. Initial preproduction capital expenditures are estimated at \$316 million, with sustaining capital of \$71

million and closure costs of \$22 million, including taxes and duties.

Loma Larga has proven and probable reserves of 13.9 million metric tons (mt) grading 4.91 grams (g) per mt gold, 29.6 g/mt silver, and 0.29% copper, containing 2.2 million oz of gold, 13.27 million oz of silver, and 88 million lb of copper.

The underground mine will be accessed by a 1.2-km-long ramp, 5 m high by 5 m wide, that will serve as the access to the mine for personnel and materials, haulage of waste and ore, and ventilation. Due to the high-grade nature of the orebody and positive geotechnical conditions, the deposit will primarily be mined by long-hole stoping, with stopes 20 m long by 20 m wide by 25 m high. Some zones will utilize drift-and-fill mining where appropriate.

Ore production of 3,000 mt/d is planned from primary and secondary stopes for the first four years, generating approximately 1 million mt/y of ore. From year 5, daily average ore production will increase to 3,400 mt/d through plant optimization, and plant throughput will increase to about 1.24 million mt/y.

Ore will be processed using primary and secondary crushing, a ball mill, and a two-stage sequential flotation circuit to recover gold, silver, and copper into two separate saleable concentrates that will be trucked to port for export.

Overall gold, silver, and copper recoveries into concentrate are estimated at 90%, 95%, and 96%, respectively.

Orex, Pan Am Silver Form JV to Develop Project in Mexico

Orex Minerals and Pan American Silver have agreed to form a joint venture to further explore and develop the Sandra project, formerly the Sandra-Escobar project, in Durango, Mexico. The project is a consolidation of two groups of claims controlled by the companies. Orex and Pan American will own 40% and 60% interests, respectively, in a new joint-venture company that will be formed for the project.

Orex will be the initial operator of the project. The Sandra project is located north of the town of Tepehuanes in Durango state. The project consists of the Sandra property of 6,335 ha and Escobar property of 635 ha of mineral concessions.

Fortescue Provides Production Update



Fortescue has capitalized on autonomous haulage for its iron ore operations.

Fortescue Metals Group reported record quarterly iron ore shipments of 42.3 million metric tons (mt), a 10% increase over the previous quarter. The company received on average \$73/dry mt.

“Fortescue is a core supplier of iron ore to China and we see strong ongoing demand for our products and anticipate a steady recovery in economic activity in that market,” said Fortescue CEO Elizabeth Gaines. “The health and safety of our people, their families and the broader community is our priority, and we have been responsive to the [pandemic] and economic crisis. We are committed to ensuring robust plans are implemented to prevent the spread of infection to any of our sites, with a temporary extended operational roster introduced to reduce people movement, as well as measures to monitor the health of all team members and support best practice physical distancing at our operations.

Based on the strong operating performance year-to-date, Gaines upgraded Fortescue’s guidance for FY20 shipments to 175 - 177 million mt.

DeepGreen Acquires Third Seabed Contract Area From Tonga Offshore Mining

DeepGreen Metals Inc. has acquired Tonga Offshore Mining Ltd. (TOML), giving the company exploration rights to a 74,713-km² block of the Clarion Cliperton Zone (CCZ) seabed that contains an inferred resource of 756 million wet metric tons (mt) of polymetallic nodules. TOML holds an exploration contract

granted by the International Seabed Authority (ISA) and sponsored by the Kingdom of Tonga. DeepGreen acquired TOML from Deep Sea Mining Finance Ltd.

As part of the TOML acquisition, DeepGreen will benefit from existing environmental studies, a Canadian NI 43-101 compliant technical resource report and an intellectual property portfolio.

The CCZ seabed contains the world’s largest known deposits of nickel, cobalt and manganese, according to the company. Several areas of particular environmental interest encompassing 1.44 million km² have been set aside, which are intended to represent CCZ habitats and will be protected from resource extraction. Current exploration contracts in the CCZ account for 1.2 million km² and are estimated to contain enough metal to electrify the entire global car fleet.

“The TOML project will enable us to bring more critical mineral resources to market to break through the bottleneck and shift away from fossil fuels,” CEO and Chairman of DeepGreen Gerard Barron said. “Our research shows that ocean polymetallic nodules can provide society with these metals at a fraction of the environmental and social impacts associated with land-based extraction.”

Saracen Reports Record Gold Production

Saracen Mineral Holdings Ltd. reported a record March quarter with group production of more than 158,000 ounces (oz) of gold at an all-in sustaining cost (AISC) of A\$1,133/oz. This takes production for

the nine months to March 31 to 374,584 oz at an AISC of A\$1,081/oz.

Saracen operates three gold mines, Thunderbox, Carosue Dam and KCGM (50%), which sold 50 million oz, 49 million and 59 million oz respectively.

In what was the first full quarter of Saracen ownership of Kalgoorlie Consolidated Gold Mines (KCGM), the Super Pit produced 29,900 oz from ore grading 1.6 grams per metric ton (g/mt). A review of the open-pit operation has identified an opportunity to increase the number of mining areas. Mining in recent years has focused solely on the Golden Pike area. The Mt Charlotte underground mine produced 11,800 oz from ore grading 2.5 g/mt. Rehabilitation of the Sam Pearce decline was completed late in the quarter, ending a 4-km campaign that has constrained development and production.

At Carosue Dam, the Karari-Dervish underground mine produced 52,500 oz from ore grading 2.5g/mt. Paste filling of primary stopes was a key priority during the quarter. The Deep South underground mine produced 1,200 oz at 2.3g/mt. Stopping will commence during the June quarter. During the quarter, there was a scheduled shut-down at the processing plant to undertake a mill re-line and other critical maintenance activities. The company said the mill expansion project to increase throughput to 3.2 million mt/y continued to make good progress.

Thunderbox delivered another record quarter with 50,100 oz at an AISC of A\$682/oz. During February, Thunderbox C Zone pit experienced a wall failure on the West Wall ramp that impeded access to mining ore. Saracen took the opportunity to ramp-up mining in the D Zone pit while the wall was remediated. Remediation activities are now complete with access to the bottom of the C Zone pit restored mid-April.

Development of the Thunderbox Underground continued to progress well with 1,071 meters of horizontal development completed. The tender for the ramp up of the underground mine was issued this quarter and the commencement of stopping activities remain on track for FY21.

Mines in South Africa Start to Reopen

South African mines began returning to work during mid-April. On March 26, the country shut down, including most of the mining industry, with only a few coal mines supporting electricity generation. All underground operations ceased as did most surface workings.

Mining Minister Gwede Mantashe said at a briefing about the lockdown status, that mines could extend care and maintenance, and increase personnel on site. In particular, deep level mines that were at risk of seismic activity and gas buildup, could once again become active. "These mines that need attention to manage seismic activity such as rock-falls can do the work they need to do," Mantashe said.

The rest of the industry would ramp up to 50% of its capacity. Mines would, however, have to follow correct safety protocols such as social distancing and other measures to counter the risk of virus spread.

He noted that some coal exports through the Richards Bay Coal terminal had also continued. "We didn't allow full exports of coal," Mantashe said. "But we didn't want to create an energy emergency in other countries, so we allowed demand-driven exports."

Tailings operations that were mechanized have also continued. The original lockdown was scheduled to end on April 16 at midnight, but midway through, it

was extended to the end of April. The government had opted for a phased reopening of all commercial, industrial and social activity. However, the incremental restarting of mining was unlikely to achieve full production by the beginning of May, Mantashe warned.

"It is wishful thinking that mining will be at full production by May," he said. "My estimation it will go deep into May, before full production is achieved."

The Minerals Council South Africa has previously warned that falling cash flow meant some mines might not reopen.

Endeavour, Semafo Combine to Create 1M Oz/y Gold Miner

Endeavour Mining and Semafo have entered into a definitive agreement whereby Endeavour will acquire all of the issued and outstanding securities of Semafo by way of a plan of arrangement under the Business Corporations Act (Québec). The combined company will have six gold mines in Cote d'Ivoire and Burkina Faso. Production from the mines in 2020 is forecast to exceed 1 million ounces (oz) of gold.

Endeavour will contribute four mines to the combined company — Houndé and Karma in Burkina Faso and Ity and Agbaou in Cote d'Ivoire. Semafo will contribute the Mana and Boungou mines in Burkina Faso.

Houndé is an open-pit operation, with production during 2020 forecast at 230,000 oz to 250,000 oz at all-in sustaining costs of \$865 to \$895/oz. Processing rate for the carbon-in-leach plant is 4.1 million metric tons per year (mt/y).

Ity is an open-pit operation, with production during 2020 also forecast at 230,000 oz to 250,000 oz at all-in sustaining costs of \$630 to \$675/oz. The recently expanded plant throughput capacity stands at 5 million mt/y.

Mana is a combined open-pit/underground operation, with production during 2020 forecast at 195,000 oz of gold at all-in sustaining costs of \$1,085/oz.

Boungou is an open-pit operation, with production during 2020 forecast at 140,000 oz of gold at all-in sustaining costs of \$703/oz. Processing capacity is 4,000 mt/d through a carbon-in-pulp plant.

Agbaou production during 2020 is forecast at 115,000 oz to 125,000 oz of gold at all-in sustaining costs of \$940 to \$990/oz. Processing capacity through a gravity/carbon-in-leach plant for oxides is as much as 2.6 million mt/y. Processing capacity for fresh ore is 1.6 million mt/y.

Karma is a heap leach operation with production during 2020 forecast at 100,000 oz to 110,000 oz at all-in sustaining costs of \$980 to \$1,050/oz. The heap leach processing rate stands at 4 million mt/y.

The combined company will have an attractive growth project pipeline, including the Fetekro, Kalana, Bantou, and Nabanga projects.

The combined company will have 10.5 million oz of gold in reserves and 20.7 million oz in measured and indicated resources, inclusive of reserves, plus 6.3 million oz of inferred resources.

Existing Endeavour and Semafo shareholders will own approximately 70% and 30%, respectively, of the combined company.

Endeavour President and CEO Sébastien de Montessus will continue as CEO of the combined entity. Semafo president and CEO Benoit Desormeaux will become President and will oversee operational performance.

Semafo's Montreal office will become the primary support office to the operations.



Endeavour will add two SEMAFO operations: Mana and Boungou. The Boungou carbon-in-pulp plant (above) has a 4,000-mt/d capacity.

PNG Denies Mining Lease Extension for Porgera

The government of Papua New Guinea (PNG) decided not to extend the special mining lease for the Porgera gold mine. Barrick Niugini Ltd. (BNL), majority owner and operator of the mine, said the decision was tantamount to nationalization without due process and in violation of the government's legal obligations to BNL.

Located at an altitude of 2,200 meters (m) to 2,600 m in PNG's Enga Province about 600 kilometers (km) northwest of Port Moresby, Porgera has both open-pit and underground operations. Barrick and Zijin Mining each own 47.5% of the operation, with the remaining 5% interest held by Mineral Resources Enga.

Reuters reported that the PNG government refused to extend the lease citing environmental concerns, and said it will take control of the Porgera gold mine. "The state has every right to refuse the lease, or to extend the lease, and in this instance, because of the environmental issues, resettlement issues and many, many other legacy issues... the state has now refused the lease to Porgera," PNG Prime Minister James Marape said.

BNL said it remained willing to discuss the issue with government officials in the hope of averting what it described as a catastrophic situation for the communities at Porgera and in Enga, and for the country as a whole. The company also said it will pursue all legal avenues to challenge the decision and to recover any damages that BNL may suffer as a result of the decision. It also said it had no interest in discussing the government's proposed transitional arrangements for the management of the mine. BNL's right to the renewal was confirmed by the PNG National Court in August 2019.

BNL applied for the extension of the SML in June 2017 and has been engaging with the government on this matter since then. In 2019, in response to a request from Prime Minister Marape, the company proposed a benefit-sharing arrangement that would deliver more



Barrick views statements to the press and decisions regarding the lease for the Porgera mine (above) as nationalization.

than half the economic benefits to PNG stakeholders including the government for 20 years.

Barrick President and Chief Executive Mark Bristow met with Marape four times to discuss the extension issue and to reaffirm BNL's commitment to a long-term partnership with PNG. Those efforts now appear to have been unsuccessful.

Kazatomprom Decreases Operations at Uranium Mines

JSC National Atomic Co. Kazatomprom is reducing operational activities across all of its uranium mines for an expected period of three months due to the risks posed by the coronavirus (COVID-19) pandemic. According to Kazatomprom, this decision will result in a lower level of wellfield development activity and, as a result, an estimated reduction of up to 17.5% in total planned uranium production in Kazakhstan for 2020.

In 2019, Kazakhstan accounted for more than 42% of the world's uranium production.

The reduction in activity will impact production from joint venture Inkai LLP (JV Inkai), a uranium operation jointly owned by Cameco (40%) and Kazatomprom (60%). Based on information provided by JV Inkai, Cameco's preliminary assessment of the effects of Kazatomprom's decision is a reduction in Inkai's 2020 production of up to 12%, which translates into a reduction in Cameco's 2020 purchases from JV Inkai of up to 600,000 pounds of U_3O_8 .

Prior to this announcement, Cameco had expected to purchase 4.9 million pounds of U_3O_8 in 2020. Cameco said it will be in discussions with Kazatomprom and JV Inkai to determine the impact of Kazatomprom's decision on output from the operation and Cameco's purchases.

The Inkai operation is an in-situ recovery uranium mine in southern Kazakhstan that is owned and operated by JV Inkai, which in turn is currently owned by Cameco (40%) and Kazatomprom (60%).

Kirkland Lake Identifies High Grade Zone

Kirkland Lake Gold reported new drill results from 19 holes (9,522 meters) of underground exploration drilling as well as 15 holes (29,085 m) of previously drilled (not reported) and reinterpreted holes from the Macassa mine in Kirkland Lake, Ontario. All of the new holes being reported were collared within two platforms located on the east portion of the 5300 Level, with 18 of the 19 new holes (8,760 m) being focused on confirmation and extension of the South Mine Complex (SMC) to the east.

Results from the drilling included 43.1 grams per metric ton (g/mt) over 2.1 m from hole 53-4016, 31 g/mt over 2.3 m from hole 53-4052 and 16.4 g/mt over 2.1 m from hole 53-4088, which define a minimum 75-m extension of the SMC complex east of the current resource as well as 19.3 g/mt over 4.2 m from hole 53-4086 located 25 m to the south.

One of the new holes (762 m) was designed to test the Main Break below the Kirkland Minerals shaft near the east limit of previous drilling. The hole (53-4052) was highly successful, intersecting 141.1 g/mt over 2.4 m and 9.7 g/mt over 2 m near the 6,850 Level, 300 m below the deepest level off the Kirkland Minerals shaft, and 50 m east of previous drilling.

Very importantly, the high-grade intersection is located within 650 m of the company's new No. 4 Shaft location (currently under development) and is believed to be part of a newly identified corridor of high-grade mineralization 700 m long and 300 m high along the Main Break. The new corridor has been identified based on the results of new drilling as well as the interpretation of previously drilled but not reported holes along the Main Break on the Kirkland Minerals property, which is wholly owned by Kirkland Lake Gold.

"We have a truly unique and very exciting opportunity at Macassa to add substantial new mineral resources and, ultimately, mineral reserves through the continued growth of the SMC, the identification of high-grade mineralization along the largely unexplored Amalgamated Break, and also by drilling along the Main Break, which accounts for most of the 25 million ounces of historic production in the Kirkland Lake camp," President and

CEO Tony Makuch said. "While the resurgence of mining in Kirkland Lake over the last 10 to 15 years has been driven by the discovery and growth of the SMC, we have always recognized that the Main Break remains a highly prospective target for additional exploration success and Mineral Resource growth. The fact that the new corridor of high-grade mineralization along the Main Break is located close to planned infrastructure adds significantly to the value creating potential of today's results."

Exploration drilling at Macassa has temporarily ceased as part of the company's COVID-19 health and safety protocols. Upon the resumption of full operations at Macassa, exploration drilling will resume with up to six underground and surface drills.

Exploration Briefs

Chalice Gold Mines has reported significant drilling results at its 100% owned Julimar nickel-copper-platinum group metals project 70 kilometers (km) northeast of Perth, Western Australia. On April 15, the company reported that reverse circulation drilling intersected a significant new, wide, shallow, high-grade palladium-nickel-copper zone about 60 meters (m) east of the discovery hole at the project.

Intercepts included 19 m grading 8.4 grams per metric ton (g/mt) palladium, 1.1 g/mt platinum, 2.6% nickel, 1% copper, and 0.14% cobalt from 48 m down hole.

Subsequently, Chalice reported that its second diamond drill on the project had intersected both massive and matrix sulphides over significant intervals.

Commenting on the discovery, Chalice Managing Director Alex Dorsch said, "Activities at Julimar have ramped up significantly since our outstanding discovery hole, and the new exciting results confirm that we appear to have a very large palladium-nickel discovery on our hands, with associated platinum, copper and cobalt. We have defined what appears to be a new parallel high-grade palladium-nickel-copper zone to the east of the discovery intercept that remains wide open and appears to have significant strike potential.

"In addition, assays received to date have confirmed that all of our drill holes have intersected significant broad zones

of palladium — a surprising result that highlights the metal-rich nature of the intrusive and its potential to deliver a discovery of considerable scale.

"The discovery at Julimar has demonstrated that this region is a new nickel-copper-platinum group element province, and regional activities are also now being planned. Chalice remains in an enviable position, with the funding to continue our systematic exploration programs through the current challenging market conditions." (chalicegold.com)

GFG Resources has intersected a significant high-grade gold system at the Nib prospect at its 100% owned Pen gold project 40 km west of the Timmins gold district in Ontario, Canada. The intersect graded 71.27 g/mt gold over 8.5 m, including 511 g/mt gold over 1.15 m at a vertical depth of approximately 50 m below surface.

"Hole PEN-20-47 is the most significant intercept ever drilled on our 500-km² Pen gold project," GFG President and CEO Brian Skanderbeg said. "This exceptional intercept along with the multiple mineralized intervals further down hole demonstrates that the Nib prospect has the potential to host a large-scale gold system.

"These recent results in combination with numerous significant intercepts at our other regional targets validate our view that this portion of the Abitibi has the potential to host multiple gold deposits next to a world-class gold camp. We look forward to follow-up drilling on this very exciting and underexplored target in our Phase 2 2020 drill program in the third quarter." (www.gfgresources.com)

Cora Gold has initiated drilling on its highly prospective Madina Foulbé permit in eastern Senegal. A 2,000-m reverse circulation program is testing mineralization at depth.

Cora Gold CEO Bert Monro said, "Located in one of the most prolific gold regions in Africa, we are very excited to be drilling at Madina Foulbé. Historical and more recent exploration results have given our team on the ground confidence ahead of undertaking the drilling campaign — the first time Cora has drilled this permit." (coragold.com)

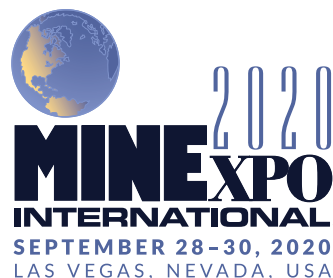
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Anglo American, Komatsu Team Up to Restore Mined Lands



Leaders from Komatsu, the Gangulu Nation and Anglo American plant the first tree of the day together at the Growing Together event at Dawson mine in March.

Anglo American and Komatsu announced a new mine rehabilitation partnership that will see more than 9,000 trees planted at Anglo American's Dawson mine in Central Queensland's Bowen Basin. The partnership, Growing Together, aims to return mined land to agricultural use, and support the reestablishment of native plant species using the latest reclamation methods, according to the companies.

It commenced with employees from both companies working together to plant more than 4,000 trees at the Dawson mine last month. They were joined by around 40 students from Moura and Banana state schools and traditional owners from the Gangulu Nation. Together, they demonstrated sustainable mining practices in action, planting various native eucalyptus species across a 90-hectare site where mining activities have ceased.

Tyler Mitchelson, CEO for Anglo's met coal business, said the project was a great example of like-minded companies coming together to support sustainable mining practices in the region.

"Collaboration across our industry and the communities where we operate is a powerful way to achieve improved sus-

tainability outcomes in the local area," he said. "We're committed to the highest standards of environmental performance, and this new partnership with Komatsu adds to our existing \$162 million rehabilitation investment across our five Central Queensland mine sites."

More than \$80 million will be spent on rehabilitation from 2019-2023, according to Mitchelson.

The planting included a pilot of biodegradable COCOON planting technology, which reduces the need for irrigation, to help drought-proof the newly planted trees. The Cocoon pods require 100 times less water than traditional methods and can support a young plant through its critical first year with an accessible reservoir of water and moisture.

President and CEO of Komatsu Mining Jeffrey Dawes said the new partnership is a continuation of Komatsu's Growing Forward signature environmental initiative, the reforestation of formerly mined lands, which was launched on Earth Day 2019 to advance the company's commitment to a sustainable future for all.

"We believe that maintaining high environmental standards is more than a

good business practice, it is a fundamental responsibility owed to our employees, customers, communities and the environment we all share," Dawes said. "We are proud to be working together with Anglo American and members of the local community as we expand our global focus on reforestation of formerly mined lands."

The Growing Together partnership continues Komatsu's existing reforestation efforts with Green Forests Work (GFW), a non-profit organization dedicated to promoting proper mine reclamation methods and the restoration of natural habitats, including national forests. As part of those efforts, Komatsu is committed to reforesting 1,000 acres of land and native ecosystems in the Monongahela National Forest in West Virginia, USA. By the end of 2020, that project will have planted 150,000 trees and created 100 wetlands.

Arch Coal Reports Progress with Leer South

During the first quarter, Arch Coal invested \$62.1 million in the continued build-out of Leer South in West Virginia, USA, bringing the capital expended on the project to \$165 million since its launch in February 2019. Arch reaffirmed that it expects to invest a total of \$360 million to \$390 million in the project, including \$220 million during full year 2020.

"We are making strong and consistent progress and maintaining tight capital discipline in the development of Leer South, which we view as the industry's premier growth project," Arch incoming COO John Drexler said. "We are achieving excellent rates of advance in the development of the first longwall panel, which is more than two miles long, and we remain on track for the commencement of longwall production in the third quarter of 2021."

With the addition of Leer South, Arch expects to increase its annual High-Vol A output to around 8 million tons; enhance its already advantageous position on the U.S. cost curve; strengthen its coking coal profit margins across a wide range of market conditions; and cement its position as the leading supplier of High-Vol A coal globally.

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(News-Leading Developments - from p. 6)

The company said the filing was brought about primarily by the impact of the coronavirus (COVID-19) pandemic. Although Dominion has a strong diamond inventory, sorting houses and diamond markets are closed, so there is no ability to generate sufficient revenue to support the company's ongoing financial obligations, the company added.

Given the rapidly evolving environment and uncertainty of the scope and duration of the restrictions and health and safety concerns associated with the COVID-19 pandemic, along with market dislocation and the continued capital calls from the Diavik joint venture, Dominion said it believes this is the most prudent course of action.

Dominion said it is considering a proposal from an affiliate of The Washington Cos., Dominion's current equity owner, to provide debtor-in-possession (DIP) financing, which would help provide sufficient liquidity through the CCAA process. The company said it is reviewing the proposal.

Whether or not Dominion agrees to the Washington proposal, it expects as part of the restructuring to obtain new financing, which combined with the company's available cash, should provide sufficient liquidity to continue to operate during the CCAA process for the benefit of local communities and other stakeholders.

As the spread of COVID-19 subsides and diamond markets reopen, Dominion said it plans to resume mining operations at the Ekati and safely recall workers.

Argonaut Gold, Alio Gold Agree to Merge

Argonaut Gold and Alio Gold have entered into a definitive agreement for an at-market merger whereby Argonaut will

acquire all of the issued and outstanding shares of Alio.

Argonaut is a Canadian company whose primary assets are the El Castillo and San Agustin mines, which together form the El Castillo Complex in Durango, Mexico, and the La Colorada mine in Sonora, Mexico. Advanced exploration projects include the Cerro del Gallo project in Guanajuato, Mexico, and the Magino project in Ontario, Canada.

Alio is also a Canadian company, whose cornerstone asset is its Florida Canyon mine in Pershing county, northern Nevada, United States. The company also owns the development stage Ana Paula project in Guerrero, Mexico.

Production from the merged company's four producing mines is forecast at more than 235,000 gold equivalent ounces per year (oz/y).

Upon completion of the transaction, existing Argonaut and Alio shareholders will own approximately 76% and 24% of the pro forma company, respectively.

Argonaut President and CEO Pete Dougherty said, "This is a transaction that makes sense for both sets of shareholders. Combining complementary assets into one larger, more relevant company generates significant synergies.

"With a solid production base of over 235,000 gold equivalent oz expected this year, a strong balance sheet, and strong cash flow generation at current gold prices, we will be well positioned to evaluate and execute on growth opportunities from within the combined company's development asset portfolio," Dougherty said.

B2Gold Reports Record Quarter for Gold Production

B2Gold Corp. said it continues to focus on its COVID-19 response measures and

to date has not experienced any incidents of the COVID-19 virus at its sites or corporate offices. It recorded consolidated gold production of 250,632 ounces (oz), well-above budget by 7% (16,156 oz) and a significant increase of 25% (50,090 oz) over the first quarter of 2019 with solid performances from all the company's operations.

It also recorded quarterly total gold production of 262,632 oz, including 12,000 oz of estimated attributable gold production from Calibre Mining, which operates the El Limon and La Libertad gold mines in Nicaragua.

The Fekola mine in Mali achieved record quarterly production of 164,011 oz, well-above budget by 9% (14,011 oz) and significantly higher by 49% (53,662 oz) over the first quarter of 2019.

The Otjikoto mine in Namibia continued its remarkable safety performance, extending the number of days without a lost-time injury to 733 days (approximately 2 years or more than 6 million man-hours) at the end of the first quarter of 2020.

B2Gold said it remains well-positioned for continued strong operational and financial performance. Total consolidated production guidance remains at more than 1 million oz of gold; operating costs are forecast to be between \$415/oz and \$55/oz and consolidated all-in sustaining costs are forecast to be \$780/oz-\$820/oz.

In addition to sharing best practices and helping with COVID-19 risk mitigation, B2Gold said it is also committed to providing financial assistance to both the local communities and to local and national authorities in the countries in which it operates.

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.miningindaba.com.

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



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Data-driven Drilling Diminishes Deviation

New solutions offer intelligent controls, automation, near real-time measurements, and optimally planned holes for the new age of precision mining

By Jesse Morton, Technical Writer

Holes that are true to plan, whether in exploration drilling or in reaming an ore pass, can be invaluable. It can mean discovering a new high-grade zone that attracts needed investors to fund startup. Or it could generate better fragmentation to improve the load on the primary crusher.

Hole plans true to the orebody specs can be of even greater value, impacting everything downstream to the energy consumption of the entire mill.

Several new solutions hit the market recently, or will soon hit the market, that offer, among other things, holes that are almost laser straight, clean, or true to plan, or are optimally planned, or that can be quickly compared to plan to help with snap decisions. Each shows just how difficult it can be to truly know the geology and in turn to answer it. Each also likely speaks to a dawning future of precision mining, where plans and decisions are data driven, and where wasted time and energy are, increasingly, things of the past.

Intelligent ITH Longhole Drill

Sandvik reported its DU412i ITH longhole drill can drill holes that deviate less than 2% regardless of hole length.

Maximum accuracy “ensures that the holes are drilled as planned,” Jukka Naapuri, product manager, underground long hole drills, said. “The result is minimized dilution, minimized ore loss, and good fragmentation as correct burdens and spacings at the bottom of the holes allow explosives to cut and break the rock as planned.”

The unit can drill 115- to 165-mm-wide holes accurately up to 60 m in production drilling. It can drill single-service support longholes up to 203 mm and up to 150 m in length. The unit can also be configured to ream 762-mm primary slot raises up to 35 m accurately, Sandvik reported.

Naapuri said the unit is the most versatile fully automated and teleremo-



The Sandvik DU412i ITH longhole drill can, without modifications, be used in both production drilling and slot development. Leadership at the company calls it the most versatile rig of its kind on the market. (Photo: Sandvik)

te-operated ITH longhole rig in the market. “Without modifications it can be used in both production drilling and slot development, offering great versatility to mining operators utilizing ITH drilling,” Naapuri said.

The unit is capable of V-30 reaming at a quicker rate than other methods of slot development. It all but guarantees “that the slot will be successful,” Naapuri said, especially in comparison to methods such as drilling and blasting.

“It gives the capacity to develop blind slots without the requirement for an upper level,” Naapuri said.”

For slot-raising, it comes standard with “blind bore feed and split centralizer, a spaced-out RH6250 rotation head and a PC225 carousel,” Sandvik reported.

Pipe handling during reaming is mechanized.

The unit comes with the new iSOLO drilling control system, supported by the Sandvik Intelligent Control Architecture platform. “iSOLO supports drill plan transfer for onscreen drill plan management and OptiMine remote monitoring,” Naapuri said. “It has readiness for AutoMine fleet and information management.”

AutoMine packages enable it to repeat drilling cycles, operate unmanned through breaks and shift changes, and be operated remotely, Sandvik reported. “The standard Silver drilling package features single-hole automation, including uncoupling of pipes, while the optional Platinum delivers fan automation, drill plan management and as-drilled data download.”

The DU412i was successfully trialed at production drilling in a gold mine in Ontario. It was trialed at slot development at Sandvik's test mine in Tampere, Finland. "There 762-mm primary slot raises up to 20 m have been reamed successfully," Naapuri said. "Four units have been sold in Canada and we have started ramping up our production in the Tampere plant."

Deployment requires a supply network for 7 bar (100 psi) compressed air. "An alternative to this are Sandvik KA-series portable atmospheric compressors, which deliver the same at much less investment," Naapuri said. The 7 bar compressed air "will be boosted on board the DU412i up to 28 bar (400 psi) for the ITH hammer."

When using 6-ft drill pipes, the drifts have to be a minimum of 4 by 4 m. Cross sections have to be a minimum of 4.5 by 4.5 m. "If pipe length is 5 ft, then the unit can be used in production drifts that are roughly 3.7 by 3.7 m," Naapuri said.

The rig also needs a WLAN/LAN network for transferring the drill plan to and from the office, for equipment health monitoring, and for teleremote drilling operation. "Teleremote drilling will soon be expanded to include fan-to-fan tramming."

Sandvik has been in the underground top hammer longhole production drill space since the 1970s. "Top hammer longhole drilling, in terms of units delivered, represents about 80% of the deliveries globally," Naapuri said.

The company started developing i-class drills in 2012, at roughly the time it acquired Cubex, maker of ITH longhole drills. In 2015, the company moved to offer the i-class platform on ITH units.

Naapuri said the new unit ends the debate of whether compressed-air-drilling technology can hack it underground. "Increased productivity and product safety requirements apply to ITH longhole drilling, and the DU412i is the first fully automated and teleremote-operated product to meet the requirements of the industry across the application," Naapuri said.

High on that list of requirements is tight accuracy. "Hole accuracy is paramount in production drilling and service support," he said. "ITH drilling ensures Sandvik can meet even the strictest requirements in this area."

Controls Auto-adapt Energy

Komatsu reported the Montabert Intelsense drilling control system, typically

deployed to Joy face-drilling jumbos and other drifters, helps ensure straight, clean holes while optimizing the life span of drilling consumables.

"Intelsense optimizes the performance and reliability of the drifters with the objective of achieving a low maintenance cost," said Hugues Neyrand, drilling business line manager, Montabert.

The control system is designed to optimize drilling performance by auto-adapting the energy generated into the drifter.

"The danger is to have uncontrolled energy that is not transmitted to the rock but dissipated into the drilling tools or inside the drifter, which can cause damage," Neyrand said.

Depending on the geology, the system adjusts striking pressure, which is directly connected to the feed force. "Each rock condition needs its proper setup to optimize performance," Neyrand said. "The Intelsense system self-adjusts and controls the hydraulic parameters supplied to the drifter in order to perform at its best with the highest penetration rate."

In soft rock conditions, the system will increase feed speed and lower striking pressure. In hard rock conditions, it will increase feed force and striking pressure.

By optimizing feed pressure, deviation is prevented and the result is straighter, cleaner holes for blasting, Komatsu reported.

Intelsense also includes an anti-jamming system to control the torque at the bit. That reduces the risk of getting the drill bit stuck in the face.

"The system offers huge benefits to improve the longevity of drilling consumables," Neyrand said. "The drifter is working optimally, so the maintenance interval is significantly extended," he said. "Such will provide important cost reductions for the mine and will increase the equipment's reliability."

For example, the system can help extend shank life substantially. "The full energy of the drifter is used for the rock penetration, thus reducing the loss of energy into the tooling or inside the drifter," Neyrand said.

OEMs have historically used the system to improve the competitiveness of their rigs, Komatsu reported. Robodrill, for example, has used it for 20 years to offer a very aggressive price per drilling meter.

"China's Kaishan understands the benefits on controlling the energy," Ney-

rand said. "They are referenced as a premium manufacturer in China, and are now competing abroad in the Russian and Kazakh mining market."

While others have tried to replicate Intelsense, Neyrand explained that Montabert stays one step ahead through continuous improvements to its control and drifter development.

Controls Offer Precision, Digitalization

Epiroc reported its long-proven Rig Control System (RCS) helps drill rigs navigate and drill in an optimized manner, adapt to different rock conditions, and execute multiple straight holes with superior precision.

"Safety, productivity, higher utilization and consistency are also important values to be achieved," said Guilherme Paiva, global automation lead, underground drilling, Epiroc.

The system can be complemented by other Epiroc control and automation solutions, such as the telematics system Certiq, Rig Remote Access, Underground Manager, and ABC Total, for digitalization of drilling and beyond.

A control and automation package first released more than two decades ago, RCS offers benefits in drill performance, in maintenance, and in planning.

The system provides electronic navigation, and eliminates the need for manual face marking, which minimizes exposure to risks, Paiva said. The precision drilling results in straighter, as-planned holes, which brings savings in explosives and gives homogenous fragmentation. Better blasting can mean numerous downstream benefits, from reduced need for rock reinforcement and scaling to better dilution control, which helps the mill.

Paiva told *E&MJ* that RCS lowers maintenance costs by minimizing drill and consumable wear, facilitating failure identification, simplifying failures tracking, and thus enabling assertive asset- and fleet-management practices.

That helps improve planning and scheduling.

"RCS leads to a decrease in operational variability over time due to less dependency on operator skills," Paiva said. That ultimately speaks to "continuous improvement management and a higher level of predictability for planning and scheduling."

One output from RCS, "reliable data, can be visualized in Certiq and Under-

ground Manager for analysis, evaluation and optimization of the drilling process,” Paiva said.

Company literature described Certiq as a telematics solution that gathers, compares and communicates vital equipment information. It offers detailed knowledge and summaries of entire fleets. Deliverables include “production data, alarms, warnings, reporting capabilities and operational data,” Paiva said, “on a Web interface with standard dashboards.”

Underground Manager is software for planning, administrating and evaluating a drilling operation, Epiroc reported. Paiva said the solution offers “drill plan design and evaluation tools, and measurement while drilling (MWD) analysis.”

Data from RCS can also be leveraged by Epiroc’s ABC (Advanced Boom Control) Total, an onboard automation package. The solution offers advanced capabilities in the area of drill plan handling, MWD, breakthrough stopping, multi-hole drilling and more.

Paiva said the above solutions can be adopted incrementally as part of Epiroc’s comprehensive underground operations value chain optimization and digitalization solution, 6th Sense. “6th Sense is not just another system,” he said. “It is all about a long-term work to create a platform of automation and digitalization in support of the actual operations.”

Digitalization is bigger than the sum of its parts, Paiva said. “Drill rigs configuration, software options, system settings, drill string components, maintenance service and monitoring results with a continuous improvement approach are all elements that must be balanced in order to achieve sustainable results.”

Incremental digitalization is disruptive and must be carefully managed, he said.

“It calls for a new way of working,” Paiva said. “Our customers need people, processes and technology to synchronize. 6th Sense is the Epiroc way to optimize our customers’ value chain through automation, system integration and information management, for a smart, safe, seamless operation.”

RCS encapsulates the company’s mission by being a solution in itself while integrating into increasingly more comprehensive systems and solutions, Paiva explained.

NSR: Production Optimiser Ups Accuracy, Production

Minnovare published a white paper that showed how the Production Optimiser dramatically improved drill results at Northern Star Resources (NSR) mines.

According to the paper, the gold miner implemented the plug-and-play solution across its Kalgoolie operations in mid-2018. NSR reported the Production Optimiser provided a significant improvement in drilling accuracy and consistency.

“It helped us reduce our bridge-to-stope tons ratio by more than 50%,” Jeff Brown, principal, innovation and technology, NSR, said. “That reduction resulted in less rework and delays, and ultimately an improvement to both the reliability and productivity of the mines.”

Other listed realized benefits included increased productivity and reduced fixed costs. According to Minnovare, total output was increased by 33% and valued at roughly \$12 million.

Brown said the solution helps ensure operators give their best effort. “Aside from improved accuracy, the digitization of what was traditionally a paper-based process delivers an efficiency gain that boosts people’s productivity through greater accountability and visibility,” Brown said. “It has brought a level of data integrity and quality control to our drill and blast operations that simply wasn’t there previously.”

Production Optimiser determines the dip and dump angle of the boom in real time, and connects wirelessly to the Production Optimiser Mobile Interface.

The Interface runs CORE, the software that assimilates the data captured, analyzes and tracks progress, and communicates and syncs digital drill plans. Using CORE, the operator can do the daily drill plan, which is detailed down to individual hole specs. Drilling data is

automatically imported into CORE for analysis and syncing.

According to company literature, the system integrates seamlessly with the rig and mine planning software for direct importing and exporting of data.

The solution can be used on any production rig make and model and in either narrow vein or large stope mines. It operates independently of current set up systems and processes. That means it offers reduced reliance on survey mark up, and no laser alignment, rig leveling, or onboard inclinometers are required.

Minnovare said that conventional set up processes rely on multiple variables and are often prone to error. “Therefore accuracy is often unreliable,” Mick Beilby, cofounder and commercial director, Minnovare, said. “The Production Optimiser reduces the number of variables in the process, resulting in a simplified, more consistent and more accurate set-up process.”

The biggest gains offered result from how the solution aids in the setting up and aligning of the rig. Improper setup and alignment accounts for 70% of all blasthole deviation, Beilby said. “If you aren’t ending up in the right place, you can expect poor blasting outcomes.”

Accordingly, one of the capabilities offered is Smart Collar, which automatically recalculates holes with obstructed collars.

By giving increased speed and accuracy, the solution reduces stope turn-over time and makes possible ambitious drilling patterns. The result is optimum blasts that lead to reduced dilution and increased recovery, Beilby said. “It’s a tight-focused area that can have extremely wide-ranging impacts on the overall performance of the mine.”

Production Optimiser launched in 2018 and was quickly adopted by mines in Australia, Africa and the U.S. “It was adopted by more than 35 mines in just two years,” Beilby said.

Speedy Surveying System Audits Holes

Carlson reported plans to release a new version of its proven borehole surveying and deviation measurement system, Boretrak, in late Q2 2020. The new system is designed with improvements over Carlson’s previous models, the Cabled Boretrak and the Rodded Boretrak.

The improvements help speed up the workflow, improve the usability of the sys-



Epiroc’s RCS offers improved drilling precision and the ability to incrementally digitalize drilling. (Photo: Epiroc)

tem, and extend the angular range of deployments. Boretrak2 produces more accurate results, which are vital when used to optimize safety-critical blasting operations, said James Husack, support and special projects engineer, Carlson Software.

Boretrak2 uses an inertial measurement unit (IMU) that incorporates a three-axis gyro, accelerometer and magnetometer, to measure boreholes as small as 2 in. in diameter in any direction or inclination. The system provides “an as-built survey of how a borehole was actually drilled compared to the design parameters,” Husack said.

“It offers quick, easy-to-use, reliable and repeatable borehole mapping in a variety of environments and situations,” he said. “It has been built from more than 30 years of product and field experience.”

The hardware consists of a compact, lightweight and rugged Boretrak probe and a deployment system, Carlson reported. A variety of deployment systems can be used, depending on the operation. Usually, a simple metal cable is suitable for downhole deployments, while push rods or standard Boretrak rods can be employed for horizontal or uphole operations. The system also comes with a PDA or tablet PC to run field software.

The PDA or tablet runs software “that allows operators to visualize the results in the field alongside data from Carlson’s underground scanners, the C-ALS and VS+,” Husack said. “Results can be passed to Carlson Blast Ops software for additional blast design analysis.”

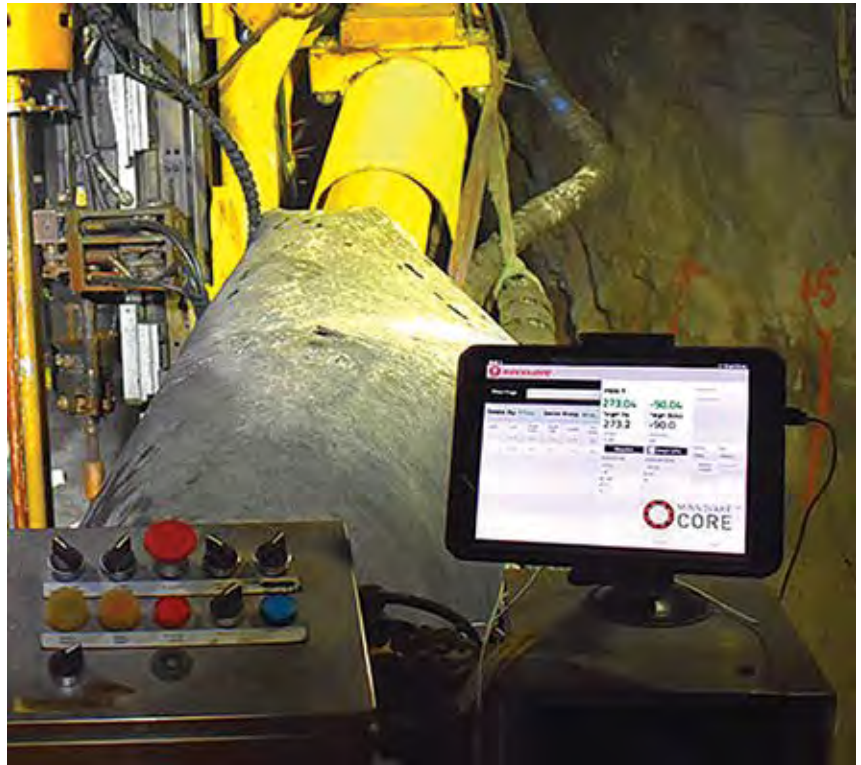
The company can also supply other software packages for more advanced processing and 3D scanners to pick up complementary data that can be georeferenced and analyzed alongside the borehole survey, he said. “Minimal training is required for the customer to get up and running.”

Boretrak2 improves upon Carlson’s old Cabled Boretrak model as it does not rely on a magnetic compass to orient the system, the company reported.

“Boretrak2 can be used in environments that contain ferrous materials and near things that could cause magnetic fields that would otherwise compromise a compass-based system,” Husack said.

Boretrak2 also improves upon Carlson’s old Rodded Boretrak:

“Users of the traditional Rodded Boretrak Systems were forced to use rods to fix the orientation of the probe.” Husack said. “But with Boretrak2, the need for



Production Optimiser drill plan software, CORE, eliminates paperwork and increases transparency, which helps encourage operators to do their best work. (Photo: Minnovare)

this has been eliminated, and the rods will only be used to move the probe horizontally or uphole,” he said. “The rods are no longer required to orient the system, a fact which means the deployment operation is much simpler and less prone to error.”

The software supplied with Boretrak2 is faster, more versatile and more intuitive than the software previously supplied with older Boretrak models. “New users of the Boretrak2 should easily adapt to the established workflows taught during training with minimal impact on their existing operations,” Husack said.

The fact that the Boretrak2 can be deployed at any angle, uphole or downhole, means that it is an essential tool to help audit and manage underground drilling, Carlson reported. Analyzing the Boretrak2 data alongside scans of stopes and voids collected by Carlson’s C-ALS and VS+ scanners provides a unique and comprehensive solution for underground data capture, Husack said.

MWD for Optimal Plans, Snap Decisions

DataCloud reported RHINO, in combination with MinePortal, can provide near real-time geology data for process opti-

mization across an operation, from drill plans to the mill.

Installed on a drill steel, RHINO, an Industrial Internet of Things (IIoT) sensor system, captures acoustic impedance. The data from RHINO is assimilated in the DataCloud’s digital mine platform, MinePortal, which provides incremental measurements on orebody hardness through a process called Seismic While Drilling (SWD). MinePortal allows the user to turn SWD measurements into graphs and 3D models.

DataCloud said those measurements and models can be used to develop optimal drill plans. “You can better plan spacing if you know more about your orebody,” Thor Kallestad, CEO, DataCloud, said.

It can also be used to ensure exactitude while drilling, Steven Putt, director, mining software, DataCloud, said. “In cases where the ore and waste have a contrast in hardness, blasthole drilling data can be analyzed to detect when drilling has crossed an ore-waste boundary,” he said. “Knowing quickly and exactly where the boundary is can help blast crews backfill holes in order to prevent dilution.”

For orebodies where grade has a relationship to hardness, SWD can be used to

help detect higher grade ore. “If you are drilling through a harder, or softer spot, and that means that there is more money in the ground, then you want to know about it,” Putt said. SWD, accurate down to a fraction of a meter, tells you almost instantly, he said.

SWD was proven in the oil and gas drilling space, Lindsey Miller, director, marketing, DataCloud, said. “It is a super-popular technique.”

Putt said that SWD can be more accurate than other MWD techniques while providing near-real-time actionable data and often at lower costs.

Other techniques rely on sensors that measure bit speed or torque. Those sensors typically aren’t purpose-designed to provide data for measuring rock hardness. Results, therefore, can vary in accuracy depending on the drill operator, the drill, and the maintenance of the sensors.

“An operator might be using a little more pulldown so it affects the measurement,” Putt said. “You’ll see a little bit of a different response on one operator verses another.”

If any of the sensors are not calibrated properly, the resulting measurements and calculations will be off, Putt said. “Even if they are working OK, you’ll see that one drill might have just a little bit of a different number to another drill,” he said. “And there might be one drill where it is completely different.”

Which is what happens when technology is used for an application different from that for which it was designed, Putt said. “It is just because those sensors weren’t really made to do this,” he said. “They are just sensors that came with the drill.”

Oftentimes, the data coming off those sensors have to be piped into Excel, creating sprawling, unwieldy spreadsheets, he said.

“Even if the existing sensors on the drill were good enough to get viable information from the rock, the problem with the existing systems is all you get is a database full of numbers,” Putt said. “We’re talking a data point for every fraction of a foot or fraction of a meter,” he said. “They typically don’t give you any tools to review the data other than Excel. And the data piles up quickly to the point where you can’t actually look at it in Excel anymore.”

Drill hole chip samples often have to be sent off to a lab, processed, and then sent back, a significant investment in time. When they come back, they often can provide only an average for an entire hole.

“You have a 50-ft-deep hole and you are saying it is throughout only one value of gold. The case might be that there is a narrow vein running right through the middle of it,” Putt said. “If the results say that entire hole needs to be sent to the mill for processing, every piece of rock that you send to the mill that has no gold in it is basically wasting money. You’ve taken rock with no value, large chunks of rock, and you’ve ground it down to powder just to throw it away.”

Conversely, RHINO provides near-real-time data. And it does it with technology engineered specifically for the task.

RHINO is “purpose built to detect what the drill is drilling through with a kind of complete independence of the type of drill,” Putt said. “It is a tool that we built for a specific purpose, verses these other ways of retrofitting.”

The graphs and models in MinePortal are easier to use and understand than the spreadsheets and databases created by typical MWD solutions. “We don’t just say here is some data, good luck,” Putt said. “We actually do integrate it completely into a 3D modelling package that we can color by hardness or any other property that we pick up.”

The solution can be used to optimize more than drill plans and processes.

Accurate rock hardness data is crucial to calculations used in and mixing and timing explosives. “There are a few decisions that you can change to help optimize your blasting,” Putt said.

It can be used to optimize the mill.

“If, from SWD, you have a high-resolution good idea of what the input rock is going to be, then, with MinePortal, you can track that rock all the way to the mill, using the truck and the loader and the data coming off of them,” Putt said. “Once that material gets to the mill you can track how efficient the mill was at crushing it and what your recoveries were. And then you can create this feedback loop that says, given this type of rock, and these measurements from the drills, you treat it this way with blasting, and you blend it this way, and you are going to get this result in the mill, and you can start to tweak the levers to make sure you are doing the best job possible.”

Miller said RHINO’s sensor speaks to an edge device in the cab via radio frequency. “That edge device uses cell or Wi-Fi to send data on to the cloud,” she said. “It’s successful even at slower bandwidths.”

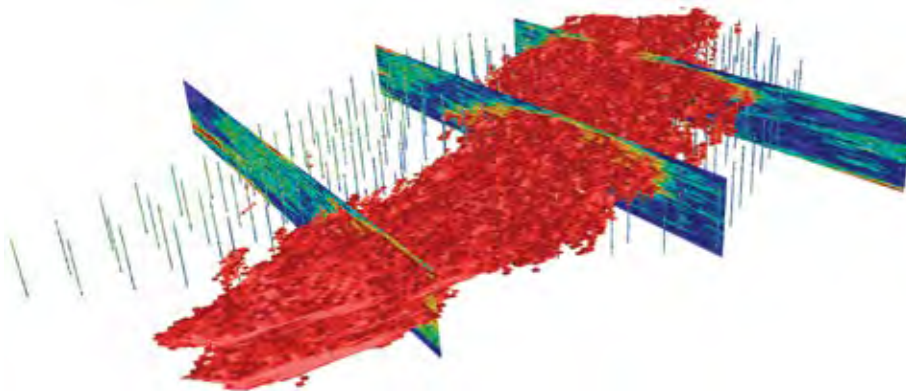
If there is no connectivity at a location or if there is a temporary outage, RHINO will wait for a hot spot or a Wi-Fi signal to send data.

Ideal customers are those with a grade that trends with hardness. “From a costs and savings standpoint, those are the ones that we target,” Putt said.

Customers that benefit most, however, are those whose processes are data driven. “It is not a specific company we are after,” Miller said. “It is more like a specific mindset of people who work there who know that data is everything, and you have to process it and utilize it to optimize your planning.”

MWD, Modelling Solutions Streamline Ops

Sun Metals said it used Seequent’s Leapfrog Geo to arrive at an efficient explora-



DataCloud’s Rhino sensor system and its digital mine platform MinePortal can convey in near real-time the exact moment when a drill hits rock of a different hardness, an important development for a mine with ore with grade that trends with hardness. (Photo: DataCloud)

tion drilling plan for Stardust mine that revealed a new high-grade zone. “It was a tremendous validation of the scientific use of data using modern technology to do targeting,” Steve Robertson, CEO, Sun Metals, said.

And it was the reward for several months of mundane data entry work.

When Sun Metals, backed by principals of Oxygen Capital Corp., acquired the undeveloped property in northcentral British Columbia, the existing exploration drilling data was all in hard copy form, on stacks of paper.

Buying properties for which there is a lot of data that is not optimally organized, and then reorganizing that data, is part of Sun Metal’s strategy. “We take a better look at the data, make better use of it, and build value more efficiently by using the data previously generated by others,” Robertson said.

With Stardust, “we went into an environment where there had been 100,000 m of drilling on the project before us, but none of it was put into a computerized database,” he said.

The miner spent several months transforming data in Leapfrog Geo, Seequent’s geological analytics and modelling program.

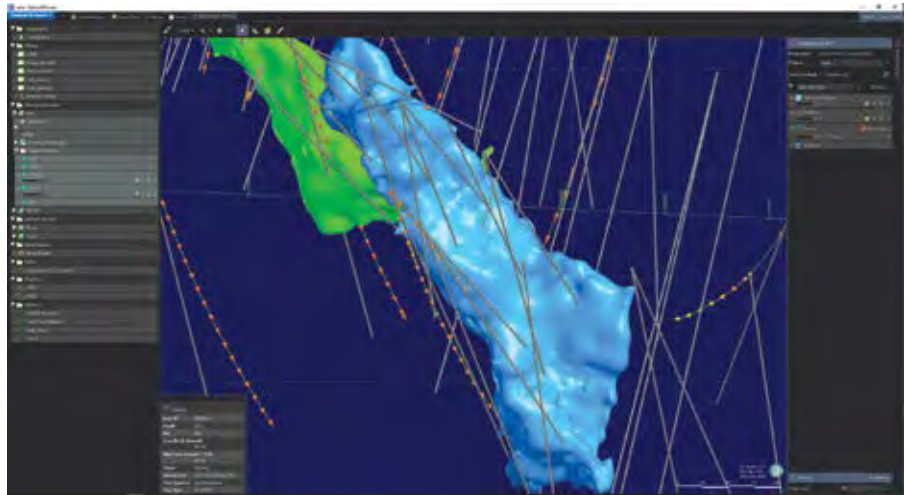
“We came up with an obvious high-priority target out of that analysis that directly resulted in the discovery of a new zone, and that discovery hole was 100 m of 5% copper equivalent,” Robertson said. “It was a tremendous success,” he said. “We went out last season and continued to drill out that zone and we’ve now extended it to a 375-m plunge length on this new high-grade zone that we discovered using this technique, and so it has been a pretty good success for us.”

The company selected Leapfrog Geo due to its ease of use. “You don’t have to be a dedicated expert that spends their entire life in front of the computer to be able to be pretty proficient at the use of it,” Robertson said.

“It is very visually impactful,” he said.

That ability to crank out convincing, accurate models distinguishes the product, Robertson said. “That is the beauty of the package,” he said. “That is what makes it so successful at my mine.”

Leadership at Seequent told *E&MJ* the big advantage conferred by use of Leapfrog Geo is the resulting downstream optimal use of funds.



Near real-time MWD data captured by IMDEXHUB-Q can be imported and manipulated in Seequent’s Central, a 3D venue for sharing, analyzing and storing information. (Photo: Seequent)

“It allows people to make decisions in the shortest period of time that will enable them to use money in the most efficient and most effective manner,” said Rob Ferguson, segment director, exploration and resource management, Seequent. “You may be spending more money because you find the deposit is bigger so you have to drill more. So it is not about saving money but about making real-time decisions that improve your exploration program.”

Leapfrog Geo assimilates data from a multitude of sources that can be in an array of formats. “It allows users to work with all their data, and add additional data at any stage,” Ferguson said, “which flows downstream, to build the most accurate picture of the geology.”

That picture allows users to process data; visualize data in 3D; import, correct and analyze different data types, including drilling and structural data, and filter them to see where information is coming from; and gain rapid insights using the geostatistical evaluation and exploratory data analysis.

“It allows geologists to build up virtual models, called digital twins, of what that deposit looks like,” Ferguson said. “Once those geologists build up that model, they pass that to the mine engineer that will produce mine plans, optimizations, and the sequence of mining down through the value chain.”

For near real-time data on drilling accuracy, measure-while-drilling solution IMDEXHUB-IQ can be leveraged by Seequent’s Central for a single unified source

of active drilling information. “Exploration geologists and managers can visualize and analyze drill hole data alongside 3D models in real time,” Ferguson said. “Teams can visualize in real-time the accuracy of the drilling to the model, saving time and money with the next drill holes.”

Both IMDEXHUB-Q and Central are cloud based. The former leverages down-hole sensors that determine hole location based on dip and azimuth.

“That information is transmitted to IMDEXHUB-IQ, which is technology for storing data,” Ferguson said. “Once that data is up in that environment, users of Central can directly connect to that database and pull the information directly into Central, which has tools for visualizing the location of the drill hole in 3D space and relative to 3D models that have been created for the drill plan. You can compare those actual locations of the drill hole with the planned location of the drill hole.”

The Central is an interactive 3D application used for data review and collaboration. “All the existing information, which could be from planned drill holes, existing drill holes, geological models, topographies, and any other information that is relevant, can be displayed in this 3D window,” Ferguson said.

The integration partnership that allows Central users to import IMDEXHUB-IQ information will likely be replicated with other providers going forward. “IMDEX was the first. It has been in place for 18 months. It has been well adopted,” Ferguson said. “Our goal is to have as many integrations as possible with providers over time.”

New Shovels Offer Efficiency, Sustainability

The latest releases have comfy cabs, preprogrammed work modes, and the ability to go green

By Jesse Morton, Technical Writer

A number of new Tier 4 Final excavators were introduced recently, including a couple big ones. They offer preprogrammed work modes that target lower emissions, higher efficiency or optimal production. Mechanical upgrades mean better reliability, higher uptime and a longer life. That they launch now could suggest demand is strong. It could also suggest that the suppliers of this highly competitive niche market have to track and mirror each other so tightly that a new release from one almost guarantees the same from others.

Either as an indicator of current market strength, or in spite of the lack thereof, the latest releases speak to the most basic need of operators, higher productivity. No doubt, these machines can move some rock. They also address environmental concerns with a smaller carbon footprint. A glance at the latest headlines from the around space illustrates.

Better Reliability, Durability

Hitachi's new EX-7 Series of hydraulic excavators have several features designed to optimize fuel burn, increase productivity and ensure operator comfort, company engineers explained.

"With an array of new technology, they get the job done," Hitachi Mining Engineer Jim Plourde said.

Manufactured in Japan and available in the U.S., Canada, Latin America and Brazil, the EX1200-7, EX2600-7, EX3600-7 and EX5600-7 all "feature technologies that reduce fuel consumption costs while achieving superior productivity and enhancing sustainability," Hitachi Mining Engineer Jordan Popp said.

The EX2600-7, EX3600-7 and EX5600-7 each come with either a Cummins or an MTU Environmental Protection Agency (EPA) Final Tier 4 (FT4) engine option. For deployment to sites in non-regulated countries, those units come with an engine option that features Fuel Consumption Optimization (FCO).

"For example, on the EX3600-7, the FT4 engine, which also has FCO technologies but uses Diesel Exhaust Fluid (DEF), contributes toward 4% net fluid savings," Plourde said, "while the FCO engine without DEF features a 7% net fluid savings as compared to the EX3600-6."

The series offers improved reliability and durability over the EX-6 Series.

Contributing to increased uptime, "contamination sensors in each main pump help reduce the risk of machine faults by detecting excessive contamination and alerting the operator when needed," Plourde said.

Popp said the EX3600-7 is "loaded with intelligent features" to maximize uptime. "Machine pins and bushing life is extended with the help of the new auto-lubrication system with a large-capacity grease tank, a new grease pump, an in-line grease filter with breather, and a grease level indicator in the cab help reduce downtime."

On each unit, the hydraulic hoses were switched from an arched to an underslung configuration, reducing hose deflection.

Other features were designed to target increased productivity and efficiency. "We packed in so much new technology, like main pump electric regulators on each individually controlled hydraulic pump, that enhance engine power, lower fuel consumption and increase productivity to lower the total cost of owner-



The largest model in Hitachi's new EX-7 Series, the EX5600-7 offers a maximum bucket capacity of almost 45 yd³. (Photo: Hitachi)

ship,” Popp said. Such illustrates that the company “knows the importance of strong productivity and increased uptime.”

Accordingly, the cab was designed to ensure maximum operator comfort. It has a “best-in-class operation station that offers increased visibility and comfort with ergonomic controls to help increase productivity,” Plourde said. “An advanced multidisplay monitor also helps improve the machine’s performance and uptime by providing more accurate operating status information.”

Optional is the Aerial Angle, which is described by the company as a 360° vision system that helps contribute to job-site safety. “This customer-favorite system assists with noting equipment surroundings through a display monitor that combines a set of images captured by cameras positioned at different locations around the machine,” Popp said.

The smallest in the series, the EX1200-7, has an operating weight of roughly 130 tons, a maximum bucket capacity of roughly 9 yd³, a gross power rating of 760 hp, an overall width of almost 18 ft, and a rear-end swing radius of about 16 ft.

As a backhoe and with a 9-m boom, it has a maximum digging reach of roughly 50 ft and a maximum digging depth of roughly 30 ft. As a loading shovel with a 6.5-yd³ bucket, it has a maximum digging reach of close to 38 ft and a maximum digging depth of close to 16 ft.

The company describes the EX1200-7 as one of the more versatile units in the series and as an operator-friendly machine.

The biggest in the series, the EX5600-7, has an operating weight of 600 tons, a maximum bucket capacity of almost 45 yd³, a gross power rating of 1,540 hp, an overall width of 34 ft, and a rear swing radius of roughly 26 ft.

With a bottom-dump-type 38-yd³ bucket, it has a maximum digging reach of roughly 66 ft and a maximum digging depth of almost 16 ft.

With a backhoe-type 44.5-yd³ bucket on a 33-ft boom, it has a maximum digging reach of 55 ft and a maximum digging depth of roughly 29 ft.

Company literature describes the EX5600-7 as delivering performance and reliability that is unrivaled in its class.

By investing in an EX-7 series excavator, a customer is subscribing to services provided by the Hitachi Mining Applications Group, which focuses on maximizing efficiency, reliability and durability of the equipment sold. “This team supports customers with technical knowledge, jobsite visits and more to optimize their operation,” Plourde said. “For example, we’ve performed operational efficiency studies to identify areas for operational improvement.”

Hitachi launched the series in April 2019 with the introduction of the EX2600-7 and EX5600-7. The EX1200-7 was introduced in May, and the EX3600-7 was introduced in August. The research and development behind the series was driven by customer feedback, Popp said.

“Innovation is a collaborative effort, and includes listening to our customers and their needs,” he added.

Plourde said the series speaks to the company mission of supplying reliable solutions through equipment with best-in-class efficiency, reliability and durability. “We know our customers’ bottom line is affected by those key areas, so we focus on continuously improving and developing new technology that will take our machines to the next level.”

Bigger Bucket, Lower Emissions

Komatsu reported the new PC7000-11, with a bigger bucket size than earlier models in the series, meets all EPA Tier 4 Final regulations. “We’ve improved the efficiency and reduced the emissions,” Marvin Bistram, marketing manager, excavators, Komatsu, said.

Compared to earlier models, the excavator, one of the biggest on the market, offers greater bucket volume, machine health monitoring capabilities, and new safety features.

Company literature puts the shovel capacity at 36 m³. “The increase in bucket size for backhoe, as well as for the front-shovel application, is the new standard for the PC7000-11,” Bistram said.

Komatsu offers a range of buckets and wear package options, which means customers can match bucket specs to material density and other properties.

The shovel comes equipped with KOMTRAX Plus 2, which provides real-time information on the machine on a color display, the company reported. Data can be stored, or downloaded to an external device for analysis. Wi-Fi or Orbcmm satellite transmission is optional.

“KOMTRAX Plus 2 allows a simplified maintenance process and easier troubleshooting,” Bistram said. “The technician is able to precisely monitor the condition of the excavator,” he said. “Thanks to the possibility of automated



Komatsu’s upgraded PC7000-11 features a simplified electrical system that may hint of the coming changes across the entire range of Komatsu mining product lines. (Photo: Komatsu)

reports, mine management can analyze the operation data for improved fleet planning.”

Primary safety features include a design, influenced by EMESRT recommendations, that allows for needed access, includes a 45° ladder, offers optimal visibility, and uses working and service lights to communicate alerts, the company reported. A 360° camera system, KomVision, comes standard.

“We have added intelligent safety features to help alert to dangers,” Bistram said. “In the event of an impending incident, the operator will receive a warning immediately.”

The shovel features a simplified electrohydraulic system, the company reported. The number of controllers and relays is half that of previous models. It has a third less circuit breakers, which are now integrated in one spot, Komatsu reported.

“We have significantly redesigned the electrical system of the PC7000-11,” Bistram said.

An integrated payload meter is optional. “The meter identifies the bucket payload, which increases the productivity of each operator,” Bistram said.

The cabin is sound insulated, has automatic pressurization and climate control, and features a penetration-proof front window, the company reported. The operator seat is air suspended and heated. Windows are tinted and the joystick controls are electrohydraulic.

The unit comes equipped with two SSDA16V159E-2 engines, each with a rated power of 1,250 kW. It has an operating weight of roughly 700 metric tons (mt).

The shovel was developed to fill a gap in the PC7000 line, Bistram explained.

“Since 2016, the market has been growing and changing rapidly. An upcoming trend is a rising awareness of sustainability and ecologically friendly solutions,” he said. “Thanks

to our flexibility and flat hierarchies, we can react almost immediately to customer requirements. Therefore, we launched the PC7000-11. Unrivaled flexibility to market requirements is our daily drive.”

That flexibility allows the company to also provide crucial support timely. Bistram said this is best illustrated in a case where a customer in the U.S. had to quickly replace a slew ring.

“The slew ring significantly exceeded its lifetime and it failed,” he said. “The bang occurred on an older model of the current PC5500 machine, and the required version of the slew ring was not available in stock in the U.S.”

It would have to come from Germany. “But regular sea transport would have taken up to five weeks,” Bistram said. “Regular air support was not an option either.”

The ring, at 4 m in diameter, was too large for a 747 cargo plane. “We arranged a special air transport by chartering the super-large Antonov cargo aircraft,” Bistram said.

The unit was unpacked and then repacked to lower overall dimensions. Packing and transport to the Antonov took less than a day.

“The flight was rather uneventful, and the plane landed safely in the U.S., where the cargo was eagerly awaited,” Bistram said. “After unloading and customs clearance, we transported it to the mine site, and the customer started installation.”

The effort revealed the company’s ability to quickly adapt to circumstances and to take any necessary steps to support the customer, he said.

“We exist to support our customers and we take great pride in our performance,” Bistram said. That motto will soon be expressed in changes to offerings across the company’s product lines. Those changes, Bistram said, would be revolutionary, and can be described as simplifications.

New Dragline Bucket Design Improves Fill Speed

Caterpillar reported it released the double clip back bucket for draglines, designed for increased fill speed and reduced bucket weight for faster cycle times and greater payload. The design eliminates the spreader bar from the rigging system.

The bucket features a “wide mouth, aggressive lip angle, and low front height” to “reduce drag power required,” Cat reported. It minimizes the required fill distance for improved productivity and reduced bucket wear.

Unique trunnion design and location on the clipped portion of the bucket protects the lower hoist link from wear and provides quick dumping of the payload, Cat reported. The design includes a cast-in deflector to protect and increase the life of the trunnion.

The shape of the rear wall enables the bucket to fill without voids, and it

increases material density for optimum payloads, the company reported.

The general design enables the operator to see when the bucket is full, “signaling the operator to exit the cut. This promotes increased production with shorter dig times,” said Mike Evans, commercial manager, draglines, Caterpillar. “It also prevents overloading the machine, which negatively affects reliability, and leads to longer bucket life since it mitigates premature wear created by over-digging.”

Over-digging “causes machine reliability issues and premature wear to the bucket,” said Mike Stolz, dragline engineering specialist, Caterpillar. “The advantages the Cat bucket offers are tremendous.”

Fewer components mean less inventory management and lower maintenance costs, the company reported.



Caterpillar’s new double clip back bucket for draglines, with a wide mouth, aggressive lip angle, and low front height, prevents overloading and over-digging while promoting production, the company reports. (Photo: Caterpillar)

The bucket is available for a range of sizes and applications. Each bucket is designed for the specifics of the dragline and application, Cat reported.

“People will recognize the new solutions not as essential steps, like the first fully hydraulic excavator or the most extensive mining excavator, but rather as a preparatory steps to revolutionize daily mining operations,” Bistram said. “We promise that, going forward, we will do our utmost to engineer the most technically advanced mining excavators with the same zeal as we do now.”

Efficient Production

Volvo Construction Equipment released the EC950F, a 100-ton-class Tier 4 Final excavator best matched with the company's 60-ton A60H articulated hauler.

Initial field tests show the unit can load an A60H in four passes with an average cycle time of roughly 25 seconds, explained Ray Gallant, vice president, sales support, North America, Volvo Construction Equipment.

“Efficient production is the main benefit of the EC950F,” Gallant said.

Such is made possible by optimized hydraulics, which “deliver constant pressures across each phase of the digging and lifting cycle,” he said. “The hydraulic system increases pump power for fast and smooth operation, while the Posicom hydraulic system controls on-demand flow and reduces internal losses in the hydraulic circuit.”

Features include a boom swing priority valve that adjusts the flow between the boom-up and swing so that truck loading cycle times can be set to working conditions.

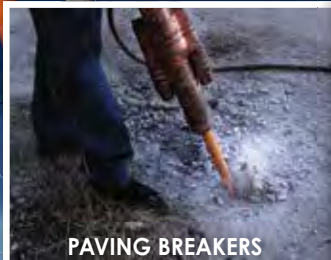


Volvo's new 100-ton-class Tier 4 Final EC950F features an attachment management system that can store settings for up to 20 different attachments. (Photo: Volvo)

“This machine also gives flexibility for using different boom configurations and bucket sizes,” Gallant said. “Using a short boom and short arm can allow for up to a 10-yd³ bucket, which is five times bigger than an average 20-ton machine.”

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The attachment management system can store settings for up to 20 different attachments, enabling the operator to pre-set hydraulic flow and pressure, he said.

The unit has preprogrammed work modes that help the operator minimize fuel burn or maximize productivity. ECO mode, for example, comes standard and offers optimized fuel efficiency.

“The integrated work modes allow operators to choose the best work mode for the task at hand,” Gallant said. The operator can select from Idle, Fine, General and Heavy work mode. “Operator settings allow them to lift quickly and swing slowly to get over a truck, or if they are on a pile or hill to swing more quickly when already above the truck.”

Uptime is maximized by certain design features to include “the heavy-duty boom and arm,” the “strong frame structure, heavy-duty underside plate and floating pins on the bucket connection,” and the “optional full-length track guard,” Volvo reported.

The unit comes with a “low-noise and spacious cab,” the company reported. It has “high-visibility handrails, conveniently positioned steps” and anti-slip plates. “For added visibility, it comes fitted with a rearview camera.”

Options include Dig Assist, and 360° Volvo Smart View; and a Falling Object Guard or a Falling Object Protective Structure.

Company literature states the unit has an operating weight of roughly 100 tons, breakout force of 77,000 poundfeet (lb-ft), breakout force of 79,000 lb-ft, lifting capacity of 50,000 lbs, bucket capacity of 9 yd³, a maximum dig depth of 29 ft, and a maximum dig reach of 46 ft. Gross power rating is 600 hp. It is roughly 15 ft wide and has a tail swing radius of under 16 ft.

The excavator is eligible for ActiveCare Direct, a telematics system, free for a year on new purchases, Volvo reported.

The system provides “24/7/365 active machine monitoring and fleet utilization reporting directly from Volvo,” the company reported. “If a machine requires attention, Volvo communicates directly with your local dealer so they can respond quickly.” Further, “customers receive a report to identify areas to improve worksite efficiency, avoid unplanned downtime, and catch problems before they occur.”

ActiveCare Direct “simplifies fault codes and alerts to make the customer’s and dealer’s jobs easier in terms of maintenance and care resolution,” Gallant said.

The excavator comes with a limited frame and structure warranty.

Gallant said the unit is the evolutionary successor to the EC950E, a Tier 3 unit released in 2016 to Africa, Asia, the Middle East, Russia and former Soviet states. “It proved to be a very capable machine,” he said.

The EC950F is expected to build on that success, he said. “The goal of every mine is to get the highest production at the lowest cost per ton,” Gallant said. “That is what the EC950F is designed to do, particularly when paired with the A60H.”

Increased Performance, Durability

Caterpillar announced its updated 6060 hydraulic mining shovel offers improved machine performance, durability, serviceability and operator comfort over previous models.



The updated Cat 6060 offers optimized hydraulics that give 10% better fuel efficiency over previous models. (Photo: Caterpillar)

Cat said the upgrades to the popular shovel were in response to market demands.

“The 6060 is the leading seller in the 600-mt size class,” Dan Harms, product manager, hydraulic mining shovels, Caterpillar, said. “That’s supported by the fact that the 6060 and its predecessor models have worked more than 6.3 million hours in mines around the world,” he said. “The next-generation 6060 that we are now introducing features improved structures for extended service life. Today’s 6060 lasts longer than ever and requires less maintenance.”

The unit, one of the biggest on the market, has two updated Cat 3512 E engines, optimized hydraulics, heavy-duty structures and undercarriage, and Cat electronics.

New engine design boosts reliability, extending the time between overhauls by 10%, the company reported. Engine oil and filter change intervals are doubled to 1,000 hours.

The optimized hydraulics give 10% better fuel efficiency over the previous face shovel model.

Structural and design upgrades include heavy duty rollers, idlers and track. The frame and shovel structures were redesigned for greater reliability, Cat reported. Slew ring design, with a triple-race roller bearing and sealed internal gearing, extends component life.

The cab, with three seats, offers unrestricted lines of sight and sound suppression, the company reported. The operator seat is pneumatically cushioned, heated and ventilated.

Enhanced Motion Control, which improves loading efficiency, comes standard. The five-circuit hydraulics design gives control over two cylinder motions, two travel motions, and swing to boost digging and loading efficiency, the company reported.

The 6060 has a bucket payload of 61 mt per pass in both face shovel and backhoe configurations. The unit has a gross power rating of 2,256 kW; and offers maximum tearout force of 300,000 lbf-ft, maximum crowd force of 500,000 lbf-ft, and maximum breakout force of almost 400,000 lbf-ft in face shovel configuration.

It is a five-pass match with the 794 AC truck.



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Sizing Up a Fluid Situation

Fuel is always a major cost for mines – oil and grease, perhaps not quite so much, but the wrong lubrication choices and applications can be expensive. Fuel-service and lube vendors offer many product and service options to avoid problems, save money and maintain asset health and performance.

By Russell A. Carter, Contributing Editor



It's estimated that industry-wide, lubrication products account for about 5% of an operation's total maintenance spending. However, proper selection and use of lubricants can affect a much larger portion – perhaps as much as up to 30% – of maintenance costs through reduced downtime and better machine productivity.

Anyone who doubts the old proverb “the more things change, the more they stay the same,” can find absolute evidence of its truth in the current state of the mining industry. With the cumulative social and economic impacts of the COVID-19 pandemic far from clear, producers face unexpected and possibly unprecedented challenges involving everything from capital investment funding to material shortages and workforce upheaval.

And yet, the mission remains the same: To stay in business, they must put rock in the box, whether it entails loading hundreds of tons of rock and dirt by shovel into a haul truck for a trip to the crusher, or continual underground scoop, tram and dump cycles. In order to operate reliably, the machines used in either mining mode need fuel, oil and grease, along with filtration and fluids for cooling and perhaps even for exhaust aftertreatment as well. The OEMs that build these machines regularly update their new-product designs to provide easier serviceability and greater overall economy of operation, but each generation of engine, drivetrain and hydraulic-system improvements seems to bring stricter requirements for fuel quality and cleanliness, oil and grease formulations, and filter performance.

A Closer Look at Costs

When global economic events disrupt traditional supply lines and future demand for mined commodities becomes unclear, mineral producers instinctively look for ways to cut operating costs. In an industry that routinely runs fleets of haulers burning anywhere from 40 to 80 gallons of diesel fuel per hour — loaded by shovels with 4,000-gallon fuel tanks — fuel cost, economy and storage/handling efficiency often get spotlighted for management attention. And as mines increasingly employ larger but fewer trucks and shovels, for example, the impact of taking a unit out of production for lube-related service often gets measured against the risks and rewards of extending its service intervals to minimize the loss of output. Increased scrutiny of lube-related costs and consumption might also lead to a closer look at whether an operation is buying the most cost-effective products, along with where, how often and how much is being used.

This has become even more of a concern as technology progresses and the mining workforce evolves. Lubrication experts are quick to point out that misapplication or over-application of a product can cause almost as many problems as inadequate lubrication (see sidebar on page

38) and can often be attributed to lack of user familiarity and expertise. In fact, a 2019 study by Shell Lubricants UK indicated that mining companies lack confidence in their workers' ability to cope with new technology. The survey revealed that many companies are concerned about the specialist maintenance requirements of new equipment (98%) and some believe they will face difficulties upskilling workers to use these new technologies (48%). Thirty-eight percent said they are currently lacking trusted external experts who could provide support in introducing “Industry 4.0” technologies.

Tonya Donaldson, Shell Lubricants global marketing director for mining, said, “It's interesting to note that although 100% of those surveyed agreed that introducing these new technologies will have an impact on their choice of lubricants, only 46% feel they will need to place more emphasis on equipment protection and only 40% would focus more on longer oil life. Companies recognize that external support will be important to help improve maintenance practices, and 88% plan to use their lubricants supplier to help them progress.”

In another study conducted the previous year, Shell found that 60% of surveyed mining companies seemed to recognize that effective lubricant selection and/or management can help reduce costs. However, fewer than 10% of the businesses in the study understood that the potential savings can be six times greater than the expected average.

Basic Training

If worker inexperience or unfamiliarity with a company's commonly used lubrication products are concerns, a focused effort to clearly identify the various types of oil, grease and other fluids used in its production fleet or plant equipment might help,

along with providing fail-safe, reliable storage and dispensing systems and installing efficient, secure fueling-station equipment.

Lubrication labeling systems are available from a number of sources. Chevron, for example, offers its SmartFill Program, a system based on a workplace organizational methodology that originated in Japan called 5S Visual Management. If applied correctly, clear visual signals throughout a facility identify where all tools and supplies are supposed to be located. These visuals range from simple diagrams or labels to detailed process flow maps and directional signs.

SmartFill comes with a customizable lube room chart to identify which lubricants belong in the storage area, and corresponding SmartFill labels in two sizes: large labels for bulk tanks, totes or large volume storage solutions, and small labels for hoses, top-off containers and component fill points. The SmartFill approach is to match the lubricant product displayed on the chart to the labels and assist in the “chain of custody” process. The lube room chart and labels should include the following:

- Product name;
- ISO grade;
- Color coding and symbols for easy visual identification for top-off containers, fill points, etc. (optional);
- Product hierarchy based on usage priority;
- Supplier part number or internal part number;
- Shelf life, which helps with first-in, first-out inventory management in the lube storage room; and
- ISO 4406 Lubricant Cleanliness specification (optional).

Noria Corp., a lubrication consulting and training company, recommends that instead of using manufacturer brand names for tagging equipment and lubricants, companies should consider using codes from the ISO 6743 Lubricant Identification System (LIS). This avoids the necessity of retagging equipment and storage devices if operations lubricant suppliers change.

Once labeled, lubrication products should be stored and dispensed with equal care. Whitmore Manufacturing’s new Luster lubrication storage and dispensing system offer a scalable solution. “World-class maintenance and oil cleanliness requires processes and equipment that are both robust and easy to use,” said Doug Reid, vice president of product development. “The new Luster line helps

companies extend the life of their fluids with a compact, durable and easy-to-use unit that fits almost any industrial location. It provides high-quality filtration and the modular design allows customers to add on additional units to cover as many lubricating oils as they want.”

“Without protection, operational fluids are degraded, leading to higher fluid replacement costs and ultimately shorter life for the valuable equipment companies rely on. In the future, as machinery becomes more advanced, prevention and protection will be an even higher priority,” Vice President of Global Sales Joel Garrett said.

The systems, according to Whitmore, are designed for customization and expandability. Three different configurations are offered: a wall mount with no reservoir, for use with drums or totes, and 65-gallon (250-liter) or 130-gallon versions. Optional equipment includes custom fluid ID labels, 3 µm or 20 µm filters, pneumatic 5:1 pump, spill containment and color-coded quick connects.

Another option for reducing the possibility of human error in lubrication applications comes in the form of automatic lubrication systems such as those offered by Graco, SKF, GreaseMax and others. Graco, for example, in January launched its Compact Dyna-Star (CDS) automatic lubrication system designed specifically for heavy-duty earthmoving machines in extreme work environments. The CDS controller can be paired via Bluetooth with a smartphone app to allow maintenance personnel to quickly monitor a wide range of lubrication metrics, including levels, pressure, configurations and more.

Graco said its automatic lubrication systems are now available as a factory option on a variety of Komatsu America’s earthmoving equipment. The automatic lubrication systems feature either a G3 Electric grease pump, MSP divider valves and a GLC-2200 controller, or an Electric Dyna-Star grease pump, GL1-X Injectors and a GLC-2200 controller. The system is also available as an after-market field install kit, which includes all the core components along with the necessary hoses, fittings, mounting hardware and protective guarding required for proper installation.

Longer Life

Potential lube-related savings can be uncovered in a range of maintenance-related areas, linked not just to the brand and type of lubricants used, but also to increased opportunities for extending the service life of those products. In a case history focusing on GE electric-wheel assembly lubrication fluids, Donaldson Corp. found that each rear wheel assembly on a haul truck represented an initial cost of \$250,000 or a replacement cost of \$600,000. According to General Electric, the expected life of a rear wheel motor is 24,000 hours. In order to achieve or surpass that figure, fluid cleanliness is essential.

In the example, which involved a project at two surface mines, it was found that after 500 hours of operation with new fluid, analysis of wheel-assembly lubricant showed its ISO cleanliness code increased to 25/23/18 with iron concentration at 250 ppm or more. Following treatment using a kidney loop cart with



Appropriate lubrication storage equipment and clear labeling of products, through tags, signage or color coding, can reduce the possibility of human error in handling and application.

Donaldson Blue DBB8665 filters, the processed fluid registered ISO codes between 18/16/13 and 20/18/14, making it possible to extend drain intervals. The mines used two auxiliary rear wheel kidney loop carts on individual wheel motors while other preventative maintenance

services were performed, typically taking less than 3 hours to complete. The reduction in contamination such as dirt and iron, said Donaldson, could provide up to a 1.7x extension (40,000 hours) for the life of the component, based on Noria Corp.'s Life Extension Table.

Another cost-related option that can pay off is the choice of whether to use synthetic or mineral hydrocarbon-based lubricants. As Total S.A., the French multinational integrated oil company, pointed out, synthetic lubricants are designed for specific applications and are usually more

Lubricant Application Technique Critical to Equipment Protection

By Ron Reiniger

Every moving component on a mining machine needs the right amount of lubricant to ensure optimal performance, extend equipment life and reduce operating costs. This is particularly true for protecting shovels, where proper application practices are critical. A common mistake that can lead to unscheduled downtime is over-lubrication.

Whether it's poor communication between shift changes, lack of reporting, or misinterpreting how the product should be applied, any one of these scenarios can result in over-lubrication, which in turn can lead to unexpected maintenance costs and increased downtime for repairs.

The process of over-lubrication is akin to that of spray painting. One coat of spray paint on a metal sheet results in an even finish. However, if the next coat is applied too quickly, the finish will start to drip and run off the surface. The same applies to shovel gears or sticks, where over-lubrication would cause the fluid to sag and drip, leaving the metal exposed to contact. These issues can easily be avoided with proper application and general maintenance practices. Below are some techniques to consider when lubricating key points on mining shovels.

Open-gear Lubrication

A shovel's open gears often operate in corrosive, hostile conditions that subject equipment to temperature extremes, precipitation and abrasive dust. This adds to the difficulty of achieving optimal lubrication. Many of these factors are out of a maintenance manager's control, but the quantity of lubricant applied to an open gear is not, and tight control here can help mitigate wear caused by exposure.



The higher levels of wear protection provided by correct application of lubricant products on critical shovel parts can extend the life of those components and reduce the possibility of costly unexpected rebuilds.

It's critical that mine operators understand the product they are working with. For example, Vultrex, Petro-Canada Lubricants' line of grease-based Open Gear Lubricants (OGL), enables users to apply less compared to other products. When properly applied, the tooth face of the gear will show a tenacious film of lubricant that will be black or dark grey in color and velvety in appearance.

Though these recommendations apply year-round, there are specific seasonal considerations to keep in mind. For example, colder climates typically need additional lubricant to keep the protective film workable on metal surfaces. In warmer climates, less product is applied to reduce the amount of fling-off, reducing messy and excessive lubricant consumption.

Shovel Stick Lubrication

Shovel sticks have lubricant needs very similar to those of open gears. In cases of over-lubrication, the plating effect is reduced on the metal running surfaces. This makes the stick surfaces more susceptible to harm from weather elements and hostile conditions. When properly lubricated, a stick should have minimal lubricant build-up toward the bucket and on non-running surfaces. This enables the lubricant to better resist adverse weather and the effects of a working environment that can range from very wet to dry and dusty conditions.

Roller and Rail Lubrication

Lubricant application practices for house rollers and rails are like those for open gears. The lubricant film determines the amount of product to apply. A stubborn, black velvety film will be created when the correct amount of lubricant is used. In colder climates, it is not necessary to increase the amount of lubricant applied. Pouring oil onto the rollers to reduce the typical "asphaltic lubricant" snap, crackle and pop is not necessary. Because the lubricant is oil-based, it will not dry out or freeze, which will make the equipment quieter.

Bearing and Bushing Lubrication

Proper lubrication of bearings and bushings is just as important as for larger components. The same application practices apply: monitor the quantity of grease applied and avoid over-lubrication. As a multi-service lubricant, Vultrex is an ideal solution for bearing and bushing lubricant needs.

The key to preventing over-lubrication is to ensure all maintenance personnel and operators are trained in proper lubrication techniques. Petro-Canada Lubricants can provide a shovel technician to support its customers, offering on-site solutions that extend equipment uptime, reduce maintenance costs and give the best return on investment.

Ron Reiniger is technical service advisor for Petro-Canada Lubricants. Inc.

resistant to oxidation, the undesirable series of chemical reactions involving oxygen that degrade the quality of an oil. Although this means synthetics will likely last longer and lead to potential cost savings through oil-change interval extension, they are also more expensive than mineral-based oils.

Total regards its ability to identify opportunities that provide measurable value to its customers as an integral part of its continuous improvement process. This process involves the customer and Total working collaboratively to identify and implement targeted actions, including the use of synthetic lubricants when warranted over mineral products in relevant applications. After compiling certain baseline information such as current oil drain interval and average hourly energy consumption, Total processes the data using a Total Cost of Ownership (TCO) tool to identify lubricant performance levels and related cost to determine an optimal solution for the customer.

Although this process can point out opportunities for sizable lubrication-related savings to its customers, Total warns that certain variables can complicate the picture, such as:

- Consistent contamination of a compartment containing a synthetic lubricant, making additional oil drains necessary and resulting in increased costs.
- Overall energy savings achieved will depend on contamination levels as well as the number of subsequent oil drains needed to reduce equipment wear as a result of this contamination.

In other words, the ultimate decision as to whether synthetic lubricants can replace mineral-based products should only be made after consideration of situational factors specific to each customer.

To support its customers that opt for synthetic products, Total Lubricants now has a suite of synthetic blend diesel engine oils especially designed for off-road applications. Total's Rubia Works 3000 FE 5W-30 is an ACEA E6 product that provides high-temperature and high-shear-rate viscosity protection. The new oil, which Total said is suitable for most Euro Stage IV or U.S. EPA Tier 4f engines, is claimed to increase fuel savings by up to 1.47% compared to standard SAE 15W-40 lubricants.

The Rubia Works 4000 range is formulated based on the API CK-4 performance classification to address severe duty op-

erating conditions found in off-highway applications. The range consists of three premium heavy-duty engine oils: Total Rubia Works 4000 15W-40, FE 10W-30 and 10W-40. The products meet engine manufacturers' SAPS (Sulphated Ash, Phosphorus and Sulphur) restrictions and help to extend diesel particulate filter service life.

All major oil companies offer similar lines, including Mobil (Delvac), Shell (Rotella), Chevron (Delo), Sinclair, Castrol and others.

Finding Ways to Save

When it comes to estimating fuel usage and setting fuel budget targets, mine operators face continual challenges. Fuel price and supply stability generally reflect overall regional and global economic conditions, but fluctuate significantly due to localized supply, regulatory changes or other related factors. Fleet fuel consumption also can vary as mining conditions change; a trend toward denser, heavier material being mined, for example, along with individual driver habits or adverse weather conditions can have significant effects. A study published by the Australian government's Department of Re-



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FlowTech Fueling estimates that its fuel overfill prevention systems have prevented spillage of more than 6.6 million gallons of diesel fuel by its customers since 2007, resulting in a total cost savings of \$19 million.

sources, Energy and Tourism on various aspects of diesel-powered haulage at surface mines reported that wet haul road conditions can result in a 25% increase in haulage fuel consumption compared with hardpacked, dry road surfaces.

Mine operators need to know the actual rate of fuel consumption by their loading

and haulage fleets in order to conduct any sort of meaningful improvement program, whether it pertains to engine control module (ECM) tweaking or a possible change-over to synthetic motor oil for fuel savings. But direct measurement of fuel consumption is not a simple task, according to Cascadia Scientific, a Canadian company that

claims it has developed a way to apply Machine Learning methods to the problem.

According to the company, the three most common fuel measurement strategies employed in mining include measuring at time of fill, Engine Control Module (ECM) fuel consumption estimations and on-equipment fuel measurement. The first two, said Cascadia, can provide useful information but suffer from specific drawbacks: In the case of ECM-based consumption estimates, the models constructed by engine OEMs to measure consumption can start out being quite accurate but can degrade in usefulness over time as an engine's fuel injectors age and foul, fuel pressures vary and cylinders start to lose compression. Tank-fill consumption estimates can provide very precise information on the exact quantity of fuel dispensed to a machine and consequently consumed but lack the "granularity" to target specific characteristics of mining machinery and daily operation. For example, a typical fueling strategy might call for a truck to be refueled once per day. Over the course of that day, the truck might complete 50 haul cycles of various lengths, vertical travel and pay-



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load, might be operated by four or more individuals, and could be idled between 10% and 40%. Cascadia believes drawing accurate conclusions about the specific contributions of these factors to fuel consumption with a measurement frequency of once per day is not possible.

For higher measurement accuracy, Cascadia offers its SmartRView platform, derived from technology that the company obtained in 2019 by acquiring the intellectual property of Blutip Power Technologies, which offered operators of high-horsepower diesel engines a way to solve fuel challenges through its fuel-savings-as-a-service business. SmartRView is a real-time, cloud-based telematics system that provides fuel data and analysis via an on-equipment measurement approach.

In addition to actual machine fuel consumption data, mine fleet operators need to know, at a minimum, how much fuel has been delivered, how much is in storage, how much is being dispensed and from where and when. In order to get a tighter grasp on fuel costs, industry experts generally recommend use of a fuel management system, either as a stand-alone product or as a module in a comprehensive fleet man-

agement system available from vendors such as Modular Mining, Hexagon and Wenco as well as OEMs like Caterpillar. (Modular Mining is a subsidiary of Komatsu and Wenco's parent company is Hitachi Construction Machinery.)

Likewise, an efficient, safe and reliable fueling system setup can contribute savings in a variety of ways. Sara King, vice president of Wyoming, USA-based FlowTech Fueling, told *E&MJ* that her company's Mobile Fuel Docks and Nonpressure Fuel Overfill Prevention systems can provide hard rock mining companies significant production gains with just a modest investment.

King cited an example: In 2018, FlowTech built two 60,000-gallon Mobile Fueling Docks at a copper mine in Arizona. The docks, she explained, are extremely customizable and easy to relocate as future mining operations require. Each dock is capable of refueling eight haul trucks simultaneously at a rate of 130 gpm. The docks also have a fuel-truck fast-fueling station capable refilling the mine's fuel trucks at 300 gpm. Fuel is filtered down to 10 microns before entering the storage tanks, and then to 5 or 3 microns before being dispensed. The double-walled tanks

are equipped with an overfill prevention system to alert the delivery driver when the fuel level in either storage tank reaches 90% full. In the event that the fuel level reaches 95% full, an inline valve automatically closes, preventing the tanks from being overfilled. The fuel storage tanks are also equipped with a secondary tank monitor, which triggers an alarm if fluid is detected in the secondary tank. The copper mine customer reported that increasing the number of refueling stations while also increasing the flow rate at each haul truck refueling station from 60 gpm to 130 gpm yielded a six-month return on investment for the entire Mobile Fuel Dock project.

King said due to the increased flow rates at the new fuel docks, the copper mine elected to outfit its haul truck fleet, consisting of 35 CAT 793's, with FlowTech's nonpressure fuel overfill prevention systems. These systems eliminate tank pressurization during refueling and make it virtually impossible to overfill the fuel tank. She concluded, "Our Mobile Fueling Docks combined with our nonpressure overfill prevention systems make it easy to increase productivity without compromising safety and environmental profiles."



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How to Make Filtered Tailings Feasible

The technology and drivers required for dry-stack tailings are all there, so why are mines still wary of high-performance filters, and how can we overcome the current inertia?

By Carly Leonida, European Editor



FLSmidth's Colossal filter demo plant at Escondida in Chile.

To dewater or not to dewater tailings? That is a question many mining companies are grappling with at the moment, and it's a tricky one to answer given the huge number of unique factors that can influence the business case at each site.

Dewatering to create thickened tailings, paste or filter cakes for dry stacking removes residual process water from the tailings making it less risky and bulky to store. It allows process water to be returned to the concentrator for reuse, helping mines drive down their operating costs and, it opens up multiple options for tailings storage including backfill and dry stacking.

Dewatering technologies have existed for years in the form of thickeners, cyclones, centrifuges, vacuum filters, belt presses etc., and these have been widely applied at high-grade, lower throughput operations and at mines in water stressed areas. However, until relatively recently, aside from the cost of water, there has been little incentive for high-throughput, lower-grade operations such as copper or iron-ore to dewater their tailings. So, what has changed?

Firstly, filtration technology. The past 18-24 months has seen the commercial

availability of next-generation pressure filters that can handle extremely high throughputs and achieve very low residual moisture content in filter cakes (as low as 5%) safely and economically. And, this has been a game changer.

The industry has been talking about the potential benefits of dry stacking tailings for years. However, applications have been few and far between, mainly due to limitations in the performance of technologies and the associated capital cost. Now that filters that can handle 30,000 metric tons per day (mt/d) and more have been proven, we should, technically, see the first full-scale implementations within the next 1-3 years.

Secondly, up until 18 months ago, in the majority of cases — bar water stressed operations like those in northern Chile, and in countries where dewatering is mandated i.e., Brazil — the business case for dewatering tailings at most high throughput operations just wasn't strong enough.

The past 10 years have seen a string of high-profile tailings dam failures including Mount Polley, Samarco and, most recently, at Brumadinho in January 2019.

The last event in particular prompted stakeholders at all levels to take greater notice of mining practices, good and bad.

If designed or managed poorly, wet tailings storage facilities (TSFs) can pose a significant risk to human life, to the environment and to businesses and, as such, investors and governments are now leaning heavily on miners to consider more sustainable storage options for tailings.

The benefits of dewatering tailings to whatever degree are clear. However, despite the necessary technology being available and, despite almost unilateral agreement from equipment suppliers, engineering firms and mining companies that dry stacking is the most promising and widely applicable method of tailings storage going forward, the industry is at something of a stalemate.

Most of this inertia can be attributed to executive and investor's suppressed appetite for risk. There are a huge number of factors that can influence the operational and economic success of high-performance dewatering technologies. It takes time to properly evaluate and understand these, and this, coupled with a wariness of being the first to buy into a "new" technology, means the industry has yet to see a full-scale dewatering/dry stacking solution at a high-throughput operation.

It is only a matter of time, but until this hurdle is overcome, the industry cannot move forward with creating a truly sustainable sector, one that can stand up to stakeholder scrutiny and reap the benefits of the green economy.

Understanding the Risk/Payback Balance

To get a handle on where the industry is at technology wise, and how mines can navigate the economic/operational/logistical maze in front of them, *E&MJ* turned to two of the biggest providers of mineral processing solutions: FLSmidth and Metso.

Todd Wisdom, director of tailings at FLSmidth, began by explaining the evaluation process.

“First, we try and answer a bunch of technical and commercial questions with the client, ranging from what’s the cost of water at their site, because that’s going to determine how much money they spend on dewatering, what’s the cost of electricity and manpower... those kinds of things.

“We look at the operational costs, in terms of spare parts, maintenance, and consumables. And we need to understand other constraints around the mine, aside from the commercial ones, like what altitude is the site at? What’s the particle size distribution and mineralogy of the tailings material, which we’ll confirm based upon the samples they send us.

“We do a desktop study to understand those constraints, and then we need to know what their TSF looks like. Is it an existing mine? If so, what was the original mine life plan? Are they getting toward the end of it? If it’s an existing mine, we’ll evaluate a sample of tailings and discuss how many years of life they’re looking to get.

“A big filtered tailings solution probably needs around 10 years to be competitive and pay back the investment in the conveyors and filtration equipment. And for large concentrators that are looking at big pressure filters, like in Chile, the cost of water needs to be more than \$3 a cubic meter (m³) for it to start making economic sense or they need to be very near the end of life on their current TSF. So, we can use some high-level rules of thumb to say whether we think particular technologies are applicable or not.”

Wisdom said one of the biggest misconceptions that accompanies high-performance dewatering equipment at present, is that mines need to implement an “all or nothing” approach. However, this is definitely not the case. A partial solution where mines dewater 20% or 30% of the tailings stream offers a good way to get familiar with the technology and can help minimize associated risks.

“Even engineers and OEMs can fall into that trap,” he said. “If a mine has only a couple of years of life left and you can put in a process that’s going to add another five years of life to the current TSF. And you’re only going to dewater, say, 20% or 30% of the tailings, that does a lot for the mine. That allows them more time to find a longer-term solution if they think the mine life will be extended.

“It allows them to de-risk a higher performance dewatering tailing solution. One

of the big issues, especially with large mines that are looking at filtered tailings, is they view it as a risk, because there’s nothing bigger than 30,000-mt/d filtered tailings operating right now — Karara in Western Australia is the largest installation.

“A 100,000-mt/d mine might look it and say ‘Ok, it’s possible, the technology is there, but we’re going to give it a really high-risk factor’ and the project never makes it across the line. If they dewater just a portion of the tailings stream, then they’re not betting the whole farm on what is, at this scale, a new technology. And it allows them to de-risk the project and get something off the ground that is beneficial for them.”

And, at that scale, the amount of water and power saved by dewatering 20% or 30% of a tailings feed is significant. The operational savings can, quite quickly, help to offset the high capital cost associated with new filtration technology and a conveyor system. It also drives down the cost of tailings storage by reducing the number of lifts required; at large facilities each lift can cost hundreds of millions of dollars, so even a partial dewatering solution can provide significant benefit.

On the flip side, if a mine chooses to dewater 100% of its tailings using filtration technology, there is a need to factor in some redundancy so that, if the system goes down, the entire mine isn’t held up.

“That’s pretty easy to do on the dewatering, filtration and pumping side because you, typically, have multiple pieces of kit,” Wisdom explained. “But on the conveying side, it can be more problematic. Typically, there’s only one overland conveyor, and the TSF can be anywhere from 1 km to 20 km away from the mine.

“Whereas, if you’re implementing a partial dewatering solution and there’s an issue with the conveyor, say it’s down for a few days, then instead of having a com-

pletely redundant system, you can just use the original TSF. But that also requires the mine to make the decision early enough that they’ve got some capacity left.”

Finding the First Partners

Where is FLSmidth at with its filtration technology?

“The Colossal filter was designed to handle 10,000 mt/d, and we did a demonstration plant with Escondida in Chile that looked at that,” Wisdom said. “They eventually decided, I think it was partly due to the high-risk factor, to put in another desalination plant.

“Then we had the EcoTails Project that we worked on with Goldcorp. That developed a whole new filter that was able to handle 30,000 mt/d.”

That filter, which is yet to receive a catchy name, has been dubbed the “5 x 3.” FLSmidth held an event in Nevada last year to showcase the technology which is now commercially available. However, there aren’t any full-size units in operation yet. The test filter, that was demoed at the event is a demonstration model — it only has two chambers — and was designed to test samples of tailings to help companies build a business case before purchasing the technology at full scale.

“The filter itself is engineered. It could be sold if there was a client for it,” Wisdom said. “Goldcorp and FLSmidth were looking at creating a consortium to build that first demonstration plant at Peñasquito in Mexico and prove the 5 x 3 filter and associated technology.

“We’re still looking for partners. It really depends on how fast different miners come forward.”

It all comes back to the old adage that miners prefer to be first to be second (or third) when it comes to selecting new technologies. And, to a degree, that’s understandable. Most mining projects carry a fair



A rendering of the 5 x 3 filter. FLSmidth developed this in collaboration with Goldcorp as part of the EcoTails project.



The 5 x 3 pilot plant that FLSmidth demonstrated in Nevada in late 2019.

amount of risk at the front end, so to create additional risk at the backend by throwing a new technology into the mix isn't an option for many companies... Unless of course the cost of water is so high that there will be a huge ROI or if there's regulatory pressure.

Wisdom thought for a moment, "I would say, especially with engineers, it's the risk factor that concerns them. They want to see more than one example of a technology installed and operating for that particular type of tailings," he said.

"There are two things we have to prove: the mechanical reliability and the process performance. The mechanical reliability can be proven at any site. The process performance, we need to prove that and scale it up based upon smaller tests. I think all of the vendors have pretty much shown that they can scale up the equipment.

"We've spent quite a bit of money trying to alleviate as much risk as we can. We can't alleviate that last step, somebody is going to have to step up and actually install one [a 5 x 3 filter], but we're trying to get as close as we can without making that last big investment."

Supply and Demand

"I would say every mine that I've been involved with, both new and existing, in the last few years, is evaluating filtered tailings," Wisdom said. "Because there aren't a lot of big new mines being built, probably, the biggest market is mines that are extending their operational life and are looking to increase the life of their TSF.

"Gold mines tend to be smaller, in the 10-15,000 mt/d range. And, I would say that for those smaller mines, filter technology is very well accepted. They're not only evaluating it but very seriously considering it for every project.

"There's a couple of drivers there technically and around profit margins. With big open-pit mines, they're usually big and open pit because they're low grade. And low-grade mines don't usually have a lot of profit margin between what it costs them to produce a ton of metal, and what they make on that ton of metal. There's very little margin for variation in equipment before it impacts on the ROI.

"Smaller high-grade mines usually have more bandwidth to play with. And, if they're underground, they're probably also looking at solutions like backfill. Once you start to dewater material to put it back underground, you've got most of the infrastructure there to dewater all of the tailings and surface-dispose the rest of it."

Wisdom's biggest piece of advice for companies that are evaluating dewatering is not to see it as an all or nothing solution.

"Especially when looking at existing mines, don't do an all or nothing solution, because I think the optimum, in terms of payback and lowest risk, is to partially dewater the tailings stream," he said.

"Make sure you look at all of the technologies. Don't get pigeonholed into 'I think this is what's going to work' because that's the only equipment the vendor of-

fers, or because you have a preconceived notion. Do a high-level conceptual study that looks at all of the options and then maybe get a more detailed study on two or three. That might potentially come out with a better solution for the mine."

Solutions as Well as Technology

Metso also has a high-performance pressure filter that is ready and waiting for full-scale deployment. The VPX was launched in June 2019. There are currently four models in the product range, but the use of modules and an electro-mechanical drive (rather than a hydraulic drive system) means that each filter can be shortened or lengthened depending on how difficult the material is to dewater and the necessary throughput. The pressure can also be adjusted to maximize energy efficiency in relation to the desired end moisture content.

According to research by Metso, only 5% of the tailings generated globally in 2018 were dewatered to create thickened tailings or paste, and less than 1% were filtered for dry stacking. However, the company estimates that by 2025 the share of generated tailings that are dewatered will increase to 13%.

Metso is so sure of the market that, in addition to launching a new product last year, it also created a business unit called Metso Tailings Management Solutions that is, as the name suggests, dedicated to advising mining clients on and creating solutions based around tailings management.

Rodrigo Gouveia is vice president of Tailings Management Solutions, and he provided an update on the company's activity.

"The VPX is a big success," he said. "We have about 20 firm proposals delivered for mines in Chile, Peru, Brazil, Australia and in India. There are discussions also in Africa and Russia. We're expecting the first order in the second quarter from a customer in South America."

Like FLSmidth, Metso quickly recognized the need for a test unit to help clients prove the technology and build their business case before committing to a full installation. The VPX10 is a mobile pilot plant that features all the sensors and control systems of the larger VPX models, but its miniature size allows it to be transported in a shipping container and installed

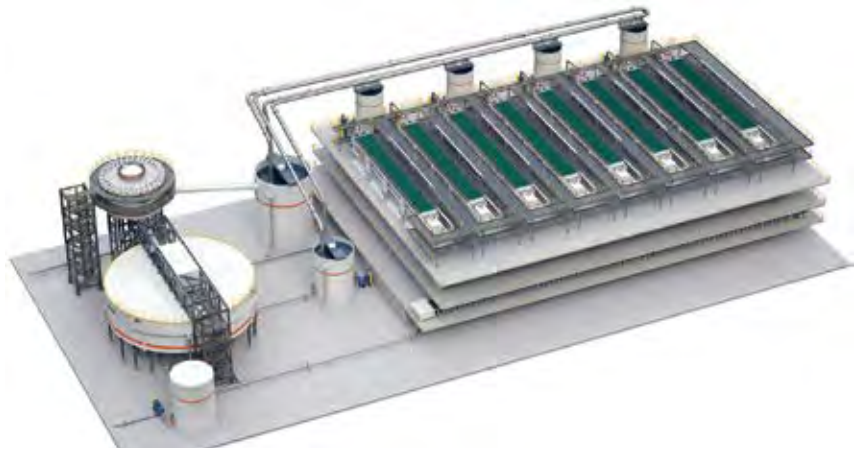
at, or close to, a customer's site, complete with thickeners and hydrocyclones.

The unit has proven so popular that it has a waiting list and, to help meet demand for numbers, Metso just installed a full-size pilot plant at its own facility in Sorocaba, Brazil.

"This machine is ready for tests on an industrial scale," Gouveia explained. "It's not a lab unit. We have completed tests for four customers in Brazil already and we have customers in Chile, Peru, Australia and India that will start sending samples to us very soon. However, that has been delayed a little due to the coronavirus.

"With the tests we are going to perform with the VPX10 in our facility in Sorocaba, we expect to have results for processing different tailings, like iron, copper and gold. That was why we decided to install the plant at our own facility, because it opens up the opportunity for us to test different material from different customers. It would be great to also install this pilot plant for one specific customer. However, we will be limited to that particular application.

"Having it inside Metso, we can easily transport 1,000 liters of pulp or slurry



A conceptual dewatering solution from Metso using high performance pressure filters amongst other technologies.

to our own facility and process it there. It's also a good opportunity for customers to see the filter in operation, to have the maintenance people see the electromechanical drive working, and how reliable this solution can be.

"We should have two more pilot units soon: one more in the pacific rim, to serve Chile and Peru, and another in Australia, to serve that part of the world."

Gouveia explained that the majority of inquiries have come from existing mines

that are looking to expand or mines where TSFs are approaching their end of life.

"At this moment, what we are hearing most from customers and EPCs is concern on fresh tailings generation," he said. "There are a lot of TSFs today that are very close to maximum capacity without the option to be increased. Dry tailings are the best solution for those applications.

"Of course, it is of interest to new operations too with environmental licensing becoming trickier. But unfortunately, as



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an industry, we are not seeing many new projects coming through. For the few new large projects that are coming, dry tailings are definitely being considered.”

Water Scarcity Pushes Innovation

Again, the main concern that Metso is seeing regards the level of investment required for dewatering and dry stacking solutions, and their effectiveness.

“We all know that the mining industry is very conservative. It’s difficult to make mining companies move on a new technology,” Gouveia echoed Wisdom’s words.

“All the studies that we have done so far show that dry tailings are the future. Not only because the risk related to tailing dams is eliminated, but also, we are seeing that with the new technology and all the cost involved with tailings management, the CAPEX and OPEX actually work out to be more efficient with dry tailings.

“New technologies like the VPX, they put a new perspective on the financial side of tailings management, because they can handle a much higher capacity. That was the problem in the past. We had good equipment to reprocess or dewater

tailings. However, the volume of water that could be recovered was low, so the cost became too high. A large number of filters were needed to cope with the volume of material but now, with these new technologies, it is very different.”

Gouveia also emphasized the issue of water scarcity; something that is only going to get worse in the coming years, particularly in areas like northern Chile where many of the big copper mines are located. The region is currently experiencing its worst drought for more than 100 years, and the lack of water is leading many mines to reduce their operations or even consider halting them.

“If you ask me about the future, I’d say that it is the ability of us, of the OEMs, to offer solutions that can process even higher capacities than are already possible,” Gouveia said.

“We are now seeing the big mines starting to prepare their long-term strategies for tailings with 100% of the stream dewatered. The volumes to be processed are huge, and existing technologies, they are able to perform the job, but the number of units required is also huge and expensive. Currently all our investments

are related to developing equipment and solutions that can process a much higher volume of tailings at a lower cost.

“I think in the next 3-5 years, it will be possible to process 100% of such volume on a cost-efficient basis.”

To help mines assess and evaluate potential solutions, Metso is currently developing a digital tool or “configurator.” This value calculator allows mines to enter their main priorities i.e., energy efficiency, water consumption, footprint etc., as well as information on the volume and types of tailings they’re producing and do a preliminary assessment on different circuit configurations. The tool can advise how many filters will be needed and even size the units.

“It’s going to be a great tool to help customers in the decision process for going to dry tailings. We are going to launch it in phases starting in June. It’s really impressive what can be obtained with this configurator, and how quick we can respond to customer expectations,” Gouveia added.

“The first phase will focus on dewatering and, later, we’ll expand the tool to reprocessing and even other stages of mineral processing. We’ll also connect it to our

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VPS configurator, which is already known in the market, for circuit simulations.”

What About Reprocessing?

Fresh tailings may be miner's main concern at present, but what about the hundreds of billions of tons of tailings currently sitting in dams, both operational and closed, around the globe?

Select mines have been reprocessing high-grade tailings for some time, but now that the technology is available to do so at a large scale and, now that mining companies can no longer afford to turn a blind eye to TSFs after closure, interest must be growing.

“I wouldn't say there's a lot of interest, but there's definitely some, especially from older mines that maybe didn't have as good separation technology or techniques early on in their mine life,” Wisdom said. “There are definitely TSFs that they could look to reprocess and recover copper or gold or whatever is potentially still in those tailings.”

Gouveia agreed, “There is great potential for reprocessing, mainly at older mines where the tailings were produced using older technologies, say, 30-50



Metso recently installs a VPX 10 filter at its facility in Sorocaba in Brazil to test the technology on different types of tailings and help customers to build a business case prior to purchase.

years ago. Some of those tailings are really rich. Our studies indicate that metals obtained from reprocessed tailings can be up to three times cheaper than virgin ore. Some iron-ore mines have 50%-55% metals content in their tailings, which

is amazing really. And there are copper operations with 0.5% of copper in their tailings which is higher than what's in the ground. It's just a question of dredging the material and floating the metal or using magnetic separation.”

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Blockchain: A New Level of Trust for Miners

Blockchain technology can help miners secure investment and future access to markets through times of unprecedented change

By Carly Leonida, European Editor



The motto 'don't trust, verify' rings particularly true at a time when social distancing is impacting the way people do business and build relationships. (Photo: Minespider/Kfir Harbi)

In April, Berlin-based Minespider announced it had secured €2.8 million in funding to further develop its blockchain protocol for mineral sourcing.

The news is indicative, not just of the market's increased appetite for transparency at every stage of mineral supply, but also of change in sentiment amongst mining investors.

"We applied for the funding last October, the bulk of it was from the European Union Commission's Horizon 2020 grants, although there was also a portion from private investors," Founder and CEO Nathan Williams explained.

"I think that we've hit a sore spot that the EU had, which is: how can we make it easier for companies that, by January 2021, are going to have reporting requirements for importing all of their material but don't have a way of proving where it comes from?"

"Especially now that COVID-19 has hit, people are really looking at priorities, as a government and as an economy. We would really like to have the new 'Green Deal' be successful, to have the history of all of these materials included in a traceable way, and a responsible new future for industry. There is a real need for that, and what we did was scratch that itch."

The Minespider protocol allows companies to create digital "passports" for raw materials that keep track of where the materials come from and the conditions under which they were produced.

Williams explained that the new funding isn't tied to a specific project; it will be used to further develop the Minespider platform and enable end-to-end testing so it can be fully commercialized.

"It's not always easy to attract investment with emerging technology, because traditional investors want projects that have proven themselves and are ready to scale," he said. "And that's like the antithesis of emerging technology. The Horizon 2020 fund is specifically dedicated to this type of technology where you've developed to a certain level, you're piloting it, but now you need to work out the business model and commercialize it. That's the phase we're in."

Sign of the Times

Williams added that Minespider has seen a lot of enquiries following the COVID-19 outbreak.

"We've been approached left and right, by companies asking: 'how can I reduce my geographical supply chain risk?' They don't know where all of their crit-

ical materials are coming from; whether they're from one province in China and, if they are, how that could affect their supply chain. We've been approached by two or three large entities and some governments as well, because we're seeing that being limited to a geography can pose a risk to your supply chain," he said.

A lot of this interest also relates to trust. With travel restrictions in place, companies can't physically visit sites or meet with potential suppliers. While video conferencing has helped, nothing beats a face-to-face meeting in order to build a sound relationship.

Williams agreed: "We're learning to trust people that we talk to over Skype or Zoom, but there's something different about being there in person, the traditional handshake, sitting down to dinner with someone and building that rapport. We're not going to have that for a while, so we've got to compensate."

"The motto within the blockchain community is 'don't trust, verify.' We're seeing more and more businesses that want to move away from a 'let's just trust everyone model' to a 'let's verify model' and that could end up being very healthy for the industry."

Key Projects

Last year, Minespider began work on two major projects. The first is to track Volkswagen's lead supply chain for use in batteries.

"This is obviously a very complex project," Williams said. "They wanted to know what was going on in their lead battery supply chain and we've on-boarded about two thirds of their supply chain now. A lot of it involves calls, visiting, identifying what data can be gathered from where. A very common issue is that companies want to know where their materials are coming from and under what conditions they're produced, but they're not 100% sure what they're going to find."

The second project focuses on tin traceability and, rather than starting with the end user, this one begins at the San Rafael mine, owned by the Peruvian company Minsur, and tracks tin along the supply chain to end users including Google, Volkswagen and SGS.

“Again, we’re attempting to create end-to-end supply chain transparency and seeing not only how to implement that on the ground, but what data can be collected at every point and where data gets entered,” explained Williams. “There’s a lot that has to be sifted through, especially when you’re talking about authentication of material.

“Once the material reaches the smelter, how do you know that it’s the same material that left the port? Well, you’ve got documents, loading documents, identification documents and often there are impurities in the material itself, which indicate which mine it came from. It’s a fascinating and very detailed challenge to solve.”

The Minespider system is designed so the passports can be scaled up to include as much data as necessary. Williams said there will always be technical limitations. However, that’s a long way off yet. The more important questions are what data is useful, and how to filter it out so you’re not just getting data, but information.

“One thing that you can very easily run into, especially if you are a downstream brand, is if you’ve got a few thousand suppliers and they’ve got a few thousand tier twos and so forth... it gets exponentially big,” he said. “Then the question is: how can you identify hotspots for risk that you want to look into more deeply, and in



Minespider is working to help Minsur ensure traceability in tin supply from its San Rafael mine in Peru. (Photo: Minsur)

which areas is the information supplied deemed good enough?”

“The next step that we’re working on right now is the analytics side of this. We’re looking at how to take that flood of data and boil it down to something useful. Step one is collecting the data, getting it into the blockchain, making sure that the workflow is feasible for all of the different participants so that they can work with it and then, of course, automation. So, that it becomes a little bit more fluid to work with this system and offers real insights from swaths of aggregated data.”

Setting your Product Apart

It’s interesting that the impetus for blockchain is starting to shift toward the mines rather than the end users of materials.

“Even a year ago, if you had asked me, where the interest in traceability would come from, I would’ve said the downstream brands,” Williams said. “But what I have found in the past year is that a lot of the interest has come from the mines themselves. There are different reasons for that. The first is the whole transparency angle. But another key problem is that companies that are responsible and want to be transparent often can’t be identified later down the line. And they’re at a disadvantage in the market.

“If you end up in the world market trading your responsibly sourced material next to material that came from mines that used forced labor, then which is going to be cheaper? If people can’t see the difference or the data that’s attached to it and therefore, don’t understand the additional value that you’ve poured into it, it’s going to be a tough sell.

“The problems that companies are experiencing are, in large part, because of a race to the bottom. What we’re seeing is an interest in changing the playing field so that it becomes a race to the top. It’s not just small companies that have poured a lot of time and money into it, large players are examining this, too.

“The World Economic Forum’s Mining and Metals Group, for example, has been exploring this topic over the past year. These risks to the supply chain don’t happen because a mine is run by one person who is devious. They happen because of a series of complex decisions involving a number of people that are in



Minespider Founder and CEO Nathan Williams on site with the Minsur team. (Photo: Minsur)



Going forward, mines will be at an advantage if they can prove their materials have been produced responsibly and sustainably; it will set their product apart in the market place. (Photo: Minsur)

the company, such as subcontractors... there are many different players. And until you know more about what's gone on and can communicate that information, you're not going to be able to identify and rectify the problems."

Currently, industrial-scale applications of blockchain in mining are few and far between; this is still very much an emerging technology. But, one thing is for sure, everyone is going to want more information about their supply chain going forward and, with increased regulation, especially in Europe, but also in other areas of the world, mining companies are going to need to be able to set their product apart in the market.

"I think, for better or for worse, we're going to see an increase in a sort of nationalistic approach to sourcing, as countries look to secure access to critical materials and secure their critical industries," Williams said. "If that is the case, then mines and even traders are going to be at an advantage if they can prove where their materials come from, because that in essence secures their future."

"And with the rise of the green economy, which is going to be huge in the coming years... it's struck a chord with so many people. I think that we're at a point where responsibly produced goods are no longer just theoretical, they're being demanded. Companies that are able to prove that provenance are an advantage. We're already seeing it from the consumer side."

Investment is Changing Too

Of course, it's not just the market that is demanding traceability but investors too. At the World Economic Forum in January, BlackRock, the world's biggest investment firm, announced that going forward it will take into account the sustainability practices of any company that it invests in.

"Over the next couple of years, we're going to see a huge increase in the interest from mining companies for one reason: to secure investment," Williams said.

"The biggest investment fund out there has committed to long-term sustainability, and every other investment fund is going to follow. For mining companies, it's already hard raising \$200 million or \$400 million to start a mining interest, let alone to try and raise it when the entire investment world is moving into greener investments."

At the end of the day, BlackRock isn't changing its investment strategy for the good of the world. It's changing because the company is seeing demand from its own investors; people want to know that they're going to get their money back on an investment and that shipments aren't going to be seized by authorities due to corruption in the supply chain. The only way a miner can guarantee that is by putting transparency measures in place and by ensuring that documents/data cannot be changed after sale.

"It's a whole ecosystem that's changing," Williams said. "It's especially im-

portant for new mines that are opening and mines that are raising funds now. How are you going to put yourself at the front of the pack so that you're more likely to get invested in? By positioning yourself as the most attractive project for the type of investment coming up. Investors want responsible mines that are producing responsible material, that are going to be at the cutting edge.

"It's not just about having cutting edge mining equipment. It's also about taking into account how your mine fits in with the community and your approach to sustainability, and how that gets communicated to everyone who's buying from you."

More Than Just Traceability

Of course, there are plenty of uses for blockchain that aren't directly related to responsible or sustainable sourcing, too.

"We've had mining companies ask us how they can help their customers import more easily, or how they can help them identify that it's really their material and not a counterfeit that was substituted by a trader," Williams told *E&MJ*. "All this is doable as well because what we're supplying is just data. It's unchangeable data that is linked via unique identifiers to a shipment of material.

"In any use case you have to think of what problem you're solving, and usually there are four or five things a blockchain's good at. It's good at securing information and making sure it doesn't change, so that's good for compliance cases. It's good for creating unique digital items and allowing two parties who don't know or trust each other to exchange something of value without a third party. It's good at disintermediating, so getting a middleman that doesn't add much value out of the equation and ensuring that any middleman that stays adds value."

Blockchains can also hold value, as seen with traditional tokens, such as bitcoin. So, one of the simpler use cases for blockchain in the mining industry is fundraising.

"You want to fundraise a new mine? You need \$100 million, so you presell the amount of material that's coming out. People pre-buy it at a fixed rate and you're taking a risk based on market rates," explained Williams. "It's like crowdfunding except you wouldn't have Kickstarter in front of it.

"The problem with that is that it's not \$20,000 you're trying to raise, it's maybe

\$100 million, so that means the groups or people you need to reach would be much larger. The investors would have to be comfortable with the technology, and the problem is how to bridge that gap.”

Blockchain can also enable new business models. Several years ago, Michelle Ash put forward the idea of vaulting gold in the ground; do you take it out of the ground, make it shiny, put it back underground and sell certificates of ownership, or just leave it in the ground in the first place?

“There’s obvious issues with that investment model,” Williams said. “For example, you can crash the whole gold market if you have enough resources. But it’s an interesting idea and there are numerous things you could do with this type of project.”

End of life is another interesting application. Say you have the most responsible mine in the world. Then, at the end of its life, you simply abandon it with little or no restoration. This mine, in the end, was not responsible. Blockchain can, technically, be used to prevent that from happening.

“What you can do is involve the financial markets; this isn’t something a mine can do on its own — for every ton of metal sold you put a certain amount into a bond. And at the end of the mine life, if they’ve cleaned up properly and get the sign off from the mining minister, then that bond gets released to the shareholders. If it doesn’t get approval then it’s used to clean up the site,” Williams said.

“This sort of thing allows us to rethink the rules and, I think, in the long term, it’s important to do that because we all have to live with the consequences of mining. Hopefully, these possibilities will allow productive collaboration between governments, regulators, investors and financial institutions and the mines themselves.”

Getting Over the Hype

Williams believes that short term — in the next six to 12 months — we’re going to see an increase in blockchain projects.

“We’re still testing the waters, because blockchain came out of 2017 with a lot of hype attached,” he said. “Everyone who was doing a blockchain project made it really big, ‘we’re going to solve supply chain issues, we’re going to solve mining, we’re going to solve... everything.’

“And now what we’re seeing is people going ‘we really don’t understand what

everything means. What are some specific things we can solve?’ So, companies that are dipping their toes in the water are looking to solve provenance, logistics, prove end-of-life responsibility for their mine, or operating responsibility.

“Medium to long term, we are going to see industrial rollout, for sure, there’s no question. Everything is moving in the direction of more transparency. There are

a lot of mines that have put effort into responsibility, and they do not want to be at a disadvantage on the world stage.

“But in the meantime, it’s all going to be about specific use cases. Identifying a specific pain point, rolling out a solution to address it, and moving to the next one. It will be the accumulation of these little solutions that will ultimately shift the industry and we’re excited to be part of it.”

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Drones Map Inaccessible Spaces at Finnish Gold Project



Exyn's A3R robots provide a single system with navigation and mapping capabilities to enable safe deployment without the need of an operator. A Canadian junior recently used the robots — in both drone- and vehicle-mounted configurations — to produce a detailed map of inactive, inaccessible areas of a Finnish underground gold mine.

Exyn Technologies, which develops autonomous aerial robot systems for complex, GPS-denied industrial environments, participated in a successful underground mapping mission in partnership with Rupert Resources, a Canadian gold exploration and development company. Using Exyn's autonomous drones, Rupert Resources was able to produce highly detailed 3D models of the historic Pahtavaara gold mine in Central Lapland of Northern Finland, in an environment otherwise inaccessible to traditional CMS tools or even manually piloted drones.

Rupert Resources needed to plan for a potential restart of operations by estimating tonnage previously removed from the mine and calculating the remaining ore in heavily restricted areas. One Exyn drone mapped 30 stopes in three days. In addition, Exyn mounted a version of its robot to a vehicle to scan all access drifts, which, together with the stope maps, provided a complete mine map in under four days.

"Rupert is actively seeking new technologies where we think big gains can be made in terms of safety, productivity

and accuracy," Rupert Finland Managing Director Jukka Nieminen said. "Exyn achieved accurate assessment of the volume of remaining stopes at Pahtavaara with an unprecedented level of detail, and obviously the use of remote technologies means that this was achieved with a greatly reduced degree of risk. We have no hesitation in recommending this technology."

Exyn's autonomous drones are built on the exynAI platform (see *Over, Under, Sideways, Down*, pp. 66-71, *E&MJ*, December 2019) enabling aerial robots to fly intelligently without a human pilot, using a multitude of high-tech sensors and AI-based software. The system operates without the need for GPS or external communications and is deployed as an all-in-one software and hardware package.

Rupert Resources' holdings in Finland are located in a region that hosts Agnico Eagle's expanding Kittila gold operation — Europe's largest gold mine — and Ni-Cu-PGM polymetallic deposits represented by Boliden's Kevitsa mine and Anglo American's Sakatti project. In

February, Agnico Eagle bought more than 15,000 shares of Rupert common stock and more than 11,500 warrants, representing approximately 9.9% of Rupert's issued and outstanding common shares on a non-diluted basis.

Successful Tire Repairs Require Planning, Preparation

Monaflex, a Guernsey, Channel Islands, company that specializes in vulcanized repair solutions for the industry, recently offered a checklist that can be used by tire-service teams to ensure that OTR tire repairs are done in the most efficient and effective way. The tips recommended by Monaflex include:

- Use Quality Supplies — From tools to rubber, patches and vulcanizing equipment.
- Train Your Team — Ensure technicians are properly trained in all aspects of the tire itself as well as the repair process. Do they understand:
 - How all the tire components — tread, sidewall, bead, bead wires, body plies etc. — work together?

- The correct way to use all tools and equipment?
- How to properly build up and install a repair to ensure maximum adhesion?
- The best protocols for safe working?
- The importance of a clean working environment and how to achieve?
- Inspect the Injury – Include a comprehensive inspection process assessing the injury's size and its location in the tire:
 - Is there an economic case for making the repair? What is its general condition? How much tread is remaining?
 - Is there more than one injury or less obvious damage to consider?
 - How far below the surface does the injury extend?
- Assess the Repair – Consider the following:
 - What tools are required?
 - How can you remove the structural damage?
 - What is the correct skive angle and buff texture?
 - What is the right patch? Consult patch manufacturer application charts.
 - What is the best and safest method of using the chosen vulcanizing system?
- Understand Your Vulcanizing System – Get to know your OTR vulcanizing system. Get the right training and adhere to best practice usage guidelines. Use the correct components for the job to ensure a perfect fit and optimum results. Always consult component application charts.
- Conduct a Final Inspection – This stage is as important as the initial inspection.
 - Did the technician find and repair all damage?
 - What does the repair look like? Are there signs of under cure, bubbles or separation?
 - Record the Shore Hardness.
 - Can you return the tire to its original operation, or should it be downgraded? Example: Use the repaired tire on a slow-moving water-wagon versus a production hauler that travels long distances at higher speeds.

Tension Technology Keeps Tabs on Bolted Joints

Correct tension within critical bolted connections is linked to safety, performance and maximum uptime. Valley Forge & Bolt said it is shifting the paradigm with SPC4 Load-Indicating Technology that makes it possible to measure the actual tension in a fastener, not just the preload



Maintenance technicians can get accurate readings of bolt tension by connecting a digital reader to a datum disk affixed to the end of a Valley Forge fastener.

that is being applied by torque or tension tools. By using SPC4 and any of its specially designed interchangeable readers, technicians can quickly gauge tension — even remotely with an optional configuration — within SPC4 bolted joints, according to the company.

Valley Forge said its SPC4 technology is ASTM F2482 compliant and accurately measures direct tension in the fastener within +/- 5%. It provides absolute, real-time knowledge of fastener tension and performance from installation through fastener life. SPC4 measures the bolt stretch, or tension, directly from the fastener. Because stretch is the force that creates clamp load, this capability makes SPC4 the most accurate method available to monitor the clamp load of critical joints, the company claims.

Technicians can use any type of tightening tool — hydraulic, pneumatic, electric, or a hand wrench — and still achieve even and optimal load on a bolted joint, according to Valley Forge. SPC4 can measure preload in the fastener at installation, monitor load while in service, or measure load and load loss during maintenance inspections. The result is optimal joint integrity, less downtime, and safe performance of equipment.

Valley Forge engineers and manufactures a variety of SPC4 readers in analog and electronic formats. Technicians quick-connect the reader to a datum disc on the end of the SPC4 fastener, and the tension is displayed in real time on the reader as a percentage of minimal yield strength. Any reader can be used with any SPC4 fastener. Wireless readers allow for

real-time remote load monitoring and include Wi-Fi and low frequency options.

SPC4 technology is available in standard bolts, studs, custom designs, and retrofits for customer-supplied fasteners, each modified with Valley Forge's exclusive datum disc and gauge pin and compatible with any Valley Forge-supplied reader.



AMR PEMCO's GM-105 Goes the Distance and More

With a powerful 125mA loop current, the new GM-105-XLD "Extra Long Distance" allows for monitoring cable lengths up to 6.5km (4 miles), and provides significant tolerance for inline couplers. In addition to ground check monitoring, the GM-105 includes ground fault monitoring to detect hazardous voltages shorted to ground. Certified to UL-C/CSA standards, the modular design is the same form factor as Startco/Littlefuse's SE-105/107. However, the GM-105 features several other improvements including an easily removable main assembly secured with one thumb screw. Since 1975, AMR PEMCO has supported the mining industry with over 50,000 circuits sold worldwide. For more information, please visit www.amrpmco.com/gm-105-xld.

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Brazilian Contractor Orders 30 MTU Engines from Rolls-Royce to Repower Fleet



With U&M's order for 30 Rolls-Royce MTU Series 4000 engines, more than 100 MTU engines will soon be running in mining applications all over Brazil, Rolls-Royce reports. (Photo: Rolls-Royce)

U&M Mineração e Construção S/A, an earthworks contractor in Brazil, ordered 30 Rolls-Royce MTU Series 4000 engines to repower its existing fleet of mining trucks and excavators. The engines are expected to improve the performance, profitability and sustainability of the machinery, Rolls-Royce reported.

U&M will be using the MTU engines in both Komatsu 930 mining trucks and Hitachi EX5500-6 mining shovels.

U&M said repowering the excavators with MTU Series 4000 engines has never been done before. "The move improves the performance, reliability and cost-effectiveness of the machinery and reduces the logistical effort needed to support the machinery," Maricio Casara, commercial director, U&M, said.

The order follows one placed by U&M in 2019 for 20 engines.

"Already having MTU engines perform reliably in part of our fleet played an important part in our decision to repower additional machinery with MTU engines," Casara said. "Also, we prefer to have the same engine type powering both our load and haul machines."

Rolls-Royce said the order speaks to the company's ability to support remote sites. "They are operating in one of the remotest regions of Brazil under very challenging conditions, making their choice a special accolade for our engines and services," Carlos Levy, managing director, MTU engines, Brazil, Rolls-Royce, said.

The 30 engines will be delivered in 2020.

RG Gold Orders 2 Ball Mills From Outotec

Kazakhstan's largest gold miner, RG Gold, signed Outotec for the delivery of two grinding mills for its Raygorodok gold mine.

The scope of contract includes delivery of two ball mills, associated ancillaries, and spare parts for a carbon-in-leach expansion project. The ball mills have the new Outotec Polymer Hydrostatic Shoe Bearing system. Outotec reported the system improves mill availability and maintenance.

The contract is booked at \$10.8 million. Deliveries are scheduled for 2021.

Outotec said the development shows its capacity to support customers despite

prevailing challenging circumstances. "We are committed to working closely with our customers to keep the mining industry moving, even during these exceptional times," said Paul Sohlberg, head of minerals processing, Outotec.

Located in northern Kazakhstan, the Raygorodok deposit, with 6 million oz of estimated reserves, is one of the largest in the country.

Separately, Outotec reported it was contracted by First Majestic Silver Corp. for the delivery of minerals processing technology for the latter's mill optimization projects in Mexico.

The \$16.2 million order covers the design and delivery of an autogenous mill, counter current decantation thickener and a tailings filter for the San Dimas silver and gold mine; and thickeners and a tailings filter for the Santa Elena silver and gold mine. Deliveries are calendared for 2020 and 2021.

The order follows previously delivered Outotec HIGmill high-intensity grinding mills to First Majestic. Outotec leadership reported one of these mills at the Santa Elena operation has significantly improved the recovery of silver and gold.

"We are pleased to continue working with First Majestic in these projects," Sohlberg said. "The energy-efficient AG mill and environmentally sound thickeners and tailings filters will enable First Majestic to improve plant operations in a sustainable way."

RCC Signs Metso for Linings

The Russian Copper Co. (RCC) contracted Metso to supply SAG and ball mill linings for the former's Tominsky processing plant. The deal complements two earlier mill lining contracts for RCC's Mikheevsky processing plant, signed in December 2019, Metso reported.

The contracts cover roughly one year's worth of mill lining needs and are part of RCC's large-scale mill lining project.

First shipments were calendared for March 2020. The contracts, combined, are booked at \$26 million.

RCC said it invests in the best available technologies and so went with Metso. “This ensures superior operational performance of our enterprises, as well as the safety of technological processes for human health and the environment,” RCC President Vsevolod Levin said.

RCC is one of the biggest copper producers in Russia.

Separately, Metso reported further investments at its Mesa repair facility in Arizona with the goal of optimizing safety and broadening service capabilities. The facility offers repairs and field services while supporting Metso’s Life Cycle Services contracts.

Metso said the Mesa repair facility has seen steady growth since it opened in 2015, with 2019 setting a record for safety performance, revenue and profitability.

To offer a more complete service to customers on large rebuilds, the Mesa facility recently installed a state-of-the-art stress-relief oven. It will improve quality control as well as accelerate the turnaround times for clients, the company reported.

Mesa also invested in other equipment to support the repair of mining screens, LIMS (Wet Low Intensity Magnetic Separator) drums and babbitted bearings for mills.

A screen test stand was manufactured and was calendared for completion at the end of March. The stand will allow each screen that is rebuilt at Mesa to be test-run before being sent back into the field, which should reduce the potential for issues during installation and start-up.

Equipment needed to repair LIMS drums was also put in place last year, and has seen a steady inflow of repairs coming from mines in the Iron Range, Metso reported.

In the future, the facility aims to further grow its portfolio of value-added services to improve productivity and reduce operational costs for its clients in both the mining and aggregates sectors.

Boliden Kevitsa Deploys Modular’s FMS

Boliden’s Kevitsa mine, in northern Finland, deployed Modular Mining’s DISPATCH, ProVison and MineCare systems.

Modular Mining’s solutions were selected to optimize haulage, improve loading accuracy and increase availability



Kevitsa mine, in northern Finland, adopts a FMS package by Modular Mining and a local Komatsu dealer. (Photo: Modular Mining)

across more than 30 pieces of equipment in Kevitsa’s mixed-manufacturer fleet, Modular reported.

The DISPATCH Fleet Management System (FMS) and ProVison Machine Guidance System replaced previous technologies at the mine. DISPATCH FMS will optimize the mine’s haulage cycle, while the ProVison Excavator system assumes responsibility for machine guidance, Modular reported. MineCare offers cloud-based, proactive, asset health monitoring and maintenance management capabilities.

Modular said the successful deployment was due in part to the assistance of local Komatsu equipment dealer Suomen Rakennuskone Oy. “We are proud to be

part of an integrated Komatsu solution that combined world-class equipment, strong local dealer support, and our all-makes technology,” said Greg Lanz, vice president, business development, Modular.

Hudbay’s New Britannia to Build Jameson Cell Circuit

Glencore Technology reported Hudbay’s New Britannia operation will build a flotation circuit made entirely of Jameson Cells. The circuit will offer the Northern Manitoba operation a means to process finer grinds and higher grades of ore in a small footprint with optimal recoveries.

The circuit will be housed in a dedicated building, built within target costs, Glencore Technology reported.

The development comes after pilot plant testing at the nearby Stall concentrator.

Hudbay leadership said geology drove the decision. “It might look innovative, but it is just a real-world decision based on technical understanding, costs and risk perception,” Peter Amelunxen, vice president, technical services, Hudbay, said.

The solution will have to handle great variation in copper feed grade while maintaining flotation tails grade below 0.1% copper reporting to the tails leach circuit, said Matthew Taylor, manager of metallurgy at the mine. “Any gains in availability, recover, and product quality have to be achieved through a smaller footprint and a proven simplicity of operation.”



In a move Hudbay reports was based on ‘real-world’ decisions, New Britannia will build a flotation circuit of Jameson cells to handle a feed of widely varying grade fines. (Photo: Glencore Technology)

The circuit is expected to maximize the project NVP over the forecast mine life, head grades and mineralogy, Glen-core Technology reported.

Woolpert Buys Fourth TerrainMapper

Woolpert announced it purchased its fourth Leica Geosystems TerrainMapper, a linear-mode aerial lidar sensor, to support the firm's geospatial growth worldwide.

Woolpert owns and operates more than 15 sensors and a fleet of more than a dozen aircraft and helps test new lidar systems at the federal level.

Leica Geosystems said the TerrainMapper collects lidar data at high altitudes, across complex and variable terrain. "The TerrainMapper provides an increased efficiency resulting in higher density through higher pulse rate, higher laser power and gateless technology," said Jonas Svoboda, aerial acquisition manager. "Collections take less time than they did previously, and the camera enables us to more easily co-collect data. These advancements are an added ben-



PHIL announces production of its Rear Eject Body in Brazil. (Photo: Philippi-Hagenbuch)

efit for our clients and therefore highly valuable to us."

PHIL Starts Body Production in Brazil

Philippi-Hagenbuch (PHIL) reported production of its Rear Eject Body will begin in Brazil in Q2 2020. The expansion of services in South America is expected to better serve the markets in the region.

PHIL's line of Rear Eject Bodies are designed for underground hauling situa-

tions where overhead barriers inhibit traditional dump bodies. They eliminate the need to raise the body of the truck when discharging materials.

PHIL said demand in the region drove the development. "By adding production for our world-class Rear Eject Body in Brazil, we are able to offer the product closer to where our clients need it," said Josh Swank, vice president, sales, PHIL. "This helps reduce import tariffs and freight, while providing localized parts availability."

Partnership on Comprehensive Mine Monitoring System

Worldsensing and IDS GeoRadar, a Hexagon company, partnered to launch what they described as a comprehensive mine safety monitoring system. The integrated system will be the first in the world to offer surface, subsurface and geospatial

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IDS GeoRadar and Worldsensing partners on a comprehensive mine monitoring system that will provide a single interface for the management of a range of wireless sensors. (Photo: IDS GeoRadar)



Whitehaven Coal implements autonomous haulage at Maules Creek in H1 2020. (Photo: Whitehaven Coal)

monitoring in a single package, greatly simplifying contracting and deployment, the latter reported.

The system will use Worldsensing's Loadsensing IoT-based wireless monitoring system. It will also use Hexagon's HxGN Geomonitoring Hub for integrated visualization and analysis, delivered through IDS GeoRadar. Combined, the solutions offer a single interface to a monitoring system that employs a range of wireless sensors, radar, GNSS and more.

GeoRadar said the solution reflects the company's commitment to helping customers best use their data. "It will positively influence the mining world for years to come," IDS GeoRadar President Alberto Bicci said.

Maules Creek Rolls Out AHS

Whitehaven Coal reported it implemented an autonomous haulage system for moving overburden at Maules Creek, making it the first major coal operation to embrace autonomous mining.

The system consists of a fleet of six Hitachi EH5000 trucks and an excavator. During Q2 2020, additional labor resources were trained and deployed to allow for seven-day operation, the miner reported.

"During the quarter, we fully met our manning requirements at Maules Creek and are now investing in the skills development to achieve full utilization of equipment and productivity of our workforce," Whitehaven Coal CEO Paul Flynn said.

Since December 2019, Maules Creek has recruited miners to ensure the fleet was fully deployed by the end of Q2 2020.

Maules Creek mined 2.36 million metric tons (mt) of raw coal during Q1 2020, a 39% improvement over the previous quarter. Mining efforts during the previous quarter, however, were focused on overburden movement in support box-cut development.

Maules Creek's year-to-date raw coal production is 17% below the same period last year, which, the miner reported, was affected by labor shortages and production disruptions due to drought and bushfires.

Yokohama Centers, Facilities Remain Open

Yokohama Corp. of North America recently announced all of its U.S. distribution centers remain open, as well as all but two production facilities.

The company is maintaining most operations as it seeks to mitigate any possible disruptions related to the COVID-19 panic. Yokohama reported it will continue efforts to work closely with dealer partners.

Production, however, was suspended at Yokohama Tire Manufacturing Mississippi and Yokohama Tire Manufacturing Virginia.

Volvo Penta is Named Great Place to Work

For the second year in a row, Volvo Penta of the Americas was recognized as a Great Place to Work by a national institute that promotes and measures workplace excellence.

The Great Place to Work Institute certification recognizes companies that achieve high scores in employee satisfaction based on surveys of workers. The survey revealed that 94% of employees at Volvo Penta of the Americas said the company is a great place to work, exceeding its previous score of 91% in 2019.

Workers noted Volvo Penta's positive work culture, benefits, people and opportunities offered by the company.

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Sensors Look and Listen for Bearing Problems

SKF recently introduced a compact vibration and temperature sensor that monitors the condition of rotating parts on heavy machinery. Designed mainly for use as part of a SKF rotating equipment performance (REP) contract or fee arrangement, the company claims its Enlight Collect IMx-1 allows customers to reduce unplanned downtime and maintenance costs.

The system comprises an autonomous battery-powered wireless vibration and temperature sensor, a line-powered communication and network manager gateway, host software for data trending visualization and analysis and a mobile phone app for sensor and gateway commissioning. SKF said it can detect and process common bearing issues such as imbalance, misalignment, temperature, looseness, electrically induced vibration and early-stage damage.

The battery-powered sensors can be deployed in large numbers to automate the gathering of data regarding the health of machinery, a process typically carried out by technicians with manual portable devices. When mounted to a bearing housing, collected data can be wirelessly sent to a host computer network, where it can then be for-

warded to cloud-based analysis services at SKF REP centers. The sensor has an ingress protection rating of IP69K, enabling it to work reliably when exposed to dust, dirt, oil, grease, contaminants, flying debris, temperature changes, wind, rain or high-pressure hot water washdowns.

Based on a mesh network, the system allows data transmission to be routed around radio obstacles such as pipework and liquid storage vessels that create signal blocks for conventional line-of-sight systems, and sent over greater distances than would be possible using a single device. Product Manager Chris James said, "The mesh network is self-forming, which makes it easier and quicker to deploy than other wireless communications technologies such as Wi-Fi or Bluetooth. It is also innovative in the way it manages available bandwidth and the power consumption of the sensors, which leads to a long enough battery life to meet the needs of our multiyear service contracts.

"Critically, the sensor gathers data consistent with our manual data-collector, particularly when it comes to detecting early-stage bearing defects. Although severely damaged bearings are

relatively straightforward to detect, by that stage they are close to failure. The key is to find defects early, so that corrective action can be planned in good time with minimal disruption."

However, extracting tiny signals of an early-stage defect from background noise is difficult. The SKF Enlight Collect IMx-1 uses SKF's acceleration enveloping technology to achieve this.

James added, "Any condition monitoring program is only as good as the measurements it takes. SKF has been executing predictive maintenance contracts on a large scale for decades, so we know how a wireless device needs to perform, and the result is the SKF Enlight Collect IMx-1. However, wireless devices in themselves do not deliver reliable rotation. That is achieved with the combination of analysis experience to provide machine insights and mechanical engineering competence to support execution of any corrective actions."

pH Measurements Made Easier by Versatile System

ABB has launched a new range of color-coded sensors that are designed to make it more convenient to choose and manage an optimal pH measurement solution, according to the company. The application-driven designs are categorized into three groups: the entry-level 100 series for cost-effective measurement in general process applications; the high-performance 500 series for harsh industrial applications; and the 700 series for specialist applications.

Digital and analog options are available, with the digital solution offering advanced in-built diagnostics. ABB's EZLink plug-and-play technology links any of the new sensors to ABB's digital transmitter range, including the recently launched AWT420. The company said EZLink enables faster installation and commissioning and provides easy access to maintenance data, allowing users to replace sensors at the optimum time and cut costs without risking process control.



The Enlight Collect IMx-1 is a data-collector and radio, in a single, compact battery-operated device.



ABB's new line of pH sensors includes EZLink plug-and-play technology that can link any of the sensors to an ABB digital transmitter. Innovations include advanced electrode monitoring and diagnostics.

The new range incorporates several innovations including ABB's perpetual impedance diagnostics to detect electrode faults without the need for a solution earth. Another feature is the smart Reference Electrode Monitoring (REM) system, which provides early warning of electrode poisoning. Optimal temperature compensation is assured by locating the pH electrode, reference electrode, and inbuilt temperature sensor together at the electrode tip. This provides a faster temperature response and better accuracy during calibration and in-process control applications, according to ABB.

The sensors are available with ABB's bespoke range of sensor glasses, specifically designed to meet requirements such as high pH levels, low or high temperatures, or the need for high acid resistance. General-purpose glass is offered for a range of aqueous media.

Remote Cellular Transmitter Uses Latest LTE Technology

SignalFire Wireless Telemetry expanded its wireless IoT product offering with Ranger, a cellular transmitter that utilizes the latest LTE CAT M1 technology to connect industrial sensors to the cloud for remote monitoring, control and alarming. It is designed to work with a wide range of sensor types and brands, making it easily integrated into industrial monitoring systems, according to the company.

Ranger is equipped with two digital inputs, one analog input and one

relay output. The digital inputs can detect on/off status or frequencies up to 2 kHz. The analog input can be set to 1-5 Vdc or 4-20 mA and is powered by the integrated battery pack. The relay output is a latching double pole single throw type, capable of loads up to 2A at 30 Vdc, 0.3A at 110 Vac or 0.5A at 125 Vac. Furthermore, the built-

in GPS allows for tracking the location of the Ranger and its measurements on a map.

It comes with a web- and mobile-friendly interface that allows users to remotely monitor assets, view trends, and receive alarms either by text or email. It also provides for remote configuration and troubleshooting of the Ranger node and the sensor to which it is attached. The SignalFire Cloud uses secure MQTT technology for integration with private cloud platforms, when applicable. Operators can turn on/off the relay output from the cloud interface to remotely control pumps, motors, valves and more.

"LTE CAT M1 technology is uniquely suited to IoT, allowing battery-powered sensor devices to efficiently communicate utilizing existing cellular networks," SignalFire General Manager Josh Schadel said. "SignalFire's new platform will provide application-specific solutions that are reliable as well as easy to install and maintain. This technology will enable monitoring of sensor data that was previously difficult or impossible to do."



The cloud platform used by the Ranger node provides for remote configuration and troubleshooting of nodes and their attached sensors, as well as remote on/off control of pumps, motors and valves.

Containers for PPE Sanitation From COVID



INOVINTA group's SHYFTinc is awarded almost \$1 million to further develop an autonomous mobile inventory management system. (Photo: INOVINTA)

FORTAI announced the imminent release of the Sanitization SmartCube, used to sanitize personal protective equipment (PPE) and based on the company's SmartCube solution.

SmartCube is a mobile inventory management solution that allows safe containerization and transportation of materials, to include explosives.

The Sanitization SmartCube development team includes expertise from the INOVINTA group.

Separately, INOVINTA group subsidiary SHYFTinc reported it received \$900,000 from the Ontario, Canada, government to further develop ADMMIT, an autonomous mobile inventory management system. The system tracks, delivers, and manages material movement in real time, from purchase to consumption, and links to mine planning and inventory controls, SHYFTinc reported.



Combined with the company's Smart-Cube containers, the system offers a mobile warehouse and can be used to track tools, explosives and parts.

The company was the first mining supplier to receive money from Ontario's Autonomous Vehicle Innovation Network. SHYFTinc develops automation and software solutions that target mining job site safety and productivity.

www.shyftinc.com

Shift Manager Software as App

RPMGlobal announced the MinVu Shift Manager app. MinVu Shift Manager is a short-term planning and execution software solution that allows users to collaborate and communicate through a single,

integrated plan to drive more effective on-shift decision support. Remote teams can use it to collaborate across the value chain, the company reported. Making the software solution compatible with mobile should help put real-time data in the hands of decision-makers wherever they are located, the company reported.

www.rpmglobal.com

Replacement Bodies Up Production

Austin Engineering announced New Ultima truck bodies are being trialed on 240-metric-ton (mt) haulers at Western Australian gold mines, where the bodies could improve fleet availability and productivity.

The bodies were fitted to the fleet after the mine identified various challenges, including the weight of the OEM bodies, maintenance costs and non-achievement of target payloads.

With improved structural integrity, the bodies lifted payload capacity to 230 mt per load, an increase of 20 mt per load over the OEM bodies, Austin Engineering reported. A V-profile floor, designed to actively channel the load to the center of the tray, improved machine stability and safety.

The floor design also reduced dump cycle times.

The tray provided 10% to 15% weight savings, the company reported. The bodies also reduced unscheduled body repairs.

www.austineng.com





Underground Truck With Bigger Payload

Caterpillar released the AD63 Underground Articulated Truck, which, the company reported, offers a 5% increased payload (63 mt) and more torque for enhanced production capabilities over its predecessor, the AD60.

The unit can be configured to meet emissions regulations.

New features speak to operator comfort, maintenance access, safety and machine health monitoring, Caterpillar reported.

The truck has a 789-horsepower (hp) Cat C27 diesel engine that meets EU Stage V emission standards. It does not require diesel exhaust fluid. The powertrain gives increased torque and improved gear retention on variable grades, Cat reported.

The unit has a ducted-ventilation system in the cab, with battery-powered air conditioning and defogging. It has a trainer seat, and a redesigned access ladder and handrails.

The truck uses Product Link Elite for data collection and machine health monitoring. Data can be shared and direct connectivity is available for remote support and services. Displays show load measurements to operators.

The unit will be available in late 2020. www.cat.com

Smart Phone App Tracks Drivers

Earthwave Technologies released Fleet-Watcher App, described as an App-as-a-Device solution that delivers tracking ability via a smart mobile device. Functionally it is comparable to a solution that

uses a permanently installed transponder, the company reported.

A smart device equipped with the app transmits real-time tracking data that is used by the Fleetwatcher Materials Management Solution platform. Current applications include driver and equipment assignment support and driver safety reporting.

The app is available from Play/App stores. Upon download, it is operational in minutes, the company reported.

www.earthwavetech.com



Tablet for Hazardous Environments

i.safe MOBILE GmbH presented the IS930.1, which is described as a robust tablet with ATEX and IECEx approval for use in hazardous environments.

The unit has an 8-in. capacitive and low-reflection screen made of RugDisplay glass. The screen has a maximum resolution of 1,920 by 1,200 pixels.

The device comes standard with Android 9. It requires LTE or WiFi, and can be controlled by Bluetooth 5.0 or NFC, the company reported.

For machine health-monitoring applications, the IS930.1 can connect to Industrial Internet of Things devices, has 4 GB RAM and 64 GB internal memory, which can be bumped up with a 128-GB microSD.

www.isafe-mobile.com



Vertical-rise Lift for Big Machines UG

Mohawk reported its vertical-rise lifts offer a capacity of up to 240,000 lb. The company also offers a four-post lift with a capacity range of 19,000 lb to 120,000 lb. For underground ops, the company manufactures explosion-proof systems, lifts that operate on AC or DC power, and options such as tire dollies, LED lighting or rolling-wheel free jacks for all capacity drive on lifts.

mohawklifts.com



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Demand Slows as Gold Prices Climb

May began with gold closing above \$1,700 per ounce (oz). The high price and market lockdowns have led to a decline in physical demand for gold. According to Refinitiv, it fell to 753 metric tons (mt) in the first quarter — the lowest levels since 2009.

Jewelry fabrication ordinarily accounts for around 55% of total physical demand, but slumped 40% on a year-on-year basis. The greatest losses were recorded in Asia with this bloc declining over 43% year-on-year. Chinese demand recorded a precipitous 62% YoY decline in jewelry fabrication in Q1 as a result of disruptions caused by the coronavirus (COVID-19) crisis and the complete shutdown of the economy. Indian offtake was heavily impacted by record gold prices earlier in the quarter before the government mandated lockdown in late March all but wiped out retail activity, with fabrication demand for the quarter plummeting 34% from 2019 levels.

“Looking ahead, gold may remain vulnerable to further losses in the short term, particularly should the COVID-19 crisis continue to deteriorate in the West and if we see another meltdown in equity markets, which would lead to yet another bout of liquidation across all asset classes, including gold,” said Cameron Alexander, manager of precious metals research at Refinitiv. “Having said that, with heightened uncertainty and expectations of the global economic recession, unprecedented levels of stimulus from central banks around the world and interest rates remaining at historically low levels and in negative territories, we believe that

gold will rebound to even higher levels. We forecast gold to average \$1,637/oz in 2020, with a possibility to test and move beyond \$1,800/oz later in the year.”

The first quarter proved to be very volatile. Gold plunged by 12% or nearly \$200 over a 10-day period, from its seven-year high of nearly \$1,680/oz on March 9 to a three-month low of \$1,470/oz on March 19. It recovered most of its previous losses later that month, averaging \$1,582/oz for the quarter, which was up by 7% from the previous three months and up 21% year-on-year. It is worth adding that the gold price expressed in other currencies recorded even more notable gains, recording double-digit percentage increases and soaring to all-time highs on some occasions.

The beginning of the year was characterized by a strong rebound in investor interest among the professional investor community and, on the other hand, sluggish demand on the retail side. Looking at CFTC weekly reports, long speculative positions jumped to a record high level of nearly 1,000 mt by mid-February, although this was followed by a bout of liquidation in the following weeks as gold got caught up in a broader sell-off. Investors in exchange traded products (ETPs) added 300 mt of gold during the first three months, with the bulk of buying taking place in March, driven by the price correction taking place that month and a pickup in safe haven demand in light of the spread of the pandemic and the worsening situation particularly in the West, along with growing fears of the global economic recession. As a result, total ETP

holdings rose to a fresh high of more than 3,000 mt by the end of the quarter.

By contrast, retail investment posted an 11% year-on-year drop in the first quarter, led by a sharp drop in physical bar investment, which is estimated to have declined by 21% to 151 mt. The drop was driven by weak demand in Asia, which was down by an estimated 67% year-on-year. Both China and India experienced severe falls in physical bar demand, down by 53% and 49% respectively, hit by the economic slowdown, high gold prices and the full lockdown in case of the former, which brought business activities and consumption to a standstill.

The picture was quite the opposite in the West, where a surge in safe-haven demand amidst the COVID-19 outbreak and heightened fears of the economic downturn saw gold bar demand more than double in Europe and up 21% in North America. Meanwhile, coin demand jumped by 26%.

Looking at supply, according to Refinitiv's preliminary estimates, mine production increased by 3% year-on-year to an estimated 842 mt. On the other hand, scrap flows slipped by 2%.

This article was supplied by Refinitiv, formerly the Financial & Risk business of Thomson Reuters. The GFMS team at Refinitiv is a leading team of metals market analysts. The team was born out of the Corporate Development Department at former mining company Consolidated Gold Fields, and the flagship publication Gold Survey has been recognized throughout the industry since its inception in 1967.

E&MJ PRICES INDEX

(May 1, 2020)

Precious Metals (\$/oz)		Base Metals (\$/mt)		Minor Metals (\$/mt)		Exchange Rates (U.S.\$ Equivalent)	
Gold	\$1,702.90	Aluminum	\$1,440.00	Molybdenum	\$19,900	Euro (€)	1.100
Silver	\$14.94	Copper	\$5,061.00	Cobalt	\$29,500	U.K. (£)	1.251
Platinum	\$774.00	Lead	\$1,583.00			Canada (\$)	0.709
Palladium	\$1,956.00	Nickel	\$11,853.00	Iron Ore (\$/dmt)		Australia (\$)	0.642
Rhodium	\$7,500.00	Tin	\$15,169.00	Fe CFR China	\$82.50	South Africa (Rand)	0.053
Ruthenium	\$270.00	Zinc	\$1,899.00			China (¥)	0.142

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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