

# E&MJ

ENGINEERING AND  
MINING JOURNAL

A Mining Media International Publication

## Utility Equipment

— Purpose-built machines offer safety advantages

*Advances in Autonomous Mining*

*UAVs Fly Complex Missions*

*Froth Flotation*

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*This month, E&MJ reports on purpose-built utility equipment for underground operations. On the cover, the LR3 elevated work platform from MacLean Engineering offers several new features. (Photographer: James Hodgins)*

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**Steve Fiscor**  
Publisher & Editor-in-Chief

## Feds Learn to Deal With Permitting Changes

The American Exploration & Mining Association (AEMA) held its annual conference in Reno, Nevada, USA, during the first week of December. The event brings together junior miners as well as some of the majors, prospectors, exploration geologists and suppliers mostly from the western USA and Canada to support the association. And, the mood this year was considerably upbeat.

One of the reasons for the renewed optimism is that projects are moving forward again. Two years after President Donald Trump issued Executive Order 13807, changes to the environmental review and permitting process are starting to take shape. They are having a serious impact on schedules for both regulators and mining proponents. In one of the sessions, presentations from consultants, a mine planner and regulators offered advice on how to navigate this new permitting minefield.

In response to EO 13807, on August 31, 2017, U.S. Secretary of the Interior David Bernhardt (deputy secretary at the time), issued Secretarial Order 3355. The objective was to implement improvements to National Environmental Policy Act (NEPA) reviews conducted by the Department of the Interior (DoI) and establish discipline and accountability in the environmental review and permitting process.

NEPA requires federal agencies to prepare an Environmental Impact Statement (EIS) and SO 3355 sets page and time limits for the EISs. Specifically, for those that had not reached the draft stage at the time of the directive, the EIS can no longer exceed 150 pages. The lead agency must issue a Final EIS within one year of the issuance of a Notice of Intent (NoI) to prepare an EIS. Within 30 days of the NoI, each bureau head must provide a deadline for the Final EIS. The Council on Environmental Quality (CEQ), empowered by the Executive Branch (i.e., President Trump), can take action to identify and remove impediments to efficient and effective reviews.

What does this mean? The work that was done between the issuance of the NoI and Final EIS, a process that used to take years, has been compressed to one year. That means that mine planners and consultants must do much more work on the front end to place the onus on the regulators to meet the 12-month deadline. The regulators, who are still trying to determine how to comply with SO 3355, are now in the hot seat. As an example, representatives from the Battle Mountain District of the Bureau of Land Management (BLM), one of the lead agencies under DoI for mining, gave a presentation, "The Trump Administration Changes are Here." In it, they explained some of the creative methods they have employed to comply with SO 3355, but it was clear they were sailing in uncharted waters. They also discussed the workload the BLM now faces, vacancies in the agency and their process for prioritization. Fielding questions from the audience, it quickly became clear that this BLM district office was the exception and not the norm. BLM assured the audience that their ideas were being shared with other districts, but the Battle Mountain District has little rainfall, few endangered species and other factors that can trip up an EIS.

These rule changes do not guarantee a positive outcome for miners. They ensure more timely answers. While the Final EIS will only be 150 pages long, substantial supporting documentation still exists. It is a major leap in the right direction. Throughout the rest of the AEMA conference, these policy impacts were clear. Presenters talking about older projects still face the same delays, while those with new projects are talking about bringing those online in 2021 rather than 2028.

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Issue	Open-Pit Mining	Underground Mining	Mineral Processing	General Interest	Special Features
<b>January</b> Close: 12/23/19 Art: 12/30/19 Mail: 1/16	Equipment Rebuilds	Battery-Powered Equipment	Screens & Media	Blasting	Project Survey
International Society of Explosives Engineers (ISEE), Denver, Colorado, USA					
<b>February</b> Close: 1/22 Art: 1/29 Mail: 2/14	Loaders & Dozers	Maintenance Planning	SAG Mill Maintenance	Motors & Drives	Exploration
Society of Mining Engineers (SME), Phoenix, USA; Prospectors & Developers of Canada (PDAC), Toronto, Canada					
<b>March</b> Close: 2/18 Art: 2/25 Mail: 3/13	Wear Protection	Trucks & LHDs	Pre-Concentration	Wearable Technology	Stockpiles & Storage
MiningWorld Russia, Moscow, Russia					
<b>April</b> Close: 3/24 Art: 3/31 Mail: 4/16	Pit Planning	Raise Boring	Iron Ore Beneficiation	Mining Tires	Gold Miners Roundup
Canadian Institute of Mining (CIM), Vancouver, Canada; Expomin, Santiago, Chile					
<b>May</b> Close: 4/21 Art: 4/28 Mail: 5/15	Hydraulic Excavators	Improved Drilling Accuracy	Dewatering & Drying	Fuels & Lubes	Nordic Mining Technology
Euro Mine Expo, Skellefteå, Sweden; Elko Mining Expo, Elko, Nevada, USA					
<b>June</b> Close: 5/25 Art: 6/1 Mail: 6/18	Fleet Management Systems	Mine Rescue	Slurry Pumps	Power Generation	Company Profiles
<b>July</b> Close: 6/24 Art: 7/1 Mail: 7/17	Blasthole Drilling	Roof Support	Crusher Maintenance	Material Handling	Diamond Mining
<b>August</b> Close: 7/22 Art: 7/29 Mail: 8/14	Pit Dewatering	Narrow Vein Mining	Gold Processing	Data Security & Management	MINExpo Preview
<b>September</b> Close: 8/25 Art: 9/1 Mail: 9/17	Truck Shovel Mining	Novel Mining Techniques	Expansion Planning	Mining Leaders & Influencers	Sustainability
MINExpo 2020 International, Las Vegas, Nevada, USA					
<b>October</b> Close: 9/23 Art: 9/30 Mail: 10/16	Maintenance Programs	Ventilation	HPGR Systems	Conveyor Systems	Intelligent Monitoring
China Mining, Tianjin, China					
<b>November</b> Close: 10/21 Art: 10/28 Mail: 11/13	Slope Stability	Bits & Steels	Tailings Management	Buyers Guide	Iron Ore Outlook
American Exploration & Mining Ass'n Annual Conference, Spokane, Washington, USA					
<b>December</b> Close: 11/24 Art: 12/1 Mail: 12/17	Autonomous Mining	Utility Equipment	Copper Processing	Diesel Engines	Company Profiles

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# Kirkland Lake Gold Buys Detour Gold



The acquisition will add 600,000 oz/y of gold production to Kirkland's portfolio of operations. (Photo: Detour Gold)

Kirkland Lake Gold Ltd. will acquire Detour Gold Corp. in all share deal. Under the terms of the transaction, all Detour Gold shares will be exchanged at a ratio of 0.4343 of a Kirkland Lake Gold share for each Detour Gold share. Upon completion, existing Kirkland Lake Gold and Detour Gold shareholders will own approximately 73% and 27% of the company, respectively.

The exchange ratio implies consideration of C\$27.50 per Detour Gold common share based on the closing price of the Kirkland Lake Gold common shares on the Toronto Stock Exchange on November 22, representing a 24% premium to the closing price for Detour Gold shares. The implied equity value of the transaction is C\$4.9 billion.

The acquisition adds a large-scale, long-life Canadian mine with current production of about 600,000 ounces per year (oz/y) to Kirkland Lake's portfolio, which solidifies the company position as a leading gold producer with pro forma 2019 production of more than 1 million oz/y. It also adds 15.4 million oz gold to Kirkland Lake's mineral reserve base.

"The acquisition of Detour Gold is an excellent fit for Kirkland Lake Gold," said Tony Makuch, president and CEO of Kirkland Lake Gold. "We have already taken two mining operations, Macassa and Fosterville, and transformed them into high-quality assets that generate industry-leading earnings and free cash flow.

"The addition of Detour Lake provides an opportunity to add a third cornerstone

asset that is located in our backyard in northern Ontario. Detour Lake will provide the pro forma company with a 20-plus year mine life, which provides unparalleled optionality and excellent growth potential for the benefit of all shareholders."

In addition to shareholder and court approvals, the transaction is subject to applicable regulatory approvals. Both shareholder meetings and closing of the transaction are expected by the end of January 2020.

## ICMM Launches Report on Climate Resilience in Mining

The International Council on Mining and Metals (ICMM) launched a report "Adapting to a Changing Climate: Building Resilience in the Mining and Metals Industry" at WWF's Water Summit 2019 in Frankfurt, Germany. The report shares learnings from ICMM's company members on how to build operational resilience and how to assess and manage the physical impacts of climate change at mine sites.

The report also provides practical guidance that aims to help the mining and metals industry build climate resilience by enhancing the sustainability of communities and ecosystems, limiting future liabilities, safeguarding business continuity and making prudent investments.

During a panel discussion at the Water Summit, Tom Butler, CEO of ICMM, said, "Our climate is changing, and this presents challenges for the mining and metals sector. Understanding this challenge, ICMM has collated insights and

developed tools that can support our members and any responsible mining company to build resilience by identifying and properly managing these risks. Fundamental to the way ICMM operates is sharing knowledge and experience with each other and I am pleased today to share what we have learned so far with the publication of this report."

## Osisko Gold Completes Acquisition of Barkerville Gold Mines

Osisko Gold Royalties Ltd. and Barkerville Gold Mines Ltd. have successfully completed their previously announced business combination, where Osisko will acquire all of the issued and outstanding common shares of Barkerville it did not already own. It was finalized on November 21, resulting in Barkerville becoming a wholly-owned subsidiary of Osisko.

Under the terms, each former shareholder of Barkerville is entitled to receive 0.0357 of a common share of Osisko in exchange for each common share of Barkerville.

"We are pleased to have concluded this transaction with Barkerville, and look forward to leveraging our industry-leading technical team, with a proven track record of creating value through resource discovery, project development and mine operation, to create value for Osisko's shareholders and to realize the potential upside of the Cariboo project," Chair and CEO Sean Roosen said. "We would like to thank Barkerville's board of directors, management and shareholders for their hard work and support of this transaction."

Following the completion of the arrangement, the board of directors of Barkerville has been reconstituted to include Roosen, Bryan A. Coates, Luc Lessard and Chris Lodder.

## Granite Creek to Acquire Interest in Copper North

Granite Creek Copper Ltd. has entered into an agreement to acquire more than 26.1 million shares of Copper North Mining Corp., representing approximately 30% of the outstanding Copper North shares, in consideration for more than 10.5 million shares of Granite Creek.



Tim Johnson, Granite Creek CEO, said, “We believe this acquisition will be accretive to Granite Creek shareholders as the adjoining claim blocks of both companies share many synergies including common geology, infrastructure and expanded exploration potential. We look forward to delivering more information about this acquisition and the on-going results from Granite Creek’s recent exploration programs in the Minto Copper District, over the ensuing weeks and months.”

The acquisition is subject to customary closing conditions.

Granite Creek is a Canadian exploration company focused on the 100%-owned Stu Copper-Gold project located in the Yukon’s Minto Copper District. This 115-square-kilometer property is on trend with Pembridge Resources’ high-grade Minto Copper-Gold Mine to the north and Copper North’s advanced-stage Carmacks Copper-Gold-Silver project to the south. The Stu project has excellent access to infrastructure with the nearby paved Yukon Highway 2, along with grid power within 12 km.

## US Partners With Australia on Critical Minerals

On November 18, the United States and Australia formalized their partnership on developing both nations’ critical mineral assets by signing a project agreement between Geoscience Australia CEO James Johnson and U.S. Geological Survey (USGS) Director Jim Reilly. The two partners outlined specific steps to strengthen an existing Memorandum of Understanding by collaborating on research and increasing critical mineral capacity for both countries.

“Today’s commitment is an important next step in accomplishing the goals of the Trump administration’s strategy to secure the supply of minerals critical to our national security and economic growth,” Reilly said. “We are grateful for the strong partnership we continue to enjoy with our Australian counterparts.”

Critical minerals are used in nearly all economic sectors for a range of products, including mobile phones, electronics, batteries, fiber optics, steelmaking, military gear and medical equipment.

The new activities will focus on joint critical mineral potential mapping and quantitative mineral assessments; determining geological controls on critical min-

## Mining Leaders to Convene at PDAC 2020

The organizers of the Prospectors & Developers Association of Canada’s (PDAC) annual conference and exhibition have once again put together an exceptional program. The event, which takes place March 1-4, 2020, at the Toronto Convention Center, brings together mineral explorers, miners and financiers in the capital of global mine investment.

“There are countless reasons for attending the PDAC Convention in Toronto each year,” said Felix Lee, the 37<sup>th</sup> PDAC president and principal consultant, CSA Global Canada. “While the weather is most likely not one of them given the time of year, you can bet that everyone is there in some way, shape or form for the unbeatable networking opportunities the event offers. Whether it’s making new business contacts, reconnecting with former colleagues, finding the next job, or browsing the latest investment prospects, people are at the center of it all.”

The theme of the keynote session on Monday morning, March 2 is Discoveries of the 21<sup>st</sup> Century. The panel includes three distinguished mining leaders: Mark Bristow, CEO, Barrick Gold; Joe Ovsenek, CEO, Pretium Resources; and Robert Friedland, chairman, Ivanhoe Mines. Bristow will discuss what it takes to find deposits and build world-class operations in different continents. Ovsenek will walk conference delegates through the Brucejack mine from discovery to production. Friedland will share his insights on developing what he calls the triple crown of southern Africa’s mining future.

Throughout the week, the technical program includes presentations from industry experts on Mineral Exploration, Project Development, Capital Markets and Indigenous Programs, along with short courses and plenty of networking opportunities. A new seminar this year, Building an Investor Tool Kit, will feature a series of professionals who will offer practical tips on how to start investing in the mineral industry.

At the Mineral Outlook Luncheon, Catherine Raw, COO, North America at Barrick Gold, will discuss mergers and acquisitions in the mining sector and the return of the mega deal. The International Mines Ministers’ Summit, a special platform for ministers who are responsible for mining around the world, will return for its fifth year.

In 2019, the PDAC conference and exhibition attracted more than 25,800 attendees from more than 130 countries. This year the exhibit includes more than 1,100 companies. Last year, the association had to expand the Trade Show North area to meet the growing exhibitor demand.

PDAC is the leading voice of the mineral exploration and development community. With more than 8,000 members around the world, PDAC’s mission is to promote a globally-responsible, vibrant and sustainable mineral sector that encourages leading practices in technical, operational, environmental, safety and social performance. For more information, visit [www.pdac.ca](http://www.pdac.ca).



Investors mix with prospectors at the 2019 PDAC meeting.



US Geological Survey (USGS) Director Jim Reilly and Minister for Resources and Northern Australia Matt Canavan (Photo: DOI Photographer Tami Heilemann)

eral distribution; and developing data analytics capability to understand supply and demand scenarios for developing critical minerals trade between the two countries.

"This is a partnership that will deliver opportunity and security to both nations," Minister for Resources and Northern Australia Matt Canavan said. "Growing global demand for critical minerals means there is huge scope for Australia to develop secure and stable supply chains to meet the growing demand for critical minerals in key economies such as the U.S."

These research priorities and international cooperation are both significant aspects of the United States' Federal Strategy to Ensure a Reliable Supply of Critical Minerals, which the Trump administration published in June. It directs the USGS to explore international partnerships with close allies and partners to learn more about how those countries study their critical minerals and what lessons the United States could take from them.

"The U.S. has a need for critical minerals and Australia's abundant supplies makes us a reliable and secure international supplier of a wide range of those, including rare earth elements," Canavan said.

## Lucara Going Underground at Karowe Diamond Mine

Lucara Diamond Corp. has reported the results from a feasibility study that support development of an underground mine beneath the currently mined open pit at its Karowe diamond mine in Botswana.

The company expects the underground mine to extend mine life at Karowe to 2040 and generate significant revenue and cashflow.

Life-of-mine production is estimated at 7.8 million carats. Preproduction capital costs for underground development are estimated at \$514 million. Payback period is estimated at 2.8 years. Average life-of-mine operating costs are estimated at \$28.43/metric ton (mt) of ore processed.

The resource remains open at depth.

Lucara President and CEO Eira Thomas said, "Lucara is highly encouraged by the results of the Karowe underground feasibility study, which has outlined a much larger economic opportunity than first envisaged in the 2017 PEA and represents an exciting, world-class growth project for our company.

"Diamond deposits are rare and getting rarer. In this context, we are extending a mine that is in a class of its own, having produced 15 diamonds in excess of 300 carats, including two greater than 1,000 carats in just seven years of production. Further, we have sold 10 diamonds for in excess of \$10 million each, including the record-setting 813-carat Constellation, which sold for \$63.1 million.

"A significant portion of the cost to expand our mine underground can be funded from cash flow, and the investment is expected to be paid back in under three years, as the underground allows us to exploit the highest-value part of the orebody first and generate more than \$5.25 billion in gross revenue.

"What's more, margins remain healthy despite the application of conservative diamond pricing models that reflect the current, difficult market environment. Lucara's short-term view is that the market is now stabilizing. Longer term, market fundamentals are expected to strengthen in line with supply shortfalls from mature, depleting mines in Australia and Canada.

"It is important to note that a return to diamond prices observed in 2015 would nearly double the NPV (5%) of this project to \$1.4 billion."

Combined open-pit and underground indicated resources at Karowe now stand at 54.27 million mt grading 15.3 carats/hundred mt for a contained diamond resource of 8.3 million carats, excluding stockpiles.

Longhole shrinkage bulk mining will be applied in the underground mine,

providing early access to higher-value ore. On the basis of a construction start in mid-2020, ore from underground will seamlessly integrate into current operations, providing mill feed starting in 2023, with a ramp up to 2.7 million mt per year (mt/y) of feed to the processing plant by 2026. Current production rates will be maintained through the underground ramp-up period.

Access to underground operations will be via two vertical shafts (production and ventilation) of approximately 765 m and 715 m depth, respectively. The 7.5-m-dia production shaft will be equipped with two 21-mt skips for production hoisting and a service cage for man and material movement. It will also serve as the main fresh air intake to the mine.

The 6-m-dia ventilation shaft will be equipped with a heavy-lift hoist for moving large equipment throughout the life of the mine and for hoisting development waste during preproduction.

Drill levels will be spaced at 100-m vertical intervals, and drilling will utilize in-the-hole hammer drills.

The extraction level design is similar to a block cave design, with five extraction drives driven 31.5 m apart across the width of the resource. A total of 56 drawpoints are planned, giving significant extraction flexibility.

Ore will be mucked from drawpoints using 21-mt load-haul-dump units that will feed a jaw crusher. Crushed rock will then be conveyed to two 3,500-mt bins adjacent to the production shaft.

Comminution test work was conducted to determine the crushing and grindability characteristics of the deeper kimberlite, which was found to be compatible with the current processing plant comminution circuit.

The predominant diamond separation and extraction process at Karowe utilizes Tomra X-ray Transmission (XRT) sensor-based bulk-sorting machines to separate liberated diamonds from kimberlite and waste host-rock gangue. XRT tests were conducted on all deeper kimberlite and host-rock zones, and all were found to be conducive to efficient diamond separation and recovery with the existing circuit.

Lucara Diamond Corp. is a Canadian company, headquartered in Vancouver, British Columbia, and a member of the Lundin Group of companies.

## J.H. Fletcher & Co.

Reduced commodity prices (particularly for gold) have taken its toll on producers, specifically companies that work higher-cost narrow-vein operations. Due to this struggle, Fletcher saw the necessity of developing machines to aid in relieving these operating burdens. Specifically, the need for narrow-vein deposit mining equipment to provide producers with a lower delution rate. Fletcher's main focus was to provide a piece of equipment that would improve productivity and reduce the physicality of hand drilling and mucking in tight spaces.

J.H. Fletcher & Co. Vice President of Sales, Ben Hardman said, "Our aim is to get operators off the muck pile, and to mechanize the installation of roof support with a narrow vein machine—to get rid of as much of the 'grunt' work as possible." Hardman added, "It's a two pronged approach: making working conditions safer for the mining workforce, and getting better productivity by using specialist machines."

The machine is designed with diesel tram and electric drilling, with inch tram from drill platform. The machine is supplied with rubber tires, articulating carrier, and a single boom with a mounted lifting operator platform.

The machine designed for use in headings from 2.4-m (8 ft) wide is now operating at a western United States mine. Similar machines are being used to install side support in narrow headings and stopes in steeply dipping formations. The drill unit can reach a maximum height of 4.4 m (14 ft. 6 in.), which eliminates the need for stope backfilling before roof support can be installed. With an articulating chassis, the machine can negotiate turns with as little as 2.5 m (8 ft. 3 in.) inside radius. This ability alone saves valuable time, as well as reducing exposure to additional shifts and trip accidents associated with a muck pile or drilling pad. Basket swing allows parallel offset, and also aids in maneuvering around tight corners.

Drilling, resin insertion and bolting can all be performed from the operator's basket, which is mounted on a boom that lifts and swings to allow multiple installations. Canopies provide additional protection to the operator in both driving and basket-work positions. The machine was designed to allow access to tram compartment and drill platform from both sides of machine, allowing the operator to position the machine as they see fit, due to the irregular characteristics of slope mining.

If this machine would be useful in your application, or if your mine has unique conditions, please contact Ben Hardman or Bill Schwab at J.H. Fletcher & Co.





JENNMAR is a global, family-owned company that is leading the way in ground control technology for the mining, tunneling and civil construction industries. From humble beginnings, we have grown to include a family of partners, reaching new heights that help us help you. Since 1972, our mission has been focused on developing and manufacturing quality ground control products.

In addition to more than twenty strategically located manufacturing facilities, our brands include engineering services, resin manufacturing, rolled – steel and drill – steel manufacturing, custom steel fabrication, road, miner, and specialty bits, chemical roof support and sealing products, soil stabilization, reclaiming, grading, trenching and foundation drilling, staffing solutions, and our own trucking company.

Our brands ensures quality, efficiency and availability providing complementary products and engineering solutions. This ability to provide a complete range of complementary products and services ensure quality, efficiency and availability resulting in reduced costs, reduced lead times and increased customer satisfaction!

**SAFETY, SERVICE, and INNOVATION**

**J-LOK Resins**

J-LOK manufactures state-of-the-art resin anchorage systems that are designed to complement JENNMAR products, provide an optimum bolt, and resin system.

**JENNCHEM**

JENNCHEM designs and delivers chemical roof support, rock stabilization and ventilation sealing products to the mining and underground construction industries.



**JM Conveyors**

Manufactures conveyor belt structures, idlers and related components, providing belt through an alliance partnership with Fenner Dunlop.

**JENNMAR Specialty Products**

JENNMAR Specialty Products provides custom steel fabrication services to the mining, tunneling industries.

**JENNMAR McSweeney**

JENNMAR McSweeney is a leading manufacturer of forged drill steel for use in the underground mining industry, as well as snowplow and road grader blades and railroad products.

**JENNMAR Civil**

JENNMAR Civil provides products and services to the tunneling industry, including rock support bolts, anchoring systems, liner plate and resins.

**JM Steel**

JM Steel provides a variety of flat rolled steel products including master coils, slit coils, blanks, beams, sheets, flat bars and panels.

**JENNMAR Sanshell**

JENNMAR SanShell manufactures roof bits and continuous miner bits for the mining industry as well as specific bits for construction and metal cutting.



**JENNMAR Services**

Supplying safe and productive employees to the energy, oil & gas, industrial and manufacturing industries.

**TungsteMet**

TungsteMet manufactures standard and custom-molded carbide products for many different industries.

**JM Construction Tools**

JM Construction Tools takes pride in manufacturing and selling a full line of road planning, soil stabilization, reclaiming, grading, trenching and foundation drilling bits and carbide tooling products that are American-made. Our in-house operations gives us the flexibility to quickly test and adapt to changing environments and customer needs.

**MARJENN TRUCKING**

MARJENN Trucking provides trucking services to transport raw materials, supplies and finished products between JENNMAR plants, suppliers and customers.





## REBUILDING AMERICA'S INFRASTRUCTURE

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.



# Para Resources Pours First Doré Bar at Gold Road Mine



From the left, Carl Graham, project superintendent-Gold Road, Atkinson Construction; Alan Abrams, senior vice president, Atkinson Construction; Mark Bren, general manager, Gold Road mine (holding the first doré bar); Ian Harris, president and director, Para Resources; and Larry Luna, controller, Gold Road mine. Inset: Gold Road mine pours first doré bar.

On November 5, Para Resources Inc.'s Gold Road Project successfully smelted and poured a 380-ounce (oz) doré bar containing 220.8 oz of gold. The Gold Road mine, located in Arizona, USA, is expected to produce a doré bar two to three times per month, ramping up to 2,500-3,000 oz of gold per month during the first quarter of 2020.

"The production of a doré bar is a significant milestone for Gold Road, confirming the production cycle from mine to bar can be completed successfully," President Ian Harris said. "The doré bar and in-circuit inventory balances with the last nine days run of the Gold Road Mill. We look forward to increasing bar size now that plant in-process inventory has been established, and mine continues to add additional mining faces and convert to stope mining, which will produce higher grades due to lower dilution."

The first of two Alimak machines have been delivered to the site and will be installed this month. The second Alimak

is scheduled to be installed in early first quarter 2020. The Alimaks will open two new production raises that will give the mine access to the higher-grade material and improve airflow to the lowest levels of the mine, according to the company.

## Imperial Reports Red Chris Production for Q3 2019

Imperial Metals Corp. reported production at the Red Chris mine for the third quarter of 2019 was 19.5 million pounds (lb) copper and 8,419 ounces (oz) gold. These results represent 100% of production at Red Chris. Copper and gold production were up 11% in the third quarter compared to the second quarter of 2019. Mill throughput for the quarter averaged 30,568 metric tons per day (mt/d).

As previously announced, Imperial completed the sale of a 70% interest in the Red Chris mine to Newcrest Mining Ltd. on August 15. Imperial's portion of the third quarter production was 13.1 million lb copper and 5,634 oz gold rep-

resenting 100% of production for the period July 1 through August 14, and 30% of production for the period August 15 through September 30.

Exploration drilling commenced during the third quarter with four drills currently operational. It is expected that two more drill rigs will begin drilling during the fourth quarter. Drilling will test the upside of the East Zone, Main Zone and Gully Zone and a number of regional targets. At the East Zone, a deep in-fill resource definition drilling program is under way to provide additional geological, metallurgical and geotechnical data to support studies for future underground operations. A new step out exploration drilling program is under way searching for additional zones of high grade mineralization within the main mineralized trend. Drilling is also being conducted in the Gully Zone to follow up previous high-grade intercepts.

Imperial is a Vancouver exploration, mine development and operating company. The company, through its subsidiaries, owns a 30% interest in the Red Chris mine, and a 100% interest in both the Mount Polley and Huckleberry copper mines in British Columbia. Imperial also holds a 48% interest in the Ruddock Creek lead/zinc property.

## Equinox Developing Phase 1 of Castle Mountain Project

Equinox Gold has begun development of its Castle Mountain gold project in south-east California, 75 miles south of Las Vegas, Nevada, and 200 miles north of its currently producing Mesquite gold mine.

Castle Mountain was mined from 1992 to 2004, producing more than 1 million oz of gold from heap leach operations before it was shut down due to low gold prices. Phase 1 of Equinox's re-development project will be a 12,700-metric-ton-per-day (mt/d) heap-leach operation primarily processing stockpiled ore from previous operations.

Loaded carbon from Castle Mountain will be trucked to the Mesquite mine and processed through the Mesquite ADR (adsorption, desorption and refining)

plant. Gold production from Castle Mountain Phase 1 is expected to average 45,000 ounces per year (oz/y) over three years of operation.

Early works construction for Phase 1 began in early October, including detailed engineering, procurement, and installation of piping, other infrastructure, and heap-leach earthworks. Installation of leach pad liners began in November. The first gold pour based on Phase 1 heap leaching is planned for the third quarter of 2020.

Phase 1 development is budgeted at \$58 million, including working capital and a 12% contingency. Phase 1 construction is fully funded from Equinox's existing treasury, cash flow based on current gold prices, and available funding facilities.

Phase 2 is planned to increase Castle Mountain production to 200,000 oz/y based on processing of 41,000 mt/d of ore, of which 2,300 mt/d of higher-grade ore will be processed through a milling circuit. Although Phase 2 will operate within the existing mine boundary, the increased mining and water extraction rates will require amendments to current project permits.

A Phase 2 feasibility study is underway, with completion scheduled for the second half of 2020, at which time Equinox will submit an application to amend its existing plan of operations and permits to support the Phase 2 expansion.

Phase 2 is currently projected to have a mine life of 13 years.

Equinox Gold CEO Christian Milau said, "Castle Mountain will be Equinox Gold's third producing gold mine and our second mine in California. Construction of Phase 1 of Castle Mountain is the first step in building a project that will ultimately be a long-life, 200,000-oz/y gold mine, bringing significant benefits to Equinox Gold's shareholders, local communities, and the state of California."

Equinox Gold is a Canadian company headquartered in Vancouver, British Columbia. Its currently producing mines are the Mesquite mine in California and the Aurizona mine in northeast Brazil.

## Glencore Permanently Closes Brunswick Smelter Facility

Glencore Canada Corp. announced the permanent closure of the Brunswick Lead Smelter in Belledune, New Brunswick. The decommissioning process will begin

immediately and the smelter will cease all operations by the end of the year.

"The decision to cease lead smelting operations at our Brunswick Smelter was a very difficult one," said Chris Eskdale, Glencore's head of zinc and lead assets. "Despite years of efforts by committed employees and a strong management team, the smelter has been uneconomic since the closure of the Brunswick mine in 2013."

Eskdale said the company assessed all options and decided the smelter was not sustainable, "regardless of the recent labor dispute."

"I would like to express my gratitude to all Brunswick smelter employees, past and present, for their tremendous commitment and efforts over the many years of operations," he said. "We are fully committed to working closely with employees and unions as well as other community stakeholders to mitigate the impact as much as possible."

The Brunswick smelter opened in 1966 and employs approximately 420 people. Glencore said it intends to provide pension, severance and outplacement support services for all employees as part of closure settlements to be agreed on. The company said it is committed to meeting with union leadership to discuss an orderly transition to closure.

The company said it will look for potential relocation opportunities at its mining and metallurgical operations in other provinces and countries that may be available to Brunswick Smelter workers. The company will also work with local stakeholders and agencies to identify opportunities for regional economic development.

Glencore will meet all of its closure obligations with respect to environmental and other regulatory requirements. The company anticipates that a small number of employees will be retained to work on site monitoring, water treatment and closure projects in the months ahead.

## Skeena PEA Supports Eskay Creek Gold-Silver Project

Skeena Resources has reported robust economics from a preliminary economic assessment (PEA) of its Eskay Creek gold-silver project in the Golden Triangle of northwest British Columbia. The study considers development of a high-grade open pit averaging 3.23 grams/metric ton gold and 78 g/mt silver (4.17 g/mt gold equivalent) diluted. Production would average an estimated 236,000 ounces per year (oz/y) gold and 5,812,000 oz/y silver over a mine life of 8.6 years.

A 6,850-mt/d mill and flotation plant would produce a saleable concentrate. Life-of-mine all-in sustaining costs are estimated at C\$983/oz (US\$757/oz) of gold equivalent recovered.

Skeena CEO Walter Coles said, "Eskay Creek was a remarkable discovery that became an extraordinary underground mine in 1994 and produced until 2008. This PEA demonstrates that Eskay Creek still has a bright future ahead, revitalized as an open-pit gold and silver mine, with the additional possibility for underground mining."

"The project has the potential to produce an average of 306,000 gold-equivalent oz/y with a diluted mill feed grade of 4.17 g/mt gold equivalent.

"Also, as a brownfield site, Eskay Creek benefits from tremendous infra-



Glencore Canada's Brunswick lead smelter in Belledune will shut down at the end of the year. (Photo: Google)

structure installed by the previous operators. Finally, by creating a gold concentrate rather than doré, we are able to keep initial capital costs very low, at US\$233 million, relative to the amount of precious metals produced. This also simplifies and reduces technical risks for the project.”

The PEA is derived from a pit-constrained resource estimate and does not include results from an ongoing 2019 in-fill drilling program.

The mine will be an owner-operated standard truck-and-shovel open pit, with a leased mining fleet. The in-place infrastructure includes all-weather access roads, previously permitted tailings storage facilities, and proximity to recently commissioned 195-megawatt (MW) hydroelectric facilities and linked power grid.

The mining fleet will utilize 22-m<sup>3</sup> shovels and 142-mt haul trucks. Support equipment will include track dozers, graders, and hydraulic excavators, plus additional equipment to maintain production during seasonal periods of high snowfall.

The mine designs and scheduling for the Eskay open pit were engineered to provide 2.5 million mt/y of feed to the 6,850-mt/d process plant. A total of 21.3 million mt of diluted mill feed is planned to be processed over the mine life from the main pit area and a smaller satellite pit. Mill feed will be trucked to a primary crusher located to the west of the main pit and then conveyed overland 2 km to the process facility.

To provide the target particle size of P<sub>80</sub> 75 µm, the comminution circuit comprises a 3.3-MW semiautogenous grinding mill and a 6-MW ball mill. A pebble crushing circuit is also included.

Ground material is processed through a conventional flotation circuit, including rougher/scavenger tank cells. Rough-

er-scavenger concentrate is subsequently ground to a target size of P<sub>80</sub> 20 µm prior to multiple stages of cleaning to produce a gold-silver concentrate.

Flotation tailings are pumped to the existing tailings storage facility.

Flotation concentrate is thickened, filtered, and trucked to the port at Stewart, British Columbia for loading onto ships and transport to third-party smelters worldwide.

The Eskay Creek PEA was completed by Ausenco Engineering Canada, supported by SRK Consulting (Canada) and AGP Mining Consultants.

### Rio Tinto Invests \$1.5B to Extend Operations at Kennecott to 2032

Rio Tinto has approved a \$1.5 billion investment to continue production at its Kennecott copper operation in Utah, United States. The investment over the next six years will extend operations at Kennecott to 2032.

The investment will further extend strip waste rock mining and support additional infrastructure development in the second phase of the South Wall Pushback project, to allow mining to continue into a new area of the ore body and deliver close to 1 million metric tons (mt) of refined copper between 2026 and 2032, according to the company. This will allow further exploration of the deposit.

This additional investment will commence in 2020. With this project, Rio Tinto has invested more than \$5 billion in modernization, environmental stewardship and mine-life extension initiatives since it acquired Kennecott in 1989.

“Kennecott is uniquely positioned to meet strong demand in the United States and delivers almost 20% of the country’s copper production,” Chief Executive J-S Jacques said. “North American manufac-

turers have relied on high-quality products from Kennecott for the past century and this investment means it will continue to be a source of essential materials into the next decade.”

The first phase of the South Wall Pushback, which is expected to be complete in 2021, will extend production to 2026.

### Cleveland-Cliffs Will Acquire AK Steel

Cleveland-Cliffs Inc. plans to buy all of the issued and outstanding shares of AK Steel Holding Corp.’s common stock. Upon completion of the transaction, valued at approximately \$1.1 billion, Cliffs shareholders will own approximately 68% and AK Steel shareholders will own approximately 32% of the combined company.

Lourenco Goncalves, chairman of the board, president and CEO of Cliffs, will lead the expanded organization.

“We are excited to be able to deliver real value to the shareholders of both Cliffs and AK Steel through a value enhancing and leverage-neutral transaction,” Goncalves said. “By combining the best-in-class quality of AK Steel’s assets and its enviable product mix with Cliffs’ debt profile and proven management team, we are creating a premier North American company, self-sufficient in iron ore pellets and geared toward high value-added steel products.”

The transaction will combine Cliffs, North America’s largest producer of iron ore pellets, with AK Steel, a leading producer of innovative flat-rolled carbon, stainless and electrical steel products, to create a vertically integrated producer of value-added iron ore and steel products. The combined company will be well-positioned to provide high-value iron ore and steel solutions to customers primarily across North America.

“We believe this transaction is a compelling opportunity for AK Steel shareholders to participate in the substantial upside potential of what will be a premier vertically integrated producer of value-added iron ore and steel products with significant scale and diversification,” CEO of AK Steel Roger K. Newport said. “Our shareholders will benefit from exposure to a larger, more diversified company that is better positioned to capitalize on growth opportunities.”

The transaction is expected to close in the first half of 2020.



An investment in the Bingham Canyon mine, as seen from the mountains above, should keep it operating until at least 2032.





# Defining **Tire Management**

Kal Tire's Mining Tire Group specializes in a complete range of tire management services in over 20 countries. Our skilled workforce performs according to our global safety and operating standards, and focuses on extracting the maximum value from tires and related assets for mining customers.

As an independent tire dealer with 45 years' experience, we ensure customers get the right product for the right application. Through continuous innovation, we are able to meet the evolving needs of mining customers and help them make the most of their tire investments.



[KalTireMining.com](https://www.KalTireMining.com)

*Harte Gold Corp.* announced the following executive appointments: **Sam Coetzer** to president, CEO and director, and **Dr. Martin Raffield** to executive vice president and COO. Most recently, Coetzer was president and CEO of Golden Star Resources Ltd. Most recently, Raffield was appointed executive vice president and CTO of Golden Star, after joining Golden Star as senior vice president, project development and technical services.



Richard O'Brien



Jeane Hull

*Pretium Resources Inc.* appointed **Richard O'Brien** and **Jeane Hull** as independent directors of the company. O'Brien will assume the role of board chair following the retirement of **Robert Quartermain**, executive chairman, on December 31. O'Brien previously served as president and CEO of Newmont Mining Corp. and president and CEO of Boart Longyear Ltd. Hull previously held the positions of COO for Rio Tinto plc at the Kennecott Utah Copper Mine and executive vice president and CTO of Peabody Energy Corp.



Mark Cruise

*New Pacific Metals Corp.* appointed **Dr. Mark Cruise** to the position of COO. Dr. Cruise is the founder and former CEO of Trevali Mining Corp.

*NQ Minerals Plc* appointed **David Lenigas** chairman of the company. **Brian Stockbridge** has retired from the board of directors.



Karen O'Neill

*Kingsrose Mining* advised that CEO **Karen O'Neill** has been appointed managing director. O'Neill has more than 20 years of operational and executive experience across mining, investment banking and professional services.

*Compass Minerals* announced that **Mary Frontczak** will be joining its senior management team as chief legal officer and corporate secretary. Most recently, Frontczak served as senior vice president and general counsel at POET.



Mary Frontczak

*Pelangio Exploration Inc.* appointed **Kevin P. Thomson** to senior vice president, exploration. Thomson is currently a director of Pelangio and has provided technical expertise to the company since his appointment to the board in May 2017. **Warren Bates** has transitioned from senior vice president exploration to become the senior technical advisor to Pelangio's Technical Committee.

*Torian Resources Ltd.* appointed **Stephen Jones** as managing director. Jones, who joined Torian as a non-executive director in September, is a mining engineer with more than 30 years of experience including at least 15 years at senior management level. As part of the restructure, **Mark Borman** will retire from his role as CEO.



Bradley Drabsch



Toby Wellman

*Syndicated Metals Ltd.* appointed a new senior management team. The new appointments of highly experienced exploration geologists and mining executives **Bradley Drabsch**, managing director, and **Toby Wellman**, executive technical director, mark the final stage of the company's strategic repositioning. Both Drabsch and Wellman are directors of Centrepeak Resources Group Pty Ltd. **David Morgan** will step down as managing director, but will remain on the board as a non-executive director. Director **Rob Cooper** will resign from the board to focus on his role as CEO of Round Oak Minerals Pty Ltd. Drabsch was most recently managing director of Trek Metals Ltd. During Wellman's career, he was a senior development geologist and senior geologist for gold producer Doray Minerals.



Hon. Seamus O'Regan

*Canada* has a new natural resources minister, the **Hon. Seamus O'Regan**. He was first elected as a member of parliament for St. John's South, Mount Pearl, in 2015.

The *National Mining Association (NMA)* announced that **Katie Sweeney** has been named executive vice president and general counsel. Sweeney was formerly senior vice president and general counsel.



Katie Sweeney



Sidney Smith

The *American Exploration & Mining Association (AEMA)* has hired **Sidney Smith** as the association's government affairs manager. Smith fills the role of **Matthew Ellsworth**, who served AEMA for seven years and is now executive director for the Association of Washington Public Hospital Districts. With more than 17 years of demonstrated experience in government affairs and media relations, Smith was regional director and communications coordinator for U.S. Sen. **James Risch**, and press secretary for U.S. Sen. **Larry Craig**.



Helena Hedblom

*Epiroc* has appointed **Helena Hedblom** as the new president and CEO, effective March 1, 2020. She will replace **Per Lindberg**, who has decided to leave his position after having successfully established Epiroc as a listed company. Hedblom is currently senior executive vice president of mining and infrastructure and a member of Epiroc Group Management. Per Lindberg will resign from the Board of Directors of Epiroc AB the same time he leaves the position as president and CEO.



Paul Sohlberg

**Paul Sohlberg** has been appointed interim executive vice president, president of minerals processing business unit and member of *Outotec's* Executive Board. The position is temporary until the expected closing of the Outotec and Metso Minerals combination. Paul Sohlberg joined Outotec in 2011 and has since 2014 worked as the president of market area North and Central America. He will replace **Kimmo Kontola**, who has decided to continue his career outside Outotec.



Eduardo Coloma

*Maptek* named **Eduardo Coloma** as the new global CEO. Coloma is well known in the industry, having worked in South America and Australia for 20 years, with expertise in technical and managerial roles. It also appointed **Gideon Slabbert** to the role of general manager of Maptek in South Africa. Slabbert replaces **Nick Venter** who will join Maptek's North American operations as director of sales and technical sales support. Slabbert joined Maptek in 2017 as blastologic product manager.



Paul Fletcher

*Vast Resources* appointed **Paul Fletcher** as finance director of the company with immediate effect. Fletcher has been CFO since his appointment in February. He has 25 years of experience working in the commodity and financial services industries.

*ALLU Group Inc.* announced **Rob Houlder** as its new territory sales manager for the northeastern United States. Prior to joining ALLU, Houlder was Northeast regional sales manager for Connect Work Tools.



Rob Houlder

# Centerra Gold Suspends Operations at Kumtor Mine

Centerra Gold's Kumtor mine, located in the Kyrgyz Republic, experienced a "significant rock movement" at the Lysii Waste Rock Dump in the morning hours of December 1. The mine initiated an emergency evacuation of all personnel from the area and immediately ceased mining operations.

Two Kumtor employees who were working in the area did not report to the emergency gathering area and remain missing. A search and rescue operation, which began immediately, is ongoing in cooperation with the Kyrgyz Republic Ministry of Emergencies, according to the company.

"Our primary focus right now remains on the safe return of our two missing employees and the safety of our search and rescue teams who are working in very challenging circumstances," said Scott Perry, president and CEO of Centerra Gold at the time. "While the search continues, we are coordinating closely with the family members of the missing employees and our thoughts and support are with the families, the search and rescue teams, as well as with the entire Kumtor team."

A few days later, the company reported that the Lysii Waste Rock Dump had stabilized sufficiently that light equipment is being employed in the search effort. Open-pit mining operations remain temporarily halted because of the need to focus on search and rescue efforts but also because 100% of the waste rock being mined was to be placed on the Rock Dump located in the Lysii valley.

Kumtor's mining areas, including the Central Pit, have not been impacted by the Lysii Waste Rock Dump movement since the Lysii valley is an isolated valley over a ridge to the north of the open pit. The company is assessing alternative waste rock dumping plans, which could include using the existing capacity in the Central Valley Waste Dump, the Sarytor Waste Dump and/or in-pit dumping. A restart of open-pit mining operations won't occur until the company is certain that the search and rescue efforts will not be affected and a revised waste dumping plan has been completed.

Kumtor mill infrastructure has not been impacted from the Lysii Waste Rock Dump movement, since the Lysii Valley is isolated over a ridge to the north and at a lower elevation than the mill. While mining has been suspended in the open pit, the company said it has sufficient ore stockpiles on surface for normal production levels through the end of 2020. As previously disclosed, there is no change to the company's production outlook for 2019.

Infrastructure at the bottom of the Lysii Valley such as surface access roads, a reclaim water pipeline and powerline are unaffected by the Lysii Waste Rock Dump movement but, as a precaution, the company is building a bypass water pipeline to ensure an uninterrupted supply of water to the mill.

## Liberty Sells Interest in Turkish Copper Gold Deposit

Liberty Gold Corp. has received a US\$4 million nonrefundable pre-payment from

Cengiz Holdings A.Ş. for the sale of its 40% interest in the Halilağa copper gold porphyry deposit, located in Biga Province, northwest Turkey.

The company will also receive US\$6 million on closing of the amended sale agreement on August 15, 2020; US\$6 million on the first anniversary of the closing date, August 15, 2021; and US\$6 million on the second anniversary of the closing date, August 15, 2022.

The first and second anniversary payments will be bank guaranteed.

Cengiz will acquire Liberty Gold's 40% interest in the project by purchasing the company's shares representing 40% of a Turkish holding corporation. As a result of the transaction, Liberty Gold will receive a total of US\$22 million, unchanged in aggregate from the original agreement.

Closing of the transaction is subject to customary conditions including the approval of the Turkish Ministry of Energy and Natural Resources.

Proceeds from this transaction will be used to fast-track the drill program at Liberty Gold's Black Pine high-grade Carlin-style oxide gold property in southern Idaho. The 2020 drill program will be expanded to include an estimated 45,000 meters of reverse circulation drilling and resource estimation, core drilling and metallurgical column testing. The program will expand on exceptional results thus far in 2019, augmenting historical results showing shallow oxide gold mineralization present over a 7-square-kilometer area.

# Third Edition of Seville's Mining Hall Attracts 10,000 Visitors

More than 10,000 people visited the International Mining Hall (MMH) held in October in Seville, Spain. In its third year, the conference brought together people from the Andalusia region as well as around the world in the hopes of estab-

lishing partnerships and courting investment and bringing jobs to the region.

"I hope this will be an historical event," MMH Commissioner and CEO of Atlantic Copper Javier Targhetta said. "This sector is about to become a world reference."

The Andalusia region has a long history of mining, dating back to around 3,500 BC when they mined for copper. Most of the metal mining is done between the

*(Continued on p. 32)*

## CR innovative design boosting mining productivity across the globe

For the last 40 years, CQMS Razer (CR) has earned a reputation for delivering innovative engineering design and proven productivity results for mining operations across Australia, North and South America.

CR is strategically placed with dual headquarters in the USA and Australia, with a market presence across 15 countries. CR products and technicians can be found across a variety of commodities, including iron ore, copper, gold, diamonds, lithium, coal and oil sands mining operations.

CR is committed to supply chain excellence and timely delivery of products, with reliable, state-of-the-art foundry and manufacturing facilities ensuring customers have their products digging in the field sooner.

The long-term partnerships established with mining suppliers and owners across the globe reflect CR's reputation for trusted, high-quality products and a common goal to deliver safe and innovative mining productivity solutions.

### US acquisitions

In September 2019, CR announced a new agreement with Californian based Berkeley Forge & Tool (BFT) acquiring their mining products and associated IP, including patents and new product development pipeline. The acquisition was a strategic move by CR to continue expansion of their global market presence and complemented their existing cast lip and G.E.T product range.

The combined business enhances CR's capabilities to effectively supply and support the global mining sector especially in the North and South American markets where BFT has provided the industry with innovative products for more than 50 years.



### CR Mining product range

The CR mining product range includes hydraulic excavator cast lip systems, load haul optimization software systems, dragline buckets, G.E.T, dragline rigging, conveyor systems and fixed plant wear products.

CR cast lips including rope shovel dipper lips offer superior production hours and performance outcomes having built a reputation as the lightest and strongest available in the market.

In 2019 CR expanded its cast lip solutions with the addition of the new RazerEdge™ RE1522 cast lip for 100t plus class machines, the smallest cast lip ever designed by CR and already a popular choice with early deliveries to Australian and Canadian mine sites.

### Shaping digital mining

CR is also looking beyond traditional applications and works with some of the world largest mining operations to collect and translate real-time field data to enable real-time, ground up decision making.

In March 2019, CR reached more than one billion tonnes of resources mined by their clients using their CR Digital flagship Titan 3330™ technology.

The Titan 3330™ Load Haul Optimization System accurately calculates and displays real-time bucket payload data to the machine operator

and to site supervisors and maintenance crews, dramatically improving loading accuracy and efficiency. Titan 3330™ is proven help increase average payloads, improve productivity and reduce safety risk overloads across load haul fleets.

### 2020 and beyond

In 2020 CR will continue expansion of offices, staff and service technicians across the United States, Canada, Colombia, China, Brazil, Chile, Peru, Mexico and Australia, a direct response to growing product demand from new clients, improved supply chain capacity and repeat orders from a long-term client base.

CR will also be announcing several new products and major collaborations, all leading up to an exciting suite of activities, displays and major announcements at MINExpo 2020, the world's largest mining tradeshow.

For more information about the CR mining equipment and software range, visit [www.cqmsrazer.com](http://www.cqmsrazer.com).





SABERTOOTH<sup>®</sup> MINING SYSTEMS

As leaders in innovative mining equipment and software, CR is committed to supporting the global mining sector with reliable state-of-the-art facilities, supply chain expertise and leading-edge design.

CR is proud to introduce Berkeley Forge as part of their product range. Berkeley Forge has provided the North and South American markets with mining products for more than 50 years with continued growth in these regions. CR looks forward to continuing these long-term relationships with Berkeley Forge customers now and into the future.

DALLAS | PORTLAND | SANTIAGO | RUSSIA | CANADA | CHINA | PERU | AUSTRALIA

# Lundin Gold Inaugurates Fruta del Norte Project



Dignitaries celebrate the official opening of Latin America's latest gold mine. (Photo: Lundin Gold)

November 14, Lundin Gold Inc. held an inauguration ceremony for its Fruta del Norte gold project in Ecuador. The event was attended by Ecuadorian national, provincial, and local government authorities, representatives of the Canadian embassy, shareholders, finance lenders, community members, partner organizations, contractors and company personnel.

Ecuador Vice President Otto Sonnenholzner, Minister of Energy and Non-Renewable Natural Resources Carlos Pérez and Vice Minister of Mining Fernando Benalcázar, along with other top officials from national government ministries, attended the inauguration. Vice President Sonnenholzner reiterated the national government's support for the project, highlighting "the great work that this team has done, which makes our country proud. Let's make Fruta del Norte be the light that guides Ecuador as it develops its mining sector."

On November 16, the first doré bar was produced from the gravity circuit at Fruta del Norte. Production of gold concentrate, as part of the commissioning activities, is also well advanced with the first containers being loaded with marketable concentrate, according to the company. Commissioning of the carbon-in-leach circuit is ongoing and nearing completion.

"This is another exciting and significant milestone for the Lundin Gold team

and the people of Ecuador," President and CEO of Lundin Gold Ron Hochstein said. "We will continue to focus on completing commissioning and ramping up production on the path to commercial production in the second quarter of 2020."

Based on the current projections, the first export of concentrate and doré is anticipated by mid-December.

## Protests in Chile Impact Copper Mining

Some mining companies in Chile were, or have been, partially affected by intense protests that have shaken the world's largest copper producer, according to reports by *Reuters*. Some unions have also urged their affiliates to join in the demonstrations.

Even though the protests over social demands have been extremely intense and have left at least 18 dead and more than 6,000 arrested, the head of the prosecutor's office said the unrest has not affected the production of the red metal that seriously. However, the industry has suffered indirectly due to difficulties in transportation, port operations, and the absence of suppliers.

The Mining Federation (FMC), which brings together several private industry associations, called for a stoppage of activities, although the effect was mixed in the different jobs throughout the country. The president of the FMC, Gustavo Tapia,

told *Reuters* they had an 80% confirmation of affiliates who will participate in the mobilization, but said there was pressure from the companies to block the actions.

Union leaders from BHP Spence said the mine was forced to stop operations on November 19, but the company did not make any more comments on the situation.

The assembly of workers at the Colahuasi mine did not approve to join the stoppage, union President Felipe Román told *Reuters*.

Anglo American reported normal conditions at its operations, including its flagship mine Los Bronces, with some adjustments and flexibility in the shifts due to the country's situation.

Lumina Copper said that the "Caserones site is operating with minimal personnel just to keep the processes stable, in order to protect the safety of its employees, collaborating companies and site facilities."

## PFS Advances Horizonte's Vermelho Ni-Co Project

Horizonte Minerals has reported the results of a prefeasibility study (PFS) of its 100% owned Vermelho laterite nickel-cobalt project in Pará state, Brazil. The study confirms Vermelho as a large, high-grade resource that can serve as a low-cost source of nickel sulphate for the battery industry. The economic and technical results of the study support moving the project forward to a full feasibility study.

At full production, the Vermelho project is forecast to produce an average of 25,000 metric tons per year (mt/y) of contained nickel and 1,250 mt/y of contained cobalt, utilizing the high-pressure acid leach (HPAL) process. Initial capital costs are estimated at \$652 million, including \$97.7 million of contingencies.

A 38-year mine life would generate estimated total cash flows after taxation of \$7.3 billion.

The project would support more than 1,800 direct jobs during construction and more than 600 jobs during operation.

The Vermelho project is located in the Carajás mining district, 85 km northwest of the Horizonte's Araguaia North nickel

project. The Vermelho project is planned as an open-pit mining operation that would mine 141.3 million mt of probable mineral reserves at a cut-off of 0.7% nickel to produce a total of 924,000 mt of nickel in nickel sulphate, 36,000 mt of cobalt in cobalt sulphate, and 4.48 million mt of byproduct kieserite fertilizer.

Mine production will be based on conventional open-pit truck-and-excavator mining. Blasting will be necessary for the upper parts of the deposit. Reverse circulation grade control drilling will be completed at 12.5-m x 12.5-m spacing to define waste-ore boundaries.

Due to the wet season, mining, including stockpile re-handling, will be reduced between October and March, as is standard practice in the region.

The mine production schedule targets 1 million mt/y of HPAL feed for the first three years (Stage 1), followed by a doubling of capacity to 2 million mt/y thereafter. The annual mining rate starts at 8 million mt/y and peaks at 12 mt/y between production years 5 and 11. Strip ratios for the deposit are extremely low (0.14:1, waste to ore), consequently waste dumps are relatively small.

The mine supplies higher-grade ore in the early mine life, reaching up to 2% nickel and 0.1% cobalt in the first four years of production.

Processing will include a beneficiation plant to upgrade ore ahead of the HPAL and refining plant, which will produce the sulphates.

The Stage 1 plant and project infrastructure will be constructed over a 31-month period. The nickel and cobalt sulphate prod-

ucts will be transported by road to the port of Vila do Conde for sale to overseas customers.

The kieserite will be transported to consumers within Pará state.

## Vale Resumes Operations at Alegria

Vale has received the necessary authorization from Brazil's National Mining Agency to resume the operations at the Alegria mine, lifting the suspension decision that has halted operations since March. This will allow Vale to restart approximately 8 million metric tons per year (mt/y) of the 50 million mt/y of idled iron ore production.

The company expects a 1-million-mt increase in production from Alegria this year. It reaffirmed its iron ore and pellet sales guidance of 307 million to 332 million mt for 2019 and expects sales to be between the lower and the midpoint of the range.

## Lithium Americas Targeting 2021 Production at Caucharí-Olaroz

Lithium Americas Corp. has reported the results of a definitive feasibility study (DFS) for production of 40,000 metric tons per year (mt/y) of lithium carbonate ( $\text{Li}_2\text{CO}_3$ ) from lithium brine processing at the Caucharí-Olaroz lithium project currently under construction in Jujuy province, northwest Argentina. Caucharí-Olaroz is 100% owned by Minera Exar S.A., which is a 50/50 joint venture between Lithium Americas and Ganfeng Lithium. Lithium Americas and Ganfeng have authorized Exar to continue with development of the project to produce 40,000 mt/y of battery-quality  $\text{Li}_2\text{CO}_3$  as outlined in the DFS.

An update to the "Environmental Impacts Report for Exploitation" for Caucharí-Olaroz was approved by Jujuy province in 2017, providing all necessary permits to support 25,000 mt/y of  $\text{Li}_2\text{CO}_3$  production. In accordance with provincial requirements, an update was submitted in August and is currently being evaluated by the province to expand the production capacity to 40,000 mt/y. This update includes supplementary environmental studies and information collected during the previous two years as well as changes to the project description to reflect the current development plan and increased production capacity.

The DFS describes a project producing 40,000 mt/y of battery-quality  $\text{Li}_2\text{CO}_3$  over a period of 40 years. Construction capital costs are estimated at \$565 million. More than \$200 million in capital is already committed to contracts and purchase orders.

Operating costs are estimated at \$3,576/mt.

First production is targeted for early 2021.

The DFS includes conventional, commercially proven brine processing technology to produce battery-quality  $\text{Li}_2\text{CO}_3$  that can be used to meet the specifications of battery material producers in manufacturing cathode and electrolyte for lithium-ion batteries. The process follows industry standards: pumping brine from the salar (salt lake), concentrating the brine through evaporation ponds, and bringing the brine concentrate through an extractive hydro-metallurgical and purification process to produce battery-quality  $\text{Li}_2\text{CO}_3$ .

The project is well serviced by nearby infrastructure, including major paved highways that connect to the port of Antofagasta in Chile, a high-voltage transmission line, an adjacent 300-megawatt (MW) solar project, and a gas pipeline.

Lithium America President and CEO Jon Evans said, "With construction under way and funding in place, the results of the 40,000-mt/y DFS further support Caucharí-Olaroz as a scalable, high-purity source of lithium carbonate for battery material customers. We are thankful for the hard work from the team at Minera Exar, the support from the government of Jujuy, and our 50:50 joint-venture partner, Ganfeng Lithium, for their financial and technical contributions toward optimizing the process design and securing key equipment for the lithium carbonate plant."



Ferro-nickel metal is smelted and poured at the Horizonte Minerals' Araguaia pilot plant. (Photo: Horizonte Minerals)

# Rio Tinto Will Underwrite Ranger Uranium Project Rehabilitation



ERA determined it would need extra funding to rehabilitate the Ranger Project (above). (Photo: ERA)

Rio Tinto will support Energy Resources of Australia Ltd.'s (ERA) plans for a renounceable entitlement offer to raise \$324 million for the rehabilitation of the Ranger Project Area in Australia's Northern Territory. As a 68.4% shareholder in ERA, Rio Tinto will subscribe to its full entitlement of approximately \$221 million. Given ERA's inability to secure third-party underwriting support, Rio Tinto has also agreed to fully underwrite the offer to ensure ERA has the funds it needs to meet its current rehabilitation obligations.

"We take mine closure very seriously and ensuring ERA is able to fund the closure and rehabilitation of the Ranger Project Area, through participating in this entitlement offer, is a priority," Rio Tinto Group Executive Energy & Minerals Bold Baatar said. "We have committed to supporting this offer with the objective of ensuring ERA is in a position to rehabilitate Ranger to a standard that will establish an environment similar to the adjacent Kakadu National Park."

Under the terms of its mining approvals, ERA is required to end mining and processing activities at Ranger by January 2021 and complete final rehabilitation by January 2026.

On February 8, ERA finalized its closure feasibility study for Ranger Project Area rehabilitation, resulting in a material increase in anticipated rehabilitation costs. Following this increase, ERA advised it needed extra funding to meet its rehabilitation obligations to the commonwealth government, northern territory government and traditional owners.

The Ranger rehabilitation expenditure is not expected to generate any direct financial return for ERA.

## Alleged Murder at Pilbara Minerals' Mine Site

A man died at the Pilgangoora Lithium-Tantalum Project site in the Pilbara region, Western Australia, on Monday, November 11. The death was not related to mining, but involved two contract employees. According to the Western Australia Police Force, a man in his 40s was killed and another man in his 30s has been arrested.

According to *9 News* in Sydney, 30-year-old FIFO worker, Troy Adam Hausler, is accused of murdering 40-year-old Toby Richter following an altercation at Pilbara Minerals' mine site, about 120 km south of Port Hedland.

The Western Australia Police Force is investigating the alleged murder.

Pilbara Minerals temporarily suspended operations following the incident to facilitate with the investigation, but they have since resumed.

Pilbara Managing Director Ken Brindson said, "I am extremely shocked and saddened by what has occurred today. At this difficult time, our focus is on ensuring that our people are cared for and supported, while we continue to support the police investigation that is currently under way. On behalf of Pilbara Minerals, I would like to express our sincere condolences to the affected people and their families."

Pilbara Minerals said it will continue to provide full support to the Western Australia Police Force as their investigation progresses and is unable to provide any further comment.

## Woodlawn Ships Lead, Zinc Concentrate

Heron Resources Ltd. has successfully commenced export shipments from its 100% owned Woodlawn Zinc-Copper mine located 250 kilometers (km) southwest of Sydney, in New South Wales.

Zinc and lead concentrates from Woodlawn have been sold under the offtake agreement with IXM (formerly Louis Dreyfus Company Metals), which extends from commencement of production through to the end of 2021. The off-take contract covers 100% of the zinc, copper and lead concentrates produced over this period.

The first shipment of 5,000 metric tons (mt) of zinc concentrates comprises "commissioning" material together with more recent production. The average concentrate grade of approximately 46% zinc is within contract specifications and is consistent with the current production plan. This blended concentrate grade is particularly pleasing given the inclusion of a significant proportion of material produced during the early commissioning process.

The concentrate contains higher grades of lead and iron compared to specification, and the off-take terms have been adjusted accordingly in line with the market.



All loading and logistics procedures from site to Port Kembla and Port Botany ran smoothly and to agreed timetables.

Shipments of lead concentrates have also commenced, with the first sales parcel of 700 mt of commissioning grade lead concentrates being shipped out of Port Botany on September 28. The sale of an additional 2,000 mt of lead concentrate has been agreed and is expected to ship during November and December.

Processing of reclaimed tailings is ongoing and underground ore campaigns are being scheduled in line with the current production plan. Ramp-up of the processing plant continues to progress well and full plant capacity is expected to be achieved on a sustainable basis in mid-2020.

"The achievement of first cashflow from operations at Woodlawn is another key milestone for Heron," Heron Chairman Stephen Dennis said. "Although significantly later than planned due to delays in completion of construction and plant commissioning, this achievement confirms the marketability of the Woodlawn products."

## Magnetite Produces Scoping Study for Razorback

Magnetite Mines has reported positive results from a scoping study of its Razorback magnetite iron ore project 240 kilometers (km) northeast of Adelaide, South Australia. The study identifies development of an initial small-scale operation producing high-grade concentrate from a low-capital investment as the preferred option, retaining potential for future expansion. The company did not disclose production targets.

Low-angle, outcropping mineralization would support open-cut mining at low stripping ratios, with limited pre-strip. Established transport-related infrastructure would deliver the project's iron ore concentrate to market.

A desktop study confirmed the applicability of NextOre's magnetic resonance ore sorting system to the Razorback mineralization. The processing flowsheet includes primary and secondary crushing, grinding by high-pressure grinding rolls, air separation, rougher magnetic separation, ball milling, low-intensity magnetic separation, and hydro separation to produce the final concentrate.

Magnetite is now seeking funding to progress the project to a prefeasibility study.

Magnetite Chairman Peter Schubert commented, "The board aspires to deliver

a high-grade concentrate into the market based on a small-scale startup. We believe this will allow the company to find investors to support our vision.

"The scoping study has confirmed the Board's view that the Razorback iron project is uniquely placed within the global high-grade iron market, as the infrastructure required to develop the project is largely in place and the project is amenable to staging. Therefore, unlike most pre-development and current Australian magnetite projects, the project does not require large-scale capital investment and is not reliant on third parties for new infrastructure to develop a potentially economically viable project.

"By using existing rail and port infrastructure and starting at a small scale, we can avoid the need for high up-front capital and associated long lead times that are typical for many iron ore startups. Together with the availability of grid power and water sources in close proximity to the mine site, the project is ideally situated to exploit these advantages."

The project's JORC-compliant mineral resource totals 3.9 billion mt in two large magnetite deposits, Razorback and Ironback Hill. The company anticipates that the project will produce premium concentrates of +68% iron, with very low deleterious elements.

While Magnetite is encouraged by the results of the scoping study in general and the results of the small-scale startup scenario in particular, it sees considerable scope for potentially much larger operations.

Magnetite's current planning indicates that the Razorback project can be operational within five years of the commencement of the pre-feasibility study.

## Barrick Gold Sells KCGM Interest to Saracen

Barrick Gold reached an agreement to sell its 50% interest in Kalgoorlie Consolidated Gold Mines (KCGM) in Western Australia to Saracen Mineral Holdings Ltd. for a total consideration of \$750 million in cash. KCGM Operations include the Fimiston Open Pit (the Super Pit), Mount Charlotte Underground Mine and the Fimiston and Gidji processing plants, located adjacent to the city of Kalgoorlie-Boulder, approximately 600 km east of Perth, Western Australia.

"The sale of our non-operating interest in KCGM represents the first step in our plan to realize in excess of \$1.5 billion from the disposal of non-core assets by the end of next year," Barrick President and CEO Mark Bristow said. "While this iconic gold mine has been a valuable contributor to Barrick over the years, the asset does not fit with our strategy of operating mines that we own. The sale allows us to further focus our portfolio on core operations."

KCGM produces around 700,000 ounces per year (oz/y) of gold and has a gold reserve of nearly 7 million oz. Newmont Goldcorp owns the other half of KCGM. The transaction is expected to be completed in the fourth quarter of 2019 and is subject to customary closing conditions.

Saracen produces 400,000 oz/y from two mines, Carouse and Thunder Box, in the Kalgoorlie region of Western Australia.



The Super Pit (above) and other KCGM assets will add 700,000 oz/y of gold production to Saracen. (Photo: KCGM)

# SMB-Winning Wins Bid for Simandou Blocks 1, 2



Aerial view of the Simandou project site. (Photo: Google)

The winning bid to develop the Simandou iron ore blocks 1 and 2 in Guinea was awarded to consortium SMB-Winning. SMB-Winning was one of two companies, which included Australia's Fortescue Metals Group, to submit a bid when the bidding process opened on July 13. SMB-Winning offered \$15 billion for the iron ore blocks.

Under special terms and conditions, the SMB-Winning consortium will export its ore through the Guinean territory and construct a railway line of more than 650 kilometers and a deep-water port at Matakong, according to SMB-Winning.

SMB is a consortium formed by the Singaporean shipowner Winning Shipping, the Chinese aluminum producer Shandong Weiqiao, the Yantai Port group as well as the Guinean transport and logistics company United Mining Supply (UMS). It has become the leading exporter of bauxite from Guinea, with 42 million mt produced in 2018. The SMB employs 9,000 people in the Boké region.

Blocks 1 and 2 became available after billionaire Beny Steinmetz's BSG Resources (BSGR) said it would walk away from the Simandou project, but retain the right to mine the smaller Zogota deposit.

The Simandou Project is an iron ore exploration and mining project located to-

ward the southern end of the 110-kilometer-long Simandou mountain range, 550 kilometers southeast of Guinea's capital city Conakry. It is one of the largest undeveloped high-grade iron ore deposits in the world, it is to be a conventional open-pit mine with an expected capacity of 100 million metric tons of iron ore per year.

Simfer S.A. is the holder of the Simandou mining blocks 3 and 4. Simfer is a joint-venture ultimately owned by the government of Guinea, 15%, Rio Tinto, 45.05%, and a consortium of Chinese State-owned enterprises led by Chinalco, 39.5%.

## Attack Near SEMAFO's Boungou Mine Leaves 37 dead, 60 Injured

A convoy transporting employees, contractors and suppliers between Fada and SEMAFO Inc.'s Boungou mine in Burkina Faso was attacked on Wednesday, November 6, leaving 37 dead and 60 wounded, according to the company. Five buses, escorted by military personnel, were ambushed about 40 kilometers from the mine.

President and CEO of SEMAFO Benoit Desormeaux said, "We are devastated by this unprecedented attack. Our sincerest sympathies go out to the families and colleagues of the victims. Our priority is their safety, security and well-being."

He added that it will take the company some time to properly handle the incident and will support all those affected.

The Canadian-owned company said the Boungou mine site is secured, but operations have been suspended.

"We continue to actively work with all levels of authorities to ensure the ongoing safety, security and well-being of our employees, contractors and suppliers," the company said.

This is not the first incident near the mine site. Back in August, there were two armed attacks. On August 17, a bus was shot at by armed bandits, leaving one employee and one subcontractor dead. Another incident occurred on August 15 that left five gendarmes and one subcontractor dead.

Since those two fatal incidents, the company said it was updating its security measures. It added a ground military force, transported employees via helicopter to the mine and reinforced escorts of employees to and from the mine.

## Resolute's Syama Sulphide Circuit Will Be Operational in 6 Weeks

The sulphide roaster at the Resolute Mining's Syama gold mine in Mali (Syama), a key component of the sulphide processing circuit, is expected to be repaired and fully operational in approximately six weeks. The roaster was taken offline in early October due to the detection of a crack in the main external shell.

A detailed inspection of the main roaster chamber and structural assessment of the structural shell and related infrastructure has now been completed by Resolute's technical team assisted by Outotec, the original designer of the Syama roaster. Outotec is a globally leading global developer and supplier of mineral processing solutions. The assessment has resulted in a detailed design methodology that identifies the scope and extent of the required repairs. An integrated project schedule has been developed which includes all aspects of the required repairs including design, engineering, manning,



The roaster at the Syama perrocessing plant (above) was taken offline in early October due to the detection of a crack in the main external shell. (Photo: Resolute)

procurement, planning, and execution. The repair program is under way at Syama. The roaster is expected to be fully operational in early to mid-December.

The repair will require the construction of a platform to access the area and the removal of a limited amount of internal refractory insulation material. The schedule allows for the replacement of this material once external repairs have been completed and for independent QA/QC sign-off prior to a re-heating period and a return to full roaster service.

While the roaster repairs are continuing, Resolute is conducting a full structural and operational assessment of the roaster and all associated infrastructure and production handling systems. All planned maintenance work will be advanced where possible. This work will inform the existing plans for the normal biennial roaster shutdown scheduled during 2020 and is expected to enable a reduction to the planned number of days that the roaster will be offline for maintenance next year.

Mining activity at the new Syama underground mine is continuing during the roaster repair period. The ramp-up of mining is progressing well with production ore now being trucked to the surface using the company's fully automated haulage fleet. This is a key commissioning milestone in the development of the world's most advanced underground gold mine.

During the roaster repair period, mining activity will allow for the accumulation of ore stockpiles on the run-of-mine (ROM) pad with the expectation that up to 300,000 tons of ore will be readily available by the time the roaster is fully operational in December. The availability of such a significant ROM pad ore stockpile, in addition to available concentrate stocks, will ensure maximum throughput operations are supported during the first quarter of 2020, according to the company.

Resolute estimates the total cost of the roaster repairs at US\$5 million. This amount is expected to be offset by operational cost savings from not operating the roaster during the repair period.

The more important impact of the roaster downtime is lost gold production from the sulphide circuit. The Company intends to offset the lost production from the sulphide circuit by processing oxide material through the Syama sulphide circuit carbon in leach (CIL) infrastructure.

This plan entails processing historical stockpiled transitional ore mined from the Beta satellite open pit through the sulphide circuit mill and crusher and then bypassing the concentrator and roaster to feed this material directly into the sulphide circuit float tails leach circuit. This will allow additional gold production from the Syama sulphide circuit during the period when the roaster is offline. This additional production is expected to be further augmented by above budget performance from the Syama oxide circuit, the Ravenswood Gold Mine in Queensland, and Resolute's new Mako Gold Mine in Senegal.

### Iamgold Outlines 12-year Mine Life for Essakane

Iamgold has reported results from a feasibility study that supports a modest increase in throughput at the carbon-in-leach (CIL) processing plant at its Essakane open-pit gold mine in north-east Burkina Faso. When CIL processing comes to an end in 2026, operations will continue through 2031 based on heap leach processing of lower-grade ore. Plant optimization work to increase CIL throughput from 10.8 million metric tons per year (mt/y) to 11.7 million mt/y would require capital investment of just \$9 million.

Commissioning of the expansion is planned for the third quarter of 2020. Following the expansion, gold production

through 2026 would average 433,000 ounces per year (oz/y), with a peak year of 530,000 oz/y.

Diluted grade of feed material to the CIL plant would average 1.24 grams/mt gold. Lower-grade material would be stockpiled and held for heap leach processing.

Heap leaching would begin following the end of CIL process plant operations. Use of the existing primary gyratory and secondary cone crushing circuits during heap leaching would reduce the capital intensity of the heap leach scenario, which has an optimized annual throughput rate of 8.5 million mt/y. Annual gold production from heap leaching is forecast at 73,000 oz/y. The average processed grade for heap leaching is forecast at 0.40 g/mt.

Capital expenditures to develop the heap leaching operation are estimated at \$115 million. The development scenario envisages installation of tertiary crushing using a high-pressure grinding role unit, material handling conveyors, and a carbon-in-column adsorption plant. Loaded carbon would be transported to the existing plant facilities for stripping and refining.

Additional major infrastructure would include the leach pads, solution distribution and collection systems, and solution ponds. Existing camp capacity and power generation exceed the capacity that will be required during heap leach operations, and thus a reduction in manpower and general and administration costs will be realized during heap leach operations vs. current CIL operations.

The Essakane property currently hosts 4.876 million oz of gold in indicated resources at a grade of 0.98 g/mt gold. Proven and probable reserves stand at 3.985 million oz grading 0.96 g/mt gold.

Life-of-mine direct cash costs of production are estimated at \$778/oz, and all-in sustaining costs are estimated at \$949/oz.

As construction of the heap leach facility is not required until 2025, Iamgold retains the option of re-evaluating the economics of that construction project at that point in time. Given that the CIL process generates higher recovery and would not require additional capital investment, there may be a case where the existing stockpiled ore planned for the heap leach process might generate superior economics by processing through the existing CIL circuit, especially in scenarios with higher gold prices than have been used for the current feasibility study.



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We understand that people are mining's most valuable resource and no amount of production or deadline is worth risking a worker's safety. We are proud of our commitment to driving the industry towards zero harm.

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# Osisko Building Lead-Zinc Resources at Pine Point

Osisko Metals has updated the mineral resource estimate for its 100% owned Pine Point project near the town of Hay River in Canada's Northwest Territories. The estimate now totals 52.4 million metric tons (mt) grading 4.64% zinc and 1.83% lead (6.47% zinc equivalent), containing approximately 5.3 billion pounds (lb) of zinc and 2.1 billion lb of lead in-situ.

Compared to Osisko's December 2018 mineral resource estimate, the tonnage of the new estimate increased by 36%, with a minor 0.11% drop in the zinc equivalent grade. The tonnage increase is attributable to the company's 2018-2019 drilling campaign, historical resources on newly acquired claims, and the inclusion of newly modeled underground resources.

Osisko Metals President and CEO Jeff Hussey said, "Following our maiden mineral resource in December 2018, we are very pleased to again demonstrate significant asset growth at Pine Point. Global

zinc and lead projects with all supportive infrastructure and more than 50 million mt in near-surface resources are extremely rare, and we are delighted that Pine Point now enters this select group.

"There is a depleted pipeline of quality zinc development projects globally, and we believe Pine Point will place Osisko Metals at the forefront of junior base-metal exploration and development companies.

"Having achieved our objective of increasing the resource base to the 50-million-mt threshold, we now believe that the project could develop into a mine large enough to enter the top 10 global zinc mines on an annual zinc-in-concentrate basis. We would also emphasize that exploration at Pine Point has been minimal in the last 30 years. We believe there is more to come for the project."

Osisko plans to continue its Pine Point exploration campaign into the first half of 2020 and will be testing high-potential

target areas, with a focus on high-grade "prismatic" type deposits. Compilation work is ongoing and is being combined with an airborne gravity gradiometry survey completed in August 2019 and Lidar topographic surveys flown in 2018.

The Pine Point project continues to benefit from supportive infrastructure that includes paved roads, rail access in Hay River and hydro electrical power. The site also benefits from 100 km of pre-existing haul roads from earlier mining operations, providing access to all major deposit areas. (*osiskometals.com*)

## Exploration Briefs

**Amex Exploration** has announced results from the first 27,500 meters (m) of its planned 100,000-m 2019-2020 exploration drill program on its Perron gold property in Quebec. Within the project's High Grade Zone, 26 drill holes have intersected gold mineralization greater than 10

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grams/mt over variable widths. Other high-grade results are reported from the project's Denise, Gratien and Grey Cat zones.

During 2020, up to three drills will focus on continued definition and expansion of the known mineralized gold zones, all of which are open along strike and at depth. Regional drilling will focus on targets that have seen very limited or no drilling. These targets share similarities with the known Perron gold zones, including proximity of second-order thrust faults; intersections of thrust faults and third-order structures within the Beaupre rhyolite block; high-magnetic lineaments; and the presence of ultra-mafic-to-mafic intrusions.

The regional targets are located along the 7-kilometer (km)-long southern Perron thrust fault and the 8.4-km-long northern Normetal thrust fault, which both bound the unconformable gold-bearing Beaupre rhyolite block.

([www.amexploration.com](http://www.amexploration.com))

**Mincor Resources** has reported a further substantial increase in estimated mineral resources at its Cassini nickel sulphide deposit at Kambalda, Western Australia.

Based on a short diamond-drilling program completed between August and early November, the deposit's mineral resource has increased by 33% to 50,400 mt of contained nickel.

Updated Cassini indicated and inferred mineral resources now stand at 1.254 million mt grading 4% nickel. Importantly, the addition of 269,000 mt of ore was delivered at a grade of 4.7% nickel, increasing the average grade of the resources from 3.8% to 4% nickel and confirming Cassini as one of the largest and highest-grade nickel deposits in the Kambalda district.

More than 86% of the expanded mineral resources are now classified as indicated and are available for conversion to ore reserves.

Mincor Managing Director David Southam said, "From a maiden mineral resource of 18,700 mt of nickel in August 2018, Cassini has grown quickly into a substantial asset for our shareholders, one of the cornerstone deposits of our plan to restart nickel production at Kambalda, and the most significant greenfields discovery seen in the district in over two decades."

([www.mincor.com.au](http://www.mincor.com.au))


**Polymetal** has increased ore reserves at its Kyzyl gold operations in northeast Kazakhstan by 18% to 41.7 million mt containing 8.5 million oz of gold at an average grade of 6.3 g/mt. Open-pit reserves of contained gold have increased by 37% to 4.2 million oz at an average grade of 5.7 g/mt since December 2018, while underground reserves are up 4% to 4.3 million oz at an average grade of 7.1 g/mt.

With increased reserves, mine life at Kyzyl has been extended by eight years to 2047.

Kyzyl is located in a traditional mining region with good infrastructure and easy access to grid power and rail transportation. Operations include the Bakyrchik refractory gold deposit and a state-of-the-art, 2-million-mt/y flotation processing plant.

Low-carbon concentrate is sent for processing to Polymetal's pressure oxidation (POX) facility in Amursk, Russia, while high-carbon concentrate currently goes to third-party off-takers. With the launch of POX-2 at Amursk in 2023, Polymetal intends to process 100% of Kyzyl concentrate in-house.

([www.polymetalinternational.com](http://www.polymetalinternational.com))



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# NTEC Expects to Secure Bonding for Wyoming Operations



The Spring Creek mine acquisition casts a spotlight on the Navajo Nation. (Photo: NTEC)

The Navajo Transitional Energy Co. (NTEC) said it continues to maintain the operations it purchased from Cloud Peak Energy (CPE) and expects to secure all necessary bonds to continue operations without any delays.

The announcement comes on the heels of Navajo Nation president's decision to terminate its indemnity agreements with the sureties. The indemnity agreement was between the Navajo Nation and the sureties and it allowed for NTEC's takeover and successful operation of Navajo mine and Four Corners power plant.

The company said during its assessment of acquiring the CPE mines, it realized the possibility that the Navajo Nation would not financially back the NTEC with indemnity agreements. NTEC has been actively working with a broker to secure bonding to assure proper reclamation is performed at all the mines without a Navajo Nation guarantee.

This action would resolve the concerns expressed by some members of the Navajo Nation, but will come at a

greater cost to NTEC, and thus, the Navajo Nation, according to NTEC. NTEC will ensure that proper bonding remains in place at all the mines at all times.

## Australian Pacific Coal to Appeal for Dartbrook Coal Mine

Australia Pacific Coal Ltd. said it will appeal a state regulator's decision to not extend the life of an idled coal mine, as reported by *Reuters*. Australian Pacific, in its appeal, hopes to have the decision amended to extend the life the mining operation to a reasonable time frame that would provide a rate of return to justify necessary capital costs which will be incurred.

The New South Wales Independent Planning Commission in August approved the restart of underground operations at the Dartbrook coal mine in the state, but rejected a five-year extension beyond the current permit that ends December 5, 2022. The commission said it was not in the public interest to extend the mine's life, and its decision

highlighted the increased scrutiny authorities are showing toward coal mine approvals.

## BHP's Colombian Coal Changes Focus to Asia

Colombia's El Cerrejón owned by BHP, Glencore and Anglo American will switch focus from Europe to Asia, in a move that would put it head to head with Australian coal exporters. El Cerrejón President Guillermo Fonseca urged the Colombian government to consider cutting its tax take to make Cerrejón more competitive against Australian miners, who enjoy a shorter and cheaper route to Asia.

"Europe (demand for coal) is declining and declining much faster than we expected, Asia is still growing and definitely that is where the market is going to be for the medium to long term," he told *The Australian Financial Review*. "We are in conversations with the Colombian government around what we can do in order to capture the opportunities in the Asian market. In the short term, it probably has to do with the government take. It would be in the interest of the government that production of coal in Colombia does not fall."

He suggested a different tax and royalty program for production going to the Pacific.

He said he believed Asian markets were likely to still be consuming coal in 2050.

"I believe the transition to renewables and cleaner fuels is going to take a while," he said. "We still have a long way to go."

El Cerrejón has had a tough couple of years, with sliding demand from Europe coinciding with court rulings in Colombia that blocked the company from mining what would have been the natural extension of its coal resource.

Fonseca said those rulings and "judicial activism" combined with the structural change in coal demand had forced El Cerrejón to reduce its export guidance for the next five years.



## Arch's Mountain Laurel Mine Discontinues Longwall Operations, Accelerates Transition to Room-and-Pillar

Arch Coal has discontinued longwall operations at its Mountain Laurel mine in Logan County, West Virginia, three months earlier than planned. The move is expected to reduce Arch's fourth-quarter coking coal volumes by between 150,000 tons and 200,000 tons and its fourth-quarter operating results by approximately \$20 million versus previous expectations.

Mountain Laurel encountered challenging geologic conditions in its final longwall panel, the company said. Once removed from the mine, the longwall system will be refurbished and relocated to the Leer South mine, which is expected to commence longwall production in the third quarter of 2021. This accelerates Mountain Laurel's planned transition to a room-and-pillar operation.

Mountain Laurel currently has three of five continuous miners operating efficiently in the new configuration, and now expects to complete its transition to a room-and-pillar mine early in the first quarter of 2020. Arch said no changes in the mine's workforce are anticipated.

"We believe Mountain Laurel has a bright and profitable future as a continuous miner operation," President and COO Paul A. Lang said. "As we have stated in the past, Mountain Laurel has a world-class workforce; extensive, low-cost reserves; and some of the most advanced coal-preparation, coal-handling and coal-blending facilities in the United States.

"In effect, we are launching a brand-new mine at Mountain Laurel — one that should benefit from a lower cost structure, better product quality and a more consistent operating performance — for a very modest capital investment."

With the completion of the transition, Mountain Laurel's cost structure should decline by around \$10 per ton when compared to its average cash cost in the first nine months of 2019. As indicated, the more flexible mining configuration and enhanced coal-blending capabilities should also lead to a significant improvement in the mine's future product quality, the company said.

"We believe that this accelerated transition sets the stage for a stronger operational start and lower per-ton costs for Arch's core coking coal segment in 2020," Lang said. "Over the longer term, we expect the new mining configuration — combined with the progression of the Leer mine into thicker coal and the ultimate startup of Leer South — to drive incremental improvements in the average mining cost, product quality and profit margin of our already high-performing coking coal portfolio."

## JSW Uses Modern Tech to Model Coal Deposits

All the coal deposits of Poland's Jastrzębska Spółka Węglowa (JSW) have been mapped and stored in virtual 3D space. The company recently completed the project aimed at implementing a modern deposit management and production planning system.

Within the framework of the project, a system has been implemented based on two global IT solutions, which made the deposit management and design process much more advanced. The techniques were based on similar systems in Australia and the United States. In Poland, LW Bogdanka and KGHM mines planned their production based on 3D deposit models. Now they are joined by JSW.

The 3D model of deposits provides a graphic visualization of its geological structure and any anomalies. It was created through joint efforts of the JSW surveying and geology departments and the production preparation departments, as well as the preparation and review of data.

As a result of the project, a central geological database was created for JSW mines, fed with data from 250 surface holes, 1,440 underground holes, 14,670 roadway profiling exercises, more than 24,000 quality samples, 100 main faults and more than 150 faults.

The work on the project produced spatial structural and quality models of deposits in JSW's mines and strategic production schedules. The company has set a schedule for executing 700 km of planned roadway excavations and 480 longwalls, including 50 types of roadway roof supports and 25 algorithms for calculating production limitations.

Additionally, the visualization and the modern 3D model of the deposits allow for a better understanding of variations in extraction and geological conditions in mines, while the scheduling software supports an even better optimization of production at JSW, among others by offering development of various production scenarios for the mines.



Polish coal producer JSW recently completes a major geological model. (Photo: Dawid Lach)

*(Regional News-Europe - from p. 17)*

provinces of Seville and Huelva in what is known as the Iberian Pyrite Belt.

The area is attempting a resurgence following the worst environmental disaster in Spain in 1998 when a large tailings dam from the Los Frailes mine ruptured sending 5 million cubic meters of sludge into the Agrio and Guadimar rivers. Cleanup took three years and the government granted the concession to mine again at Aznalcollar in 2015.

Andalusia leads Spain in metals production, with more than 90%, according to the Secretary General of the Energy Industry for the government of Andalusia Natalia Gonzalez Hereza. The industry contributes to 40% of the GDP for the area, which was only 25% in 2017, she said. "It's a spectacular growth," she added.

But there is more to do, she said. The government must focus on simplification, by removing the layers that have been added to the Mining Law of 1976 over the years. "We have made this law complicated," she said.

She added that the public and private sectors must work together and build partnerships. That "is key for the framework."

Visitors to the conference could attend numerous technical sessions and conferences with more than 70 speakers. Some of those sessions included policies and investments in the Andalusia region, specifically. Elvira Saint-Gerons Herrera, director of strategic investments for the Agency of Innovation

and Development of Andalusia, said there are numerous advantages to mining in the region, besides being on the Iberian Pyrite Belt. She highlighted its geographical location, infrastructure, such as the Port of Huelva, quality of life and quality of people.

Apart from the scientific program, MMH was also the backdrop for 120 business meetings between Andalusian companies and nine representatives from companies in four other countries. They presented their products and services as part of a trade mission organized by the Regional Department of Presidency, Public Administration and Home Affairs through Extenda, Andalusian Agency for Foreign Trade Promotion.

The MMH ended with a panel featuring the regional government's ministers of Finance, Industry and Energy, and Knowledge, Enterprise and University, Juan Bravo and Rogelio Velasco, respectively; the president of OMEL, the Spanish electricity market, Carmen Becerril; and the president of CEA (Andalusia's Business Confederation), Javier González de Lara.

The MMH commissioner pointed out the effort and hard work of both the Seville Conference and Exhibition Centre (FIBES) and the Association of Research, Extraction, Mining-Metallurgic Transformation and Service Companies (Aminer), in organizing the third hall, which he said broke its records both for visitors and attendants, with more than 900, almost three times the number of the previous edition.

Targhetta said Seville can become "the great international capital city of mining," and a reference for future meetings of Mining and Minerals Hall.

An awards ceremony was also held at the event to pay tribute to professionals with extensive careers in the mining sector. It honored Dolores Norte, Alberto Lavandeira and Juan José Cerezuela.

Norte became the first woman mining engineer in Spain back in 1974. She has developed a long professional as well as academic career since then. She has held numerous management positions at Técnicas Reunidas S.A. She has also been secretary of the governing board of the Colegio de Ingenieros de Minas del Centro (Mining Engineering Association of Central Spain) and a member of the Quality Committee of the Instituto de la Ingeniería de España (Spanish Engineering Institute).

Lavandeira, CEO of Atalaya Mining since 2014, boasts more than 38 years of experience in the sector at national and international level. After graduating at Oviedo Mining School, he worked in the Spanish subsidiaries of Rio Tinto Plc., Anglo American and Cominco. Later, he managed Rio Narcea Gold Mines, Aguablanca (nickel) and El Valle-Boinás (gold). He then led the Mutanda Mine (copper and cobalt) in the Democratic Republic of the Congo with Sanref Overseas S.A.

José Cerezuela is a mining engineer. Among the many responsibilities he has held throughout his career, was as director general of mining in 1986, president of FIPAE, SUSCHEM in 2009 and president of CONFENDEM.

## NEWS - CALENDAR OF EVENTS

**JANUARY 26-29, 2020: International Society of Explosives Engineers, Denver, Colorado.** Contact: Web: [www.isee.org](http://www.isee.org).

**FEBRUARY 3-6, 2020: Mining Indaba, Cape Town, South Africa.** Contact: Web: <https://miningindaba.com>.

**FEBRUARY 23-26, 2020: The annual Society for Mining, Metallurgy and Exploration (SME) conference and exhibition, Phoenix, Arizona.** Contact: Web: [www.smenet.org](http://www.smenet.org).

**MARCH 1-3, 2020: The Prospectors & Developers Association of Canada's annual meeting, Toronto Convention Center, Toronto, Canada.** Contact: Web: [www.pdac.ca](http://www.pdac.ca).

**APRIL 20-24, 2020: Expomin, Santiago, Chile.** Contact: Web: [www.expomin.cl](http://www.expomin.cl).

**APRIL 21-23, 2020: MiningWorld Russia, Moscow, Russia.** Contact: Web: [www.miningworld-events.com](http://www.miningworld-events.com).

**MAY 3-6, 2020: Canadian Institute of Mining (CIM), Vancouver, Canada.** Contact: Web: <https://convention.cim.org/2020>.

**JUNE 1-5, 2020: Elko Mining, Elko, Nevada, USA.** Contact: Web: [www.elkocva.com](http://www.elkocva.com).

**JUNE 2-5, 2020: UGOL & Russia, Novokuznetsk, Russia.** Contact: Web: [www.ugol-rossii.com](http://www.ugol-rossii.com).

**JUNE 9-11, 2020: Euro Mine Expo, Skellefteå, Sweden.** Contact: Web: [www.euromineexpo.com](http://www.euromineexpo.com).

**SEPTEMBER 7-11, 2020: Electra Mining, Johannesburg, South Africa.** Contact: Web: [www.electramining.co.za](http://www.electramining.co.za).

**SEPTEMBER 28-30, 2020: MINExpo INTERNATIONAL, Las Vegas, Nevada.** Contact: Web: [www.minexpo.com](http://www.minexpo.com).



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## Mobile Heap Leach Conveying Solutions From Superior



Heap leach mining operations continually seek greater capacity, continuous material flow and reduced downtime. In any precious metal application these challenges are ongoing top-of-the-mind initiatives, particularly due to the complexity of stacking plans. Material handling equipment must be highly mobile and extremely flexible. And, for optimum performance, more and more operations are utilizing integrated conveyor systems, which can be custom-engineered for the specific pad design.

At the core of Superior's system is their Mine Duty TeleStacker® Conveyor, which is engineered with an internal stinger conveyor that maintains constant motion along a cell, distributing material evenly to achieve a flat top to each heaped pile, while also piling more material per move.

"Its stinger conveyor, longer than those supplied with conventional radial telescoping units, allows for greater flexibility in complex valley fill applications," said Matt Hanson, a mining project manager with the manufacturer. The TeleStacker Conveyor is equipped with the FD Series axle assembly, a technology that allows a quick transition from radial to linear mode, enabling movement along the leach pad cell centerline. Also, the unit features the patented FB® Undercarriage support system, which is constructed of durable steel and a tubular braced structure that prevents any twisting

and shifting. "This level of stability is required for the uneven ground and the constant movement typically seen in the heap leach environment," he said.

Regarding additional mobility options, Hanson said operations may utilize radial travel tracks and/or a track-mounted mobile pivot base in conjunction with the telescoping conveyor. "Radial travel tracks are a cost-effective method to gaining optimum flotation and traction. When combined with the mobile pivot base, operations can achieve free-ranging onsite and transfer point mobility as well as radial travel capability," he said.

Integrated with the telescoping radial stacker is a horizontal index conveyor (HIC), a fully skirted unit with a frame that mounts to the stacker. "For greater heap leach site mobility, the track drive on the unit is designed to move itself and the radial stacker along the cell centerline—and for maximum flexibility, the HIC can be fed at any point along the length of the conveyor," said Hanson. He added that when combined with portable jump or grasshopper conveyors, the HIC minimizes the frequent removal or adjustments of the jump conveyors along the material transfer line.

Hanson explained that a horizontal feed conveyor runs perpendicular to both the HIC and the grasshopper conveyors. "It transfers material from the grasshop-

per conveyor to the HIC to maintain a consistent, steady material flow," he said.

Multiple grasshopper conveyors comprise a substantial length and are combined consecutively to transfer material to the stacking conveyors. Hanson said retreat stacking will move in increments of the grasshopper conveyor length by removing one at a time, while advance stacking requires the insertion of a jump conveyor upon moving forward.

While a total systems approach to heap leach conveying may seem an unwieldy proposition to some operations, Hanson stressed that adaptability is made easier when the systems provider also takes a total approach to the design/build factor. "Today it's common for manufacturers to subcontract to others for both large and small components. At Superior, we manufacture all our components and conveyors, and engineer our systems as a whole to ensure such things as smooth material movement at all transfer points, as well as the necessary electrical integrity required for the integration of multiple conveyors, for example. Our approach also allows greater control over lead times and delivery," Hanson said.





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# Optimizing Autonomous Haulage

*To get the most from an autonomous haul fleet, mines need to carefully consider every aspect of system implementation and prepare their workforce for significant change. E&MJ looks at some critical areas, and how one miner is getting great results.*

By Carly Leonida, European Editor



A hydraulic excavator loads an autonomous hauler at Suncor's Steepbank oil sands mine in northern Alberta, Canada. (Photo: Suncor)

The more autonomous haulage systems (AHS) are implemented and run, the more the industry learns about their limitations and ability to interact with the mine environment.

That was certainly the case earlier this year when, in March, two autonomous trucks collided at BHP's Jumblebar iron-ore operation in Western Australia. The incident was blamed on excessive rainfall, which caused the trucks to lose traction and, luckily, there were no casualties.

The collision was reported just a month after one at Fortescue Metals Group's (FMG) Christmas Creek mine in the Pilbara. In that case, a truck backed into another unit that was standing stationary thanks to an outage in the mine's Wi-Fi system.

In both cases, external factors were determined to be the cause rather than a failure in the autonomous system. While this was good news for other system users and, no doubt, a relief for the technology vendors, there are still two important lessons that can be taken away from these events.

First, that even the largest and most experienced fleets fitted with some of the best safety technology can still experience issues. FMG has been running

an autonomous fleet at its Solomon Hub since 2012. The company had around 137 autonomous trucks in the Pilbara at last count and is expanding this to 175 by mid-2020 making it the owner of one of the world's largest autonomous truck fleets alongside Rio Tinto.

As of September, the FMG fleet has hauled more than 1 billion metric tons (mt) and has delivered a 30% productivity improvement for its owner. However, this success does not make it invincible.

It is inevitable that, as the uptake of AHSs increases and the demands placed upon them escalate, incidents will occur. So, it's important that when they do, mine engineers learn all they can and use that information to prevent them from happening again.

Second is the understanding that the success of an AHS is based on much more than just the quality and capability of the technologies selected. There are thousands of factors that must be considered and allowed for when implementing a fleet, from the network that underpins mine communications to some, such as the weather, which are very much out of the mine operator's control.

Operators and their business partners must be prepared for a continuous journey of learning, adjustment and improvement.

## Considering Autonomous Haulage

Incidents such as those mentioned previously shouldn't deter or discourage operators from considering autonomous haulage. The knowledge of AHSs and experience with them is constantly building and, if the lessons garnered are properly applied, then with each failure, the potential success of future projects improves.

The technologies used are also advancing quickly, and as systems become more refined and accessible, and the benefits more tangible, more mines are evaluating their use.

This is evident in the plethora of orders placed this year for both new autonomous trucks and retrofits; Rio Tinto purchased 20 autonomous 40-ton trucks for Koodaideri in May, and Ukrainian iron-ore producer, Ferrexpo, said in November it was converting 15 of its haul trucks to autonomous operation.

So where should operators looking to join these ranks begin?

Aidan Ayres, senior mining consultant at AMC Consultants, explained some key considerations in a recent paper.<sup>1</sup>

<sup>1</sup> *Considerations When Implementing Autonomous Haulage in Open-cut Mining*, 2019. Aidan Ayres, senior mining consultant, AMC Consultants.

“It is now more commonplace for new mines, and those with sufficient remaining mine life to consider running an AHS,” he said. “While their use has been accredited with improvements in safety, reductions in wear and increased utilization, there are AHS specific requirements, which need to be considered in order to properly quantify any potential benefit an AHS fleet could deliver to an operation.”

Ayres outlined three basic pieces of information that AHS trucks require to operate safely: their current location; route to their destination; and the location of other equipment.

“To provide this information and have a control and communication network, Wi-Fi or long-term evolution (LTE) coverage must be established throughout the truck’s operating environment. This network allows the trucks to be controlled from great distances. For example, there are operations in Australia that have control centers in major city’s servicing remote mines, thousands of kilometers away,” he said.

“In order to provide the first piece of information, the trucks need to be fitted with global positioning system (GPS) beacons. This is in addition to several other components like LiDAR, radar, vehicle controllers and Wi-Fi. Although there are concepts around AHS-dedicated trucks, current operating models are based on traditional manned machines, which have been in service for many years. Therefore, in addition to the standard cost of each manned machine, they also need to be retrofitted to effectively ‘convert’ them to AHS trucks.”

Ayres said the importance of accurate surveying is highlighted by the need to provide the second piece of information: the route to the truck’s destination. Routes and boundaries are usually updated on a daily basis and then sent out to trucks via the site’s Wi-Fi network.

“Accurate surveying accounts for the rapid rate at which the layout of a mining operation changes,” he said. “Take, for example, a truck which on Monday is driving on a large stockpile and then dumping ore to build it northward. In order for it to dump at that stockpile, a boundary had to be established by survey and then communicated to the truck. On Tuesday, the stockpile is closed as a dumping location and is reclaimed southwards, past the point of the previous tip head. On Wednesday, the stockpile is

re-opened as a dumping location. If the new tip head position is not re-surveyed, a truck could potentially drive straight off the stockpile because as far as it is aware, the tip head is still in the same position it was on Monday. This example demonstrates the need for high quality, frequently updated survey data to establish a safe working environment.”

The location of other equipment is also required. This is provided by retrofitting both heavy and light vehicles in the AHS operating area with GPS, network capability and emergency stops, which can pause the movement of the AHS fleet.

Ayres explained how important it is that these systems are reliable in order to establish a safe and efficient operating environment. Most AHS control systems will cease operations when other equipment comes into close proximity with a truck, so inaccurate location information could cause interference with haulage operations.

## The Devil is in the Detail

Mine design and planning also require careful attention. Ayres said that while improvements are always being made to the capabilities of AHS fleets, special attention is required when designing infrastructure like pits and stockpiles.

“In general, this refers to working space design factors such as maximum gradients, minimum turning circles, and minimum road widths,” he said. “If the working environment is not set up to allow for these requirements, there is a risk of unnecessarily triggering the autonomous trucks safety systems to stop the truck. These design factors are of particular importance when introducing AHS to an already producing

operation. Pit designs may need to be reviewed and modified, impacting stripping ratios and ultimately costs.”

This also applies to road design and maintenance. Because autonomous trucks operate continuously following the exact same haul route time after time, if a road is not in optimum condition it can quickly affect the life of truck tires and other components. Autonomous trucks will never deviate from their path to avoid ruts or potholes or adjust their speed to handle dips and depressions in a road. In fact, their operating speeds are usually faster than manned trucks and so poorly maintained roads can take their toll even faster.

Obstacles are another issue. “Poor road conditions, which result in incidents where rocks are dropped from trays can set off the emergency stop systems and interrupt production until someone is sent out to investigate and remove any obstruction,” Ayres explained. “Had this same obstacle been present in a manned vehicle, the operator may have been able to drive around the obstacle and simply call for a clean-up.”

*E&MJ* spoke to OTR Global principle, Tony Cutler, about autonomous haulage back in August. He explained that while haul road design and construction are critical for manned truck operations, they are even more so for autonomous fleets.

“The mining industry is not generally known for the quality of its roads and working areas,” he said. “Road base and surface integrity, width, crossfall, smoothness (undulation free) and the relationship among curve radius, super elevation and speed are fundamental to trouble-free autonomous haul truck operation.”



Trucks on the move at FMG’s Cloudbreak central hub. (Image: Fortescue Metals Group)



FMG's autonomous truck fleet moved its 1 billionth mt in September. (Image: Fortescue Metals Group)

Cutler also pointed out that most autonomous haulage operations thus far have been at mines specifically designed for autonomous haul trucks. However, going forward, the majority of new autonomous trucks will be retrofits to existing vehicles in mining operations set up for manned haulage, so special attention will need to be paid to road construction.

Mine planning also needs to account for variations in weather conditions and the impact these will have on an AHS.

“Understanding how localized conditions will affect the AHS trucks and to what degree is usually initiated once the AHS trucks are on site,” Ayres said. “There is usually an implementation period for the technology to be established

and understood and for staff to be trained. A common implementation method is to use a manned fleet in areas of the mine where ore is being sourced. This is usually kept separate to the AHS fleet in order to avoid delays in feeding the crusher and obtaining that important revenue stream.

“The AHS fleet will then be set up in a separate area of the mine where pre-stripping of waste is needed. This creates a pit-to-dump AHS only area, where all the fixed and mobile infrastructure required to run AHS trucks can be calibrated to the specific site. This will minimize the impact on the operation. It can also serve as a training facility, where staff can be introduced to and gain experience in the operation of an AHS fleet before it is rolled out, sitewide.”

Once the autonomous fleet has proven itself, it can then be integrated with manned equipment. Ayres explained that it is the job of the mine planner to account for these initial requirements for segregation and then to adjust the plan as unforeseen delays occur. Data gathered from the implementation period will also help to predict future performance and thus create more accurate mine development plans.

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## The Human Element

Staff training is another critical part of successful AHS implementation. Currently, there are no fully autonomous open-pit mine sites. This means that manned vehicles such as shovels, dozers, and light vehicles need to be able to move around the site safely and interact with the autonomous equipment where appropriate. It is important that operators also know the limitations of the AHS and what to do if a safety violation does occur.

To gain a better understanding of the training required for AHSs, *E&MJ* spoke to Ravitha Sukumaran, product manager at Immersive Technologies. The company is a leading provider of simulation-based training solutions for workforces at autonomous mining operations, and has equipped many sites with the skills and tools their teams require for both initial and continued learning.

“We have pioneered the use of blended learning systems, simulation and human performance analytics to address the implementation risks related to these projects,” Sukumaran told *E&MJ*. “Our simulator-based solutions include sup-



Autonomous haulers need to be fitted with GPS beacons in addition to several other components, such as LiDAR, radar, vehicle controllers, Wi-Fi, etc. (Photo: Suncor)

port for Komatsu’s Frontrunner AHS and the Cat Command for Hauling System.

“In addition, we have a suite of technology learning systems such as eLearning, machine inspection and a virtual ‘mission’ task trainer which blends content to ensure high levels of retained information.

“This approach addresses the majority of initial training requirements for autonomous operations and, importantly, is completed in an offline environment away from the safety and production risks of conducting training in field.”

Human performance impacts manned and autonomous operations in similar

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ways, with variability posing considerable risks to the safety, productivity and the reliability of heavy equipment fleets. Selecting the right personnel and having an effective skill development strategy is therefore important to ensuring the smooth integration of an AHS and in managing the adverse effects of human performance.

Sukumaran explained that realizing the full value from an automated system is often limited because of an underestimation of the human factor in reaching optimum system performance. This, combined with a new type of role criticality being introduced into the operation, can mean the risks are far more significant than in a non-autonomous operation.

"Autonomous haulage operations require different skills and different ways of working compared to manned operations," she said. "With increased complexity compared to traditional operator roles, using an effective and efficient training pathway is important in training many personnel effectively in a short period of time.

"The difference is in the shift away from primary truck training and more toward dig unit and ancillary machines

where the way those machines are operated have a far greater impact on the effectiveness of the autonomous operation. Due to these risks, we are seeing a more considered approach to workforce development where learning pathways from candidate screening right through to skills optimization are being deployed in autonomous operations globally."

Increasing the complexity and criticality of human roles within a haulage system means that it often takes longer to train operators for autonomous operations.

Sukumaran explained that personnel need to operate the equipment effectively but, as an additional requirement, they must also perform tasks to manage interactions with autonomous fleets, handling unexpected or ambiguous situations, all of which require elevated skill levels.

She added that the use of refresher training courses differs from site to site, and also varies depending on the number and nature of system updates an OEM makes.

"Most mine sites have their own regime and attitudes toward risk, depending where they are on their integration journey," she said. "From a behavioral

perspective and experience running hundreds of data-driven training interventions in the past, we find that retention rates tend to drop off after six months and the impacts of performance variability begin to creep back in, creating a need for a targeted training to address specific performance gaps."

She added that virtual and augmented reality training tools can offer significant benefits for autonomous operations.

"As the integration of automation into mining operations matures and workforce development needs are better understood, wearable technology including VR will find more useful applications," she said. "Being able to bring the reality of an autonomous operation to personnel in a safe and easily replicable way will have significant benefit to the projects in addressing performance gaps and managing performance variability."

## Suncor's Experience

Of course, nothing beats experience with autonomous technologies.

Anne Marie Toutant, vice president of mining solutions at Suncor Energy, spoke

## COMPANY PROFILE-PAID ADVERTISEMENT

### Paus - Robust underground

**Emsbüren, June 2019 - Always delivering the best solution for customers, no matter how demanding or individual the requirements may be, that is the core of "...the people who care". Founded by Hermann Paus in 1968 as a family business for special vehicles, Hermann Paus Maschinenfabrik is today under the management of Franz-Josef and Wolfgang Paus. In Emsland (Northern Germany), the company produces customized quality vehicle and machine solutions for elevator technology, construction machinery, industrial vehicles and especially for mining and tunnelling.**

Active dialogue is cultivated with industry experts and customers. This is the only way to achieve successful solutions for customers with professionalism, experience and innovative strength that meet the requirements of quality, environmental friendliness, compressive strength, safety and efficiency. Many national and international well-known customers and dealers belong to the customer base. In order to remain true to the claim "the people who care..." Paus works every day anew on fulfilling the most different customer requirements.

The mining industry requires machines and vehicles with their many extreme conditions to meet particularly high requirements in terms of reliability and safety. With the "Made in Germany" quality promise, Paus builds individual and tailor-made mining and tunnelling machines. With industrial production processes, on the one hand the production of the basic assemblies is ensured in consistently high quality, on the other hand, suitable vehicle solutions for customer-defined tasks can be supplied from these basic modules. **This means that consistent, high quality is already part of the production process.**

The Universa 40/50 series and the MinCa series are designed as vehicle platforms. The quick-change

system on Universa vehicles allows easy, safe configuration of various bodies on the base platform. Depending on the tasks required, whether concrete mixer, maintenance vehicle with workshop, scissor lift table or tyre changer, the Universa multi-purpose utility vehicles from Paus meet underground mining requirements **flexibly, efficiently and reliably.**

The MinCa 18A is also a multi-purpose utility vehicle offered by Paus with a range of different "superstructures". The range extends from configuration as a transporter for personnel or material, as a fire brigade emergency vehicle to ambulance equipment and combinations of superstructures. But that's not all, more options are available on request!

The smaller MinCa 5.1 is very well adapted to the narrow conditions not only for applications in narrow underground mining/tunnelling (e.g. Narrow Vein Mining). It can be configured for five miners as an equipment variant "passenger transporter" and still has room for the equipment. With its all-wheel drive it is perfect for use on difficult roads. The MinCa 5.1 offers more stability, has a small turning circle with various wheel steering systems and low maintenance safety with oil-immersed multi-disc brakes. An agile vehicle that is also available in a hybrid version.

Brand new: At Bauma 2019 PAUS presented, after intensive tests, the latest generation of the electrically driven MinCa 5.1 E with improved battery technology and proven NMC technology. In the factory-made delivery, the battery capacity amounts to 50 kWh and is sufficient for up to 8 hours. The battery pack finds its place in the rear. The capacity "under the hood" can optionally be extended with a further 50 kWh.

Explosion-protected vehicles, such as those used in coal mining, represent the top class when it comes

to the design requirements of underground mining vehicles. They must ensure reliable protection for the operator and are naturally part of the product portfolio of Hermann Paus Maschinenfabrik GmbH.

Some guidelines demand that the engine temperatures of explosion-protected vehicles must not exceed 150°C. Optionally, an extended cooling system is available, which, depending on the version, cools the exhaust gases to only 70°C. The cooling system can also be used as a cooling system. Additional flame arresters on the exhaust and air intake lines as well as encapsulated electrical components (display, battery, headlights, switches, etc.) also ensure greater safety. Paus integrates gas sensors into its vehicles to give a warning signal if defined gas concentrations are exceeded.

Furthermore, all Paus underground vehicles are explicitly designed and built for underground mining / tunnel work - they are not adapted road vehicles - advantage: considerably less maintenance than vehicles with conventional drives, longer durability and higher efficiency. **The Paus vehicle portfolio also includes LHD, dumper, scaler, grader and rock crusher solutions. Other special vehicles are available on request. All complemented by a worldwide, permanently professionally trained dealer and service network.**



Further information on the Paus product range can be found at [www.paus.de](http://www.paus.de).

about the company's experience of autonomous haulage<sup>2</sup> at Mining Media's Haulage & Loading event in Tucson in March 2019.

Suncor operates three mines in Canada's Athabasca oil sands: Millennium, North Steepbank and Fort Hills.

"In Wood Buffalo, the three mines that we operate today produce about 640 million tons of material a year, or somewhere between 1.75 and 1.8 million tons of material every 24 hours," she told the audience.

"We have an average strip ratio of 1.2 to 1.3 to 1. We've got about 120 feet (ft) of dirt on top and then 120 ft of oil sand down below. Right now, our fleet consists of about 20 large cable shovels, five large hydraulic shovels, and about 150 ultra-class trucks, plus an auxiliary fleet.

"Our autonomous program was driven by improvements in safety, focusing on fewer incidents. We were quite conservative."

Suncor started looking at AHS around 2013. "At that time, autonomous trucks

<sup>2</sup> *Suncor's Autonomous Experience*, 2019. Anne Marie Toutant, vice president mining solutions, Suncor Energy.



An operator trains on the Cat Command for Hauling system with help from an Immersive Technologies simulator. (Image: Immersive Technologies)

had only been deployed in desert climates, in Western Australia, in Northern Chile. They had seasonal temperature differentials of about 30°C-40°C. Annual precipitation was 25-40 millimeters an-

nually. The mining operations were largely competent, hard-rock ground conditions.

"We wanted the OEMs to come to northern Canada; our continental subarctic climate. We were looking at extreme weather





## Utilization Advantage

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A close-up from the control panel used in the Komatsu Frontrunner AHS. (Image: immersive Technologies)

with a temperature differential of around 78°C. We have a tenfold increase in precipitation of 420 mm a year versus previous implementations in arid environments. Our ground conditions are unique up in northern Alberta. We have oil sands; nothing that's competent or solid. And the material is subject to degradation with precipitation and high ambient conditions in the summer.

"We had two OEMs come to our site. The companies used very different approaches to gathering data, but in this

first phase from 2012 to 2014, we tested haul functionality."

The manufacturers gathered information across the four seasons and verified the functional safety, navigation and vehicle control systems.

"We took water trucks and made ice rinks for them so they could see what happened on ice. We made big mud puddles for the trucks to go through. You name it, we created it," said Toutant.

"We moved into phase two operations, selected the trucks and then started a commercial scale evaluation. We started with six trucks and one hydraulic shovel working in overburden in its own part of the operation. That took a couple of years, and we tested full load haul and functionalities. We introduced cable shovels and went from dumping overburden to dumping ore and looking at algorithms to dump directly into the hoppers feeding our facility. We were improving the system performance and production environment.

"The second phase was the first exposure for many of our leaders and employees, and we had a lot of conversations with our provincial regulators because, in

our jurisdiction, the mines inspector approves all new technology."

Suncor is currently in the third phase — full implementation — which began in 2017 and is now growing its autonomous fleet. AHS is one example of the innovative technologies Suncor is taking advantage of to improve its business in ways that were not possible before — to make people safer, increase reliability and productivity, reduce costs and improve sustainability. It's part of the company's effort to further accelerate its digital transformation journey.

"Our first mine, Steepbank, has been 100% autonomous for about a year and we're working to bring up the Fort Hills site that we commissioned and started up last year," explained Toutant.

Suncor began a phased implementation at Fort Hills in Q2 of 2019.

She explained that one of the biggest challenges Suncor faced with implementing AHS was the precision and accuracy with which the systems operate.

"These trucks will run in exactly the same path every time. In the summer, when the roads are soft, they could dig themselves into a deeper and deeper rut.

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“So, the trucks and the system need to behave more like an operator, adjusting the route of travel slightly each time to smooth out the road surface.”

To tackle this, Suncor worked with the OEM to create a multi-trajectory solution that allows the trucks to alter their route depending upon conditions. Suncor is also working on the design and layout of its haul roads to better suit autonomous operation.

### Continuous Learning

“So far, we’re pleased with our results,” Toutant said. “We’re about 12 months into fully running our Steepbank mine. Safety performance is strong.

“Production performance has also been good. We’re early in our optimization phase of AHS, so we’re still getting everybody trained.”

Toutant said that the company has seen an increase in fleet availability since implementing the AHS, as well as a reduction in maintenance needs, better fuel consumption and tire life.

“The vast majority of our operators report they feel much safer in an auton-

### Formal Training

In November, Rio Tinto announced that a formal qualification is now available in autonomous operation for workers in the resources industries.

The Certificate IV in Autonomous Control and Remote Operations was approved by the Western Australia Training Accreditation Council, providing students with the knowledge and skills needed to work at facilities such as Rio Tinto’s Remote Operations Centre in Perth.

The course is the highest-level accreditation approved to date in a partnership

omous operation,” Toutant said. “They enjoy the predictability and the ability to control each unit from their own piece of equipment.

“This is really all about the people. Don’t underestimate the learning curve internally with your own employees; that’s why we did a stage deployment. Also, the OEM you choose, your service providers and regulatory bodies, for all of them, there’s a learning curve and growth involved. Robust change management is

struck between Rio Tinto, the Western Australia government and South Metropolitan TAFE in 2017. It follows accreditation earlier this year of a Certificate II in Autonomous Workplace Operations and a micro-credential course for trade-qualified, apprentices and technicians.

About 30 Rio Tinto employees will take part in the initial pilot of the Certificate IV course, which will be delivered by South Metropolitan TAFE in 2020. Pending successful completion, the first Certificate IV course may start in 2021.

critical. It really requires a shift to system thinking because individual decisions impact the efficiency of the whole.

“When you move to this kind of technology, it’s like putting a huge magnifying glass over everything that’s going on in your operation. It’s an opportunity to move forward, but it also needs new competencies, not only in your supervision and operators, but also of your technical and maintenance organizations. It’s something that impacts everyone in an operation.”

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## Varel Mining and Industrial: Drilling Expertise and Technology

Varel Mining and Industrial designs, manufactures, and services application-specific roller cone bits for the mining and construction industries. Proprietary design capabilities, efficient manufacturing, and a global presence provide a unique ability to reliably and rapidly deploy industry-leading drilling solutions. Varel's leadership in roller cone bits and rotary percussion systems is driven by a commitment to innovative technology, advanced laboratory science, and decades of practical expertise focused on improving performance.

### Roller Cone Bits

Varel roller cone bits provide a comprehensive set of options for fine-tuning drilling performance in any rock and application. Each bit is a highly engineered product designed for the task, and easily enhanced with a wide range of specialized features. These innovative, often patented, and always-reliable technologies apply decades of experience to fully optimizing ROP, lowering total drilling cost, and extending bit life. That legacy and commitment is recognized in industry-leading bits, including Ridgeback®, D-Force™, Avenger®, and Target®; and pioneering features such as EdgeGuard® shirttail protection and Sidewinder™ cuttings removal enhancement.

### Rotary Percussion System

Percussion forces in mining blast hole drilling applications are a powerful solution for increasing ROP and lowering drilling costs. Varel's RPS tool and bits



provide percussion versatility, reliability, and performance with innovative technology that complements rotary forces. Patented RPS tools efficiently apply compressed air energy to extend the benefits of percussion options across a wide range of formation applications. The versatile tool mitigates water concerns and operates in rotary-only mode as needed. RP bits build on in-depth Varel expertise to stand up to the demands of rotary percussion tools for reliable performance. Based on Ridgeback blast hole mining bits, the percussion bits feature reinforced welds, patented HET cutting structures, and enhanced structural strength.

### Technology

At the heart of the Varel solution is a long-standing commitment to technology. Industry-leading innovation is the result of a proven process of understanding the challenge, engineering the solution, and applying it effectively and economically. Proprietary software solutions include the Advanced Modeling Package (AMP) for standalone modeling of cutting structure interaction with the formation for practical, real-world design. The drilling simulator uses Geoscience and customer

supplied lithology data, along with RC Pro cutting structure designs, to virtually approximate ROP and cutting structure life in different formations and drilling conditions. RC Pro software for cutting structure and bearing design facilitates rapid product development and design accuracy. Product performance is assured by extensive metallurgical laboratory testing performed in state-of-the-art facilities, and advanced seal testing to understand the effects of friction-related heat produced at different motor speeds and axial motion frequencies. Equally important, Varel field service engineers provide expert analyses to fine tune applications and inform the development of new products.

### Commitment and Resources

The industry was a much different place in 1947 when Varel began supplying drill bits for the mining industry. In the intervening years, it has been a leading innovator of specialized technologies and products that apply a unique expertise to producing task-driven solutions. Today, Varel is a powerful resource for reliable options that increase ROP and lower drilling costs for mining and industrial applications.



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# Versatile, Specialized Machines

*Purpose-engineered utility equipment gets upgrades that target safety, productivity and a better work environment*

By Jesse Morton, Technical Writer



Gradall's scalers feature a boom purpose built for the task. The latest updates to the series include weldments that push machine life out beyond 10,000 hours. (Photo: Gradall)

When asked, three utility equipment suppliers offered *E&MJ* three similar visions of the future of underground mining. Where they disagreed is on the fine details. One envisions a world where small- and midsized ops opt for a more expensive but purpose-designed machine to pry loose rock from the ceiling or the face. Another sees a sector where versatile elevated work platforms increasingly replace the traditional tool carriers at large-heading mines. The third sees an uptick in demand for battery-powered shotcrete machines capable of outperforming the diesel competition.

However, they agreed on the big picture. Each said that in the perfect future world, the top priority compelling the head office to drop money on new equipment is improving the underground work environment. While each solution reviewed below is designed for unique applications, each is also pitched as targeting exactly that.

## Increased Reliability

Gradall reported that smaller units from its popular line of scalers could be ideal for some smaller underground hard or soft rock operations.

Designed to meet Mine Safety and Health Administration (MSHA) standards and for optimal safety, the Tier 4F-certified scalers can be disassembled aboveground, brought into the mine piece by piece, reassembled, and then will operate 10,000 hours without a major weldment failure, Gradall told *E&MJ*.

"If this is an underground shaft mine, it is hard to get big pieces of equipment in there and then you've got MSHA inspectors looking for every little thing," Mike Popovich, vice president, excavator products, Gradall, said. "It has got to comply from a safety standpoint, and they view cracks in the weldments as unsafe."

With the latest round of upgrades to the series, the company focused on ensuring "the weldments would hold up," Popovich said. "And they have. The weldments have been extremely reliable compared to anything we've built in the past."

Which is no small feat considering the abuse the machines take. "From a durability standpoint, when you are going in and picking away rocks and they fall, they could weigh up to four or five tons," Popovich said. "They are falling off the wall and hitting your machine," he said.

"It says a lot about the weldments and about the design behind them that they last 10,000 plus hours."

Another key feature is the boom, which "naturally lends itself to scaling," Popovich said.

To save money, some miners use a machine with a knuckle boom, like an excavator, for the task. "What they end up doing is buying a relatively inexpensive machine and then the boom breaks and falls off," he said. "Then they have all kinds of liability issues with the crawler because it vibrates into pieces."

When a rock falls on a knuckle boom fully extended, "it is like taking your knee and bending it backward," Popovich said. "It breaks the boom. It cracks it in two pieces because when they designed the booms they don't FEA (finite element analysis) them for that kind of stress."

The Gradall scaler has a telescopic boom with an attachment on the end. "Our telescopic boom is naturally more efficient and better at scaling than just about anything else out there," Popovich said. "That is the original reason people went to us for scaling."

Other features include a powerful undercarriage, mining-grade axles, a ZF gearbox, and a tilting cab. "If you are scaling on the back or scaling high up the face or ribs, you can tilt back and look directly down the boom to see what you are scaling," Popovich said. "That is a nice feature."

In 2016, the biggest, the 7320, popular in salt and limestone mines, was upgraded from a 173-horsepower (hp) engine to a 215-hp turbo-charged Volvo Penta engine. "More importantly, the torque went way up to 671 ft-pounds (ft-lb)," Popovich said. At roughly 13 ft 6 in. tall and wide, with a wheelbase of 12 ft 6 in., and weighing in at 77,500 lb, it offers a maximum boom reach of 52 ft.

The smaller 5320 features a Volvo TAD571 VE engine rated at 173 hp with 590 ft-lb torque. At roughly 9 ft wide and 11 ft tall, with a wheelbase of 8 ft 9 in.,



and weighing it at 56,000 lb, it offers a maximum boom reach of 26 ft 9 in.

The scalers come standard with a single pick.

They can be equipped with rotary grinding heads, which have seen some demand lately, Popovich said. "These guys are trying to get more and more out of the mine quicker. The quicker you can scale, the quicker you can get on to the next blast and more material out of the mine," he said.

Which is where the new engine on the 7320 comes into play. "With our previous engine, we weren't able to support a very big grinding head. The 170-hp just didn't have it," Popovich said. "The new Volvo Penta has plenty of power and lots of torque and we are able to run up to 4-ft-wide grinding heads on the end of the boom."

A rotary grinding pick offers increased speed, efficiency and higher volumes. "The theory behind it is that they can increase the strike rate," he said. The increased strike rate dislodges more rock faster. "That is one of the reasons people were asking for it."

Popovich said there is a point of diminishing returns there. After all, the main benefit of the Gradall scalers is safety. For that, they are technically most effective using a single pick. "The guys that use the grinding head actually do get through the heading faster, but what we find ends up happening is they tend to smooth the rock face off and there are still hidden pieces of scale," he said. "They kind of mask some areas of scale, which could later come back to be a safety issue."

Safety is what the scalers were designed to deliver. "The primary purpose of a scaler isn't production," Popovich said. "It is safety."

Early iterations of the mechanical scaler were trialed in the 1950s. In the early 1990s, the company released a purpose-designed scaler with a dedicated undercarriage, a heavy-duty upper structure and cab, and features designed for the mining space. Units were added to the series, which culminated in 2011 with the 7320 model, featuring a new rough terrain undercarriage.

"That machine was very popular," Popovich said. "We sold a lot of them."

Underplayed in the hard rock mining space are the smaller units in the series, such as the 5320, which is on a different chassis. "We are able to supply mine scalers for smaller mines," Popovich said.

"I would say that is the area of the biggest opportunities for us."

Those opportunities come with challenges. "Our machines are not inexpensive," Popovich said. "The mine sees the expense of the machine and they consider alternatives that are hard to find."

That's because the task is highly specialized, which is why the 7320 has been widely adopted. "Generally speaking, from an application standpoint, we make the strongest, most efficient machine for the job," Popovich said. "The numbers generally reflect that."

### Swiss Army Knife of Carriers

MacLean Engineering reported the LR3 stands alone in the field of integrated tool carriers as the only available certified elevated work platform (EWP) with the offered rated loads at the rated heights. "Other machines cannot provide those offerings," Stuart Lister, vice president, marketing and communications, MacLean, said.

Released in 2017, the vehicle was originally designed for deployment to underground ops in Australia, specifically for the high-reach, heavy-load task of installing large ventilation fans. "Since its release, the unit has been adapted with a variety of quick-change deck configurations and attachments, to provide a wide range of underground production support applications," Lister said.

Featuring the company's Remote Drive System, it offers a 20-ft-high, 8-by-12-

ft work platform that can support up to 12,000 lb. It has four stabilizing jacks and an emergency lowering system. At 8 ft wide, 35 ft 3 in. long and 8 ft 4 in. in height, and weighing in at 42,000 lb, the unit has an inside turning radius of 15 ft 6 in. and an outside turning radius of approximately 27 ft.

The LR3 is compatible with MacLean's fan handler, pipe handler, cable reel and cable pusher attachments. It features a long-life power train using industry proven components, a fuel-efficient engine, four-wheel drive, and a powershift transmission, the company reported.

Lister said a common misconception is the LR3 is a "one-trick-pony." Instead, it is "the Swiss Army knife of tool carriers for construction and service crews," he said. "Here is a unit that, with its versatile options in basket arrangements and attachments, can be a multipurpose tool for your mine, a proven solution that reduces the job complexity, as well as the quantity of people and equipment to get the job done."

The main benefit offered, according to MacLean, is safety. "It offers mines a safe way to install services and can serve as a replacement to integrated tool carriers attempting to do this work," Lister said. "We are a mining vehicle company founded on the human imperative to make the underground work environment safer and more productive."

Safety and productivity benefits go hand in hand, Lister said. The machine



MacLean Engineering's LR3 was built for ventilation fan repair and replacement work, but has graduated to a multipurpose elevated work platform. (Photo: MacLean Engineering)

is designed to “increase productivity for specialized, technically demanding applications, such as the installation of large ventilation fans.”

The LR3 is ideal for “large-heading mines looking to replace their current approach to high-reach, heavy load services installation with a purpose-build, certified elevated work platform,” Lister said.

Adoption may require reviewing the op’s existing policies as well as any regulations governing working at heights, he said.

Going forward, the company will seek to evolve the solution’s application range with new attachment and deck configurations, Lister said. Additionally, “we have started to deploy specialist LR3 operator trainers to bring new knowledge to the operations

of how to fully capitalize on the capabilities of the MacLean LR3 Boom Lift.”

### Meeting Demand for Quality

Normet’s battery electric spraying equipment Spraymec 8100 VC SD has been deployed to an underground tunneling operation in Espoo, Finland.

The unit is spraying permanent concrete lining to strengthen the tunnels for a major underground wastewater treatment facility, company leadership reported. “There will be 19 kilometers of tunnels excavated for water logistics around the treatment facility,” Mark Ryan, vice president of equipment offering and R&D, Normet, said. “The geology is mostly fennoscandian shield granite, and the primary tunneling method is drill and blast.”

The unit is equipped with Normet’s latest SmartDrive (SD) battery electric architecture, which was introduced at bauma 2019, and is described by the company as more efficient than its diesel equivalents. According to Normet, the SD system offers extensive tramming range, fast charging capability, lowered noise level, lower overall total process cost (TPC) and no diesel particulate emissions.

The Spraymec 8100 VC SD is also equipped with SmartSpray technology, which increases the automation level of the concrete spraying process, and SmartScan, which measures and confirms concrete layer thickness. According to Ryan, SmartSpray technology makes the operator’s work easier and less physically tiring by automating most of the spray boom movements, resulting in a stronger and more consistent concrete layering result with a significant reduction in rebound. SmartScan makes the quality control, minimum required sprayed con-

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**Martin Engineering** is a global innovator in bulk material handling, developing new solutions to common problems and participating in industry organizations to improve safety and productivity. The company supplies flow aids, conveyor products and expert services around the world for a wide variety of applications, such as mining, coal handling, rock/aggregates and other industries. Product families include air cannons, conveyor belt cleaners, belt trackers, impact cradles, modular transfer points, dust suppression and engineered vibration. With nearly 400 active and pending patents, the firm has earned a global reputation as a developer of high-quality products, backed by unconditional guarantee.

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At the 1,000-m level in the Pyhäsalmi mine in Finland, a Normet Spraymec 8100 VC SD is tested. (Photo: Normet)

crete thickness safety inspections, and reporting faster and much easier, he said.

Ryan described the machine as the most productive choice for the job. “Safety, quality, performance and availability or uptime demands are extremely high in tunneling, and the Spraymec 8100 VC SD needs to surpass all those expectations,” he said.

With eight weeks logged; the unit has garnered positive feedback from the customer. “The spraying operations have gone according to the contractor’s planned targets,” Ryan said.

This deployment is providing Normet an opportunity to field test and demonstrate the capabilities of the SD equipment line, demand for which is expected to increase substantially in the near future, Normet reported. “We have seen interest and demand from multiple markets on multiple continents,” Ryan said.

“Customers are truly interested in the possible EHS benefits, improved productivity and overall TPC cost savings, for example via decreased need for additional ventilation to dilute heat and diesel particulate emissions, normally associated with engine driven machines,” he said. “In addition, mining and tunneling activities are being carried out in increasingly more challenging environments, deeper down and in higher altitudes than ever before, which makes it generally more expensive and extremely challenging to operate with diesel powered equipment.”

To answer the increased demand, Normet is expanding its Iisalmi, Finland, facility. With a factory floor space of roughly 22,000 m<sup>2</sup>, the facility employs 400 personnel and manufactures more than 80% of the company’s equipment. “The factory is capable of manufacturing the whole portfolio of Normet products,” Heikki Ojala, vice president, global production, Normet, said. “Additionally, R&D prototype development is done at the Iisalmi facility as well.”

As part of a longtime initiative to up production at the facility, the expansion, scheduled for completion in 2020, will double the production capacity from the current baseline, Normet reported.

The expansion includes the addition of a digital testing center where software and automation solutions will be developed and tested. “The center will also enable automation of the testing procedures,” Ojala said. “Automated test processes will

help to improve testing quality further and the throughput time of testing.”

The expansion will allow extension of line production, which will improve throughput times. “Additionally, the equipment planning targets making all equipment simple to assemble,” Ojala said. “This helps both with quality and production costs.”

With manufacturing facilities in Chile, India and China, the company chose to invest in the Iisalmi facility due to the resources and expertise at the location. “We have significant accumulated knowledge there, as we have manufactured concrete spraying machines in Iisalmi for almost 40 years,” Ojala said. That the area is home to critical subcontractors is a factor as well.



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# Pay it Forward

*How OceanaGold defied the odds, won over an insular small town, and did the impossible*

By Jesse Morton, Technical Writer

In Dixie, a small town is measured by the number of churches, stoplights and gas stations it has. Sited amid the cotton and corn fields, the deciduous forests and rolling hillsides that separate the foothills of Appalachia from the Lowcountry, Kershaw, South Carolina, the hamlet a couple of clicks from OceanaGold's flagship American gold mine, Haile, has three gas stations and almost three dozen churches.

Some of the houses in the area are certified historical landmarks, with Antebellum architecture and massive oak trees. Others, more distant from town, look like they are being swallowed by the landscape and point to a different and more difficult history.

Some of the roughly 2,000 residents of Kershaw will tell you they have had family in the area since the Revolution. In a museum by the tracks in the center of town, a table once used by George Washington abuts a wall adorned with framed yellowed pictures of miners long gone.

Mining has intermittently been a source of income for some families within the community going back more than a century, and many of the residents of the area have the pictures, antiques, keepsakes and family lore to prove it. In the late 1890s and early 1900s, *E&MJ* reported that Haile, named after the man who brought the mine into commercial production, was the biggest gold mine east of the Mississippi, and it proved large-scale gold mining was still economically viable on the Carolina Superterrane.

So it may seem not at all odd that a multinational mining corporation was able to move in, swiftly navigate the permitting process, break ground, and speedily ramp up to producing more than 100,000 ounces per year (oz/y).

Yet Kershaw is also a part of meta-modern, post-industrial, environmentally conscious America. And so it is odd in a way, considering the seemingly universal difficulty miners have today launching new mines in the U.S.



With almost three dozen churches in the area and with a history dating back to the colonial era, Kershaw, South Carolina, while economically challenged, had a strong sense of identity when Romarco and OceanaGold came to town. (Photo: Haile Operation)

Within the last year alone, miners in Arizona, Minnesota, Michigan, Idaho and Alaska have had longtime plans for new mines stalled as tribes and mining opponents sue and courts overturn permits. Plans for a Minnesota iron ore mine located in an area renowned for its support of mining may see permits that took years to acquire nixed by the courts and the legal actions of fellow Minnesotans. A proposed new Idaho gold mine in a remote mining district home to literally dozens of century-old mine sites faces delays as local tribes sue over water issues that date back decades.

In both cases, the miners had both history and the local culture on their side. And at this point, neither will meet with early phase success remotely similar to that of Haile.

Insiders say that success can be attributed to three things. The first is a rare confluence of factors, an advantageous alignment of events, that put the miner in the exact right place at the exact right time. The second is the three-pronged approach to community relations administered by David Thomas, vice president and country director, OceanaGold, Haile Operation. The third, according to the Kershaw town administrator, Mitch Lucas, is the

miner's retention of critical, game-changing talent, namely David Thomas.

## An Advantageous Alignment of Events

Mitch Lucas describes himself as a retiree wannabe. He told *E&MJ* that his government position was supposed to be a hobby job and wasn't expected to be as time and energy consuming as it has become. It now requires just under 40 hours per week, and that, like much else that is happening in Kershaw these days, is a result of the mine.

When Mitch got into local politics, the town was in decline. In the mid-1990s, Springs Industry, a specialty fabrics manufacturer with two dozen plants in South Carolina, sold its Kershaw site and dismissed roughly 1,000 employees. "When that closed, this town almost died," Lucas said.

Around that time, the town did what many others in that type of situation have tried. It lobbied for and won a prison. Kershaw Correctional Institution opened in 1997, bringing some jobs and otherwise mixed economic tidings. "If Kershaw hadn't had a prison, we really would have closed down," Lucas said.

Aside from the prison, there was a soybean plant in the county. The two provided the town a lifeline. Lucas said it

amounted to a drip feed. Unemployment remained high. Almost a quarter of the town's working age adults were jobless. Empty homes and properties overgrown with weeds and kudzu became commonplace. The town needed a break.

And so did gold miners.

Throughout the period, gold prices dropped. They hit rock bottom around the millennium and then started to tick skyward. In late 2005, they hit \$500/oz. The old mine up the road, which more recently had been acquired by Piedmont, had seen action on and off over the past century, but hadn't been mined on a large scale since 1908.

In 2006, Romarco started discussions with the local government. "First and foremost, they said they would look out for the environmental aspect of Kershaw," Lucas said. In 2007, Romarco bought the mine.

The timing was impeccable. By 2008, the market conditions were near perfect.

Stocks were crashing and investors were fleeing into precious metals. The Federal Reserve was printing money and buying bad stock bets, creating price inflation. Gold was soaring.

And housing prices, meanwhile, were plummeting. The lands surrounding the historical Haile mine were all privately owned. It was the perfect time to buy.

Between 2008 and 2011, Romarco got into real estate. Ultimately, more than 150 residents would be relocated, with most of them moving into the town proper. "That brought a big boom to the population," Lucas said. "Prior to that, there were more than 60 houses vacant in town and the surrounding area, and now there are less than 10 vacant."

In 2015, OceanaGold bought Romarco. With the launch of the construction phase, motels filled up. Restaurants, retailers, and the town's oldest gas station, Roberts Shell Station, described as the last full-service station in the South, did brisk business. "The bank balance of the town of Kershaw is in good shape," Lucas said. "Schools are definitely in good shape." The local economy is in such good shape, in fact, that the town recently voted in favor of a bond referendum that would raise taxes.

With the growth, the town needed infrastructure upgrades. For an emergency water supply to the mine, the state of South Carolina forked over roughly \$1 million. OceanaGold dropped \$1.2 million on it. "We now have a 12-in. water line that connects to

our water service department, and they built a new tank," Lucas said. "We now have the capacity to supply the emergency needs of both the town and the mine."

The town now plans to upgrade its sewer system by 2021. The main line will go from 8 in. to 12 in.

The town is working with Duke Energy to have more electricity run to the area to support a planned office park.

But the biggest economic contribution the mine has made is to employment. OceanaGold employs more than 450 at the mine. Additionally, more than 150 contractor employees work there.

Those personnel live and spend money in town. Almost 85% live within a 50-mile radius of the mine. The mine buys fuel from the Roberts Shell Station. The miner co-sponsors local festivals and parades that bring in weekenders and tourists. The boon in tax money has allowed the municipality to open three parks since 2007, bringing the total to five. "That is a lot of parks," Lucas said.

Ultimately Romarco and OceanaGold came to town at the exact right time. They filled a vacuum. They bought houses when everyone else in the nation was selling. They hired when headlines from around the country spoke of mass layoffs. They did it all during a period of relatively steadily rising gold prices.

Still, Lucas told *E&MJ* it could have gone differently. Both his father and grandfather worked at the old Haile mine and Lucas said he has childhood memories of playing in the woods surrounding the site. When Romarco showed up on the scene, the town

had issues, but it also had its pride. It was poor but it wasn't desperate. The miner had to prove it could run an environmentally sound operation. It had to show it could do it and still be economically viable.

And it had to prove it not just to the local government, but to an entrenched, empowered conservationist community, and to the permitting agencies. Which is exactly where so many other miners elsewhere have struggled.

Lucas told *E&MJ* the miner was successful because it was proactive, and because of the talent on its team, specifically David Thomas. "He and his sister won the town over," Lucas said. "When he says something, it happens. We can believe him. There is trust."

## The Trifecta of Trust

David Thomas's office is small, neat and austere. Maps paper over one wall. File cabinets line another. The impression is he has nothing to hide. He answers questions like one who makes his bread doing it, less like a prizefighter battles and more like a jazzman jams.

Thomas is a charismatic master strategist whose approach to community relations anchored OceanaGold in Lancaster County. His strategy, which he says isn't entirely proscriptive, is trifold. The first component is comprehensive research resulting in a full understanding and appreciation of the area and its people. The second is sincerity in every outreach event. The third is total transparency.

Thomas told *E&MJ* that the investment into researching and working to



Roberts Shell is reputed to be the last full-service gas station in the South. It is also where Haile gold mine gets its fuel. (Photo: Haile Operation)



During Phase 1 community outreach efforts, David Thomas, vice president, country director, OceanaGold, Haile Operations, advocates for a policy of transparency when advisors were telling him to prepare for litigation instead. (Photo: Haile Operation)

understand the local area and community was second in importance only to that spent in determining the potential economic viability of the mine. “You have to do it on a parallel path early on,” he said. “It had to sync with both exploration and permitting, and we had to accomplish a lot in a very short period of time.”

Thomas said the truly powerful people in the local government, in the conservation groups, and even at the state level aren’t necessarily the ones fronting those organizations. The real movers and shakers are sometimes two or three tiers back and operate entirely behind the scenes. Those people have to be

identified and their needs and expectations defined.

Research quickly revealed the locals would not be pushovers. Many had pride in a heritage older than the South that could have them initially resist overtures from the company. “Keep in mind you are in one of the 13 original colonies with a lengthy history of defending the territory and their GOD-given rights in this world,” Thomas said. One family, he found out, could trace its lineage “all the way back to King George times.”

Further, there were what Thomas called “legacy issues” from other companies and organizations. “Those included not only mining issues but legacy issues on landfills in the state,” he said. “There was a negative sentiment when we came in.”

That sentiment represented a clearly visible hurdle obvious to permitting agency decisionmakers. “At that time, the district chief of the Army Corps of Engineers stated very clearly that if the town does not want you to be here, you will not be here,” Thomas said.

The miner also worked to determine the identity and prerogatives of

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the primary actors in the conservation groups, which Tomas described as “very powerful and very well-funded,” before attempting to make contact. “From the very beginning, we wanted to know who they were, who the key players were, who the strong lobbyists were within those organizations and really delved into their strategic initiatives, some of which you can’t know right up front because they don’t publish it.”

From that research and some early outreach, opportunities emerged.

The miner determined that along a treeline near the mine runs Flat Creek. The waterway is a critical habitat for endangered species. At the time, it was designated a critical habitat by the U.S. Fish and Wildlife. The miner had no intention of developing the area and recognized attempting to save it offered a “strategic opportunity with respect to our potential mitigation plan that we would have.”

A \$4 million endowment was amassed, and outreach was accelerated. With some important insights and some contacts to leverage, the miner started advancing strategic relationships. “That was the



A gold mine in South Carolina? Even though history suggested otherwise, many thought it impossible in today's climate in America. Above, Haile readies for mining ops. (Photo: Haile Operation)

next step, engaging with the community on a very personal level,” Thomas said.

Thomas lists three rules for community engagement. Introductions and meetings are most effective when done face to face. Openly and directly discuss the salient issues. Then seek to understand all sides to the issues. The rules can be condensed into one. Sincerely seek to arrive at satisfactory solutions.

The miner reached out, unsolicited, to the community and to the conservation groups, extended invitations, and arranged meetings and site visits. “It was that approach that began moving things forward for us,” Thomas said.

The community and groups gradually warmed to some of the proposals.

The miner moved to acquire properties bordering Flat Creek. It also looked to pur-



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chase areas outside the county for similar ends and found properties containing areas of critical importance to conservationists. "They were enormously valuable in terms of the ecological features and cultural history associated," Thomas said. "We were able to secure them. We protected them from potential development that was on the horizon."

OceanaGold put 4,700 acres into conservation. Roughly 3,300 more are targeted for the same.

The miner also bankrolled research facilities and resources for saving an endangered freshwater mussel. It pumped money to the local high school to launch a program to build bird houses for a rare warbler.

Such was mirrored in negotiations with local landowners. Those negotiations were handled face to face and conducted on the landowners' terms, Thomas said. "It was a lot of sitting in living rooms and on back porches trying to get to know the individuals."

You had to get to know them to fully understand their needs and expectations, he said.

One 45-acre plot was directly downwind of the planned mine site. "We had to have his property," Thomas said. "If we didn't get it, we wouldn't be mining open pit."

OceanaGold's written offer spanned less than three pages. "He sends us back a 21-page response with pictures," Thomas said. "Nowhere in it was anything about dollars."

The decision to sell didn't hinge on price. It hinged on the miner appreciating the sentimental value of the property to the owner. "The passion behind it you really had to understand and appreciate."

To facilitate the meetings, discussions and the land-acquisition process, the miner hired locals. When Thomas met with one landowner with particularly strong people skills, he hired him. "I was so impressed with his demeanor," Thomas said. "His personality, integrity and character were completely beyond reproach," he said. "What better person than someone from the community to be our landman?"

The miner internally managed the land transactions and gradually cobbled together the 13,000-acre mine site. It acquired 253 individual parcels, and relocated 152 residents. Many of those residents moved into a better living situation, Thomas said. Many emerged debt-free. Some of the homes were physically relocated at the expense of the miner. Some of them were donated.

One win from it is the operation is royalty free. The company managed to negotiate away the legacy royalty issues associated with the mine. "I would argue that there are not many mines in the country or even in the world that don't have royalty obligations," Thomas said.

Ultimately what won over the community, the conservationists and the permitting bodies wasn't masterful negotiating, leadership skills, or an apparent willingness to compromise. It was instead "full-spectrum" transparency, Thomas said. "You have to inform. You have to educate."

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With transparency comes trust. With trust comes the level of credibility that can sway permitting bodies.

For example, OceanaGold readily met the needs of the third-party archaeologist contracted to work the phase one tailings facility.

After the work was completed, the miner heard through the grapevine the extent to which the archaeologist was networked into the regional power structure. She was a tribal member of the Catawba Indian Nation. She commended the miner for its openness.

“That was communicated to the Catawba Nation not by us,” Thomas said. “It was communicated by one of their own.”

In another example, the miner recognized it needed to bring on an avian specialist for parts of its mitigation work. Thomas described the individual hired as “the epitome of a conservationist.” He, as opposed to the miner, reported back to wildlife and conservation groups.

The result is the miner earned the trust of the community. “The best advocate you could have are those that are out there that are unrelated to you messaging on your behalf,” Thomas said.

### Embrace the Process

One of the approaches that set Haile apart is it didn’t farm out its outreach program and it didn’t hire on a local law firm to fight for it.

Neither choice was easy. Legal consultants, at the time, were prefacing every statement with “when we get to court,” Thomas said. “My position is there is a better way to do this.”

The approach worked. “As a result, the community had a high degree of respect for us because we removed the veil of secrecy,” Thomas said.

Another mistake some mining companies make is they start the research and outreach part too late, Thomas said. “You can’t start developing those relationships after you’ve started permitting,” he said. “It is too late. They are going to start challenging you from day one.”

Early outreach may appear cost-prohibitive to some companies, Thomas said. Some would rather not pour money into early engagement when it could be used differently later in the process. One consequence of that, Thomas said, is an ever-expanding timeframe. “You could collapse that timeframe by investment early on and by doing it sooner rather than later.”

“It took us four years,” Thomas said. “In the end, we obtained a defensible permit with impeccable environmental and technical integrity behind it,” he said. “At the end of the day, that is the goal. And I would argue that it is how you navigate that process that determines your success.”

In the case of Haile, in Cancel Culture America, that success sets a

precedent. “We’ve done things nobody thought was possible,” Thomas said. “When we started out, everybody said, ‘A gold mine in South Carolina? That is not possible.’” As the mine produces more than 30,000 oz per quarter, it is instead now an accepted reality. “That is a testament to how we have performed historically.”





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# Froth Flotation for the 21<sup>st</sup> Century

*E&MJ explains how a holistic approach to the optimization of flotation, encompassing equipment, technology and know-how can deliver circuits fit for the mining operations of tomorrow*

By Carly Leonida, European Editor



Flotation cells installed at Boliden's Garpenberg zinc mine in Sweden. (Image: Metso)

Froth flotation has been a stalwart in mineral beneficiation for more than 100 years. During this time, and particularly in the past 20-30 years, there have been significant advances in the design and application of mechanical elements for flotation systems, e.g., new mechanisms, launders, larger cell volumes, better pumps, etc. While these have enabled new levels of efficiency, on a standalone basis, they are insufficient to deliver the high recovery rates and grades demanded by future mining operations.

In order to handle the greater throughputs associated with depleting (lower grade) metal deposits, provide maximum efficiency in energy consumption, and keep maintenance requirements low, mines and manufacturers are now looking to a combination of digital technologies, targeted reagent formulas and innovative setups for existing equipment.

It is the sum of these parts that will enable mines to sustain production and keep their operational costs low well into the future.

## Talking Trends

Thierry Monredon, global manager for flotation at Metso, spoke to *E&MJ* about current trends in the design and application of flotation equipment.

"One key trend is to use a mix of mechanical cells and flotation columns with columns as the final cleaner stage, because they deliver increased recovery and higher grades in this role," he

said. Over the past few years, we've seen mechanical cells used for rougher and scavenger duties, and generally the first cleaner stage as well. The last cleaning stage is then done using columns.

"We typically see a 1% increase in grade when columns are installed as the last cleaner stage, together with the use of froth cameras."

Monredon said this trend has been particularly noticeable in base metals globally. "If I take, for example, some projects that we have worked on in India," he said. "The last project, the mining company wanted mechanical cells only. The next concentrator, if they obtain approvals for the project, will use a mix of mechanical cells and columns."

And will we see bigger cells any time soon?

"I think we have reached, in terms of sizing, a plateau. 600-m<sup>3</sup> class cells have been installed in several places, but that would be definitely be the maximum size used in the future for some time," he said.

"Quite often its cheaper to have two banks of 300-m<sup>3</sup> cells instead of one bank of 600-m<sup>3</sup> cells. The cost of equipment is the main reason that people are not interested in larger diameters at this stage."

Currently, it is operations with low grades and high throughput, for example, copper mines, that have opted for 600-m<sup>3</sup> cells.

"Grades have been decreasing, and to maximize efficiency, these operations need to have high throughput," said Monredon. "In these cases, large diameter flotation cells are compulsory, but again, 600 m<sup>3</sup> is really the limit. That's clear for me, for our company, and I believe that's what we've seen from our competition as well."

Monredon explained that not only have current cell designs reached their maximum efficiency at 600 m<sup>3</sup>, but larger diameters would also require a greater footprint and more space within the concentrator; space which is often at a premium.

"When you look at putting a building together and the surroundings that you need around the flotation equipment. When you look at the overall cost, it becomes much more expensive with larger diameter equipment," he said. "Maybe a few years ago, it [cell volumes more than 600 m<sup>3</sup>] would have been considered for very large operations like oil sands, but today that market has all but disappeared. The main demand for large flotation units today is from iron ore and copper. Generally only copper will go up to 600 m<sup>3</sup>."

## New Mechanism From Metso

Metso's flagship product for flotation, the RCS flotation cell, is an all-purpose flotation machine suitable for applications including roughing, cleaning and scavenging. RCS cells use Metso's patented Deep Vane (DV) mechanism to float various minerals and are

available in volumes from 0.8 m<sup>3</sup> to 600 m<sup>3</sup>. These are complemented by the company's range of Microcel flotation columns, VisioFroth cameras and OCS-4D optimizing control system.

Monredon said VisioFroth in particular has been key to helping mines increase their recovery and grades. The camera provides online measurement of flotation performance incorporating parameters such as bubble velocity, size and stability to allow concentrator flow control and reagent use to be optimized. The camera can be used as a standalone instrument or combined with advanced process control (APC) methods to optimize set points throughout the concentrator.

"It's not new," he explained. "But more and more people are looking to buy this hardware together with the original equipment and not get it separately at a later stage. The aim is to maximize recovery from day one by having this type of additional equipment.

"But apart from the cameras and optimizing systems that come with flotation equipment... Really, it's all the knowledge around that which is increasing the recovery."

The Metso team is currently working on a new mechanism for its RCS flotation cells. This is still at the development phase and is yet to be tested. "It will take us about 12-18 months before we release something on this," Monredon told *E&MJ*. "It's something that we've been working on for about a year now.

"In the last five years, both our main competitors have been doing this type of upgrade, so you could say maybe we are behind. But we believe it will allow us to be up front, having one of the latest products."

Metso also has flotation equipment installations coming up at a lead-zinc operation in India in the near future, and Monredon expects that the growing interest in tailings reprocessing from operations across the globe could drive sales in the flotation space in the coming 12-24 months. To make this approach physically possible, many operations will require a separate reprocessing plant along with the relevant beneficiation equipment.

"The equipment required depends on where the valuable minerals are being lost," he explained. "Is it in the coarse material or in the fines? If it's in the coarse stream, you will have to do some regrinding, and then flotation again..."

"It will take a little bit more time for that to happen on a global scale. We've seen it happening in gold, and we expect more copper and iron ore operations to follow suit."



FLSmidth's new mixedROW concept uses a combination of flotation technologies in a clever arrangement to lower energy consumption and improve recovery. (Image: FLSmidth)

And what about particle flotation — is that a viable option for mines that are looking to optimize their throughput while driving down operational costs?

Monredon is clear: "It is not a proven technology at this stage," he said. "We're not able to generate enough recovery on very coarse particles.

"It could be an option for very specific applications, but on a larger scale, it's not yet feasible."

If all goes to plan, Metso's portfolio will soon be combined with competitor Outotec's highly regarded range of flotation equipment and services. The deal to merge the two companies is expected to close next year following regulatory approval, and Metso CEO, Pekka Vauramo, named Outotec's Courier froth analyzers as a standout product when announcing the merger.

## FLSmidth Mixes it Up

FLSmidth has been one of the busiest vendors in the flotation space over the past 12 months. The company released two new concepts for flotation in October. The mixedROW Flotation System and a new Froth Recovery Upgrade Package.

## Eriez: Two Steps Ahead

Eriez meanwhile has developed an alternative to large-volume mechanical flotation cells.

Eric Bain Wasmund, Eriez Flotation Division's global managing director, explained that large mechanical cells are the mainstay for rougher flotation in almost all bulk flotation processes. Increasing the individual cell size and reducing the number creates modest improvements in footprint and operating costs, but it doesn't improve the basic metallurgy.

"Conventional mechanical cells have an advantage for scaling larger because

they have an axis of symmetry, but the disadvantage is that the metallurgical results will always be suboptimal because the step requiring high energy and the step requiring low energy are occurring in the same cell volume," he said.

Higher mixing energy means better recovery of fine ore but poorer recovery of coarse ore. Eriez has addressed this by developing a two-stage flotation device called the Stack Cell. Two stages mean that there are two separate functional chambers. The first stage introduces high energy, which is optimal for contacting and attachment of bubbles

and particles. The second stage has low energy, which is optimal for bubble-particle flotation with minimized drop-back. By keeping the stages separate, high shearing energy can be introduced into the first cell, without passing that energy into the second stage where it would negatively impact recovery.

"Plant trials with the StackCell on a variety of metal sulfide ores, including nickel and copper, have shown that the StackCell can achieve equivalent grade and recovery in about 20% of the time required by conventional mechanical cells," added Wasmund.

## SealRyt - Rotating Shaft Sealing Experts since 2001

The SealRyt Corporation has developed and patented bearing and braided packing technology that seals rotating shaft equipment more effectively than traditional packing and lantern ring techniques. Its methods have been proven to work even in harsh applications such as slurries.

### STUFFING BOX SEALING WITHOUT BOX MODIFICATION

SealRyt developed the PackRyt® Bearing System, a patented shaft stabilization methodology that retrofits into existing stuffing boxes without box modification. The PackRyt combines high-capability bearing structures with either super-conductive soft sealing materials or mechanical seals. PackRyt® Bearings are composed of a proprietary carbon composite that is extremely tough but doesn't wear shaft sleeves.

In flushed applications, the PackRyt Bearing System combines the bearing with the lantern ring for optimum performance. This design prevents the lantern ring from moving out of position or being crushed when tightening the gland follower.

SealRyt also produces premium braided packing that outperforms traditionally used brands. SealRyt developed techniques in the braiding process that improve thread lubrication coverage, twisting design, and corner blocking.

Finally, SealRyt designs and machines gland followers, stuffing boxes, and other metal-work.



### WHAT DOES THIS MEAN FOR MINING?

SealRyt technology excels in the movement of slurries from processing to tailings storage. Slurry pumping is extremely hard on pumps and seals, and when it's paired with high pressures, reliability suffers. SealRyt products are designed to be used in the hardest to seal applications. The bearing design automatically throttles flush through close clearances. Eighty-five percent flush reduction is common. Additionally, by using our proprietary carbon composite bearing system in concert with our uniquely developed braided packing, mining operations can realize drastic gains in reliability.



mixedROW does what it says on the tin. It combines the benefits of FLSmidth's nextSTEP forced air and WEMCO self-aspirating technologies in one bank of cells. Flotation cells featuring FLSmidth's nextSTEP forced air technology are positioned at the beginning of the row where they can recover coarse material using the least amount of energy possible. Cells that use WEMCO self-aspirating technology are then placed at the end of the row to maximize both coarse and fine particle recovery. The elevated rotor position within the WEMCO cells also helps to reduce energy consumption, as the froth only has a short distance to travel.

Thanks to this strategic cell setup, mixedROW is able to lower energy consumption used within the flotation process by 15%-40% while increasing recovery by up to 5%. FLSmidth said that mixedROW also has the lowest head loss on the market, as its system of dart valves allows for efficient transfer of slurry from one tank to another without significant losses.

The dart valves have also proven useful in FLSmidth's new Recovery Upgrade Package.

Dr. Dariusz Lelinski, global product manager for flotation at FLSmidth, explained how the package came about in a recent interview for the company's customer magazine.

"It is probably no exaggeration to say that the potential from augmenting froth recovery rates — in terms of what more efficient control of the level, residence time in froth and pulling rates could deliver — was only recognized a few years ago by the industry," he said.

"This is because it was assumed that there are no losses during transport from slurry to the launder. It was only a few years ago it was measured that the losses are typically 50% and can reach as high as 90% for coarse particles. What it means is that 50% (averaging over all sizes) of particles must be captured again after detachment in froth phase."

To tackle this, FLSmidth set about increasing the probability of recovery from the froth phase using a combination of instruments and technologies. The result was a Froth Recovery Upgrade Package. This uses slurry level measurement, the redesigned dart valves and new actuators from Festo that were designed specifically for FLSmidth to provide maximum control of the froth phase. This also allows quicker reactions to changes in flow and slurry density.

The package also includes FLSmidth's new Adjustable Radial Froth Crowders (ARFC). These allow increases in either recovery or grade regardless of the amount of froth formed at the top of the machine. The company said they allow for much higher pulling rates or deeper froth, which is currently hindered by the geometry of the top of most flotation machines.

The traditional way to improve froth recovery is through changes to froth height, crowding and the number of radial launders.

Lelinski explained that these are all still possible with the new package: "The most difficult part is froth recovery at the end of the row. There is not enough of hydrophobic particles to form stable, deep froth, and a large percentage of these particles is left unrecovered. Our package allows not only to recover these particles, but to control required balance between recovery and grade in this part of the flotation circuit. So overall, you get better results, but it also gives you another degree of process control, not only during difficulties of froth formation, but during normal operation allowing more flexibility in selecting grade-recovery relationship," he said.



FLSmidth announces the launch of its Froth Recovery Upgrade Package in October. (Image: FLSmidth)

The new level sensor, which monitors both the slurry and froth positions with the MultiSense probe, was developed in cooperation with HyControl, and the package also includes an advanced froth camera developed with Stone Three, a market leader in vision equipment.

“We are excited to deliver this complete package to our customers. All the elements working together in combination with radial froth crowders means this package will deliver better recovery at the same grade or increased grade at the same recovery, making this package better than the sum of all parts,” added Lelinski.

FLSmidth’s hard work in flotation has not gone unnoticed. In September, the company was recognized as the market-leading supplier for flotation cells in Chile at an event organized by the Chilean Mining Suppliers Association (APRIMIN). The award was presented by independent consultancy, Phibrand, following a survey of mining companies.

Andrés Costa, president of FLSmidth South America, was enthused: “We are very proud about this recognition because this is given by our customers. This is a real sign that we are meeting their expectations in the right way.”

FLSmidth also was recognized as one of the top suppliers in the pumps category, which leads us nicely on to the next area for optimization in flotation.

### Don’t Forget Froth Pumping

It’s all well and good investing in solutions to increase recovery from flotation, but if allowances are not also made in the design of the accompanying pumping equipment, then problems can occur.

Les Harvey, regional product manager for slurry pumps at Weir Minerals, spoke to *E&MJ* about the challenges mines are facing.

“Understanding what is happening in the pump and piping system is key to driving innovation,” he said. “The data we gather, and our experience in the field provides us with a great deal of insight into the issues our customers face. Armed with this insight, we can make design modifications and new products to help enhance our customers’ operations and alleviate some of their pain points with froth pumping.

“As we get access to more data, we are able to reliably model pump and slurry interactions and performance. This allows us to continuously improve our understanding of fluid and slurry behavior in various applications, including froth pumping.”

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### There's more to battery electric vehicles than zero emissions benefits

- 50% less planned maintenance (PM interval goes to 500 hours for MacLean BEV, compared to 250 hours for the MacLean diesel-powered vehicle equivalent).
- 50% less expensive labour and materials (on planned maintenance required).
- Almost 90% less energy consumed performing the same work underground (as measured by MacLean during comparative BEV and diesel BT3 Boom Truck ramp run trials staged in 2018).

With mining companies around the globe, seeking solutions for lower operating costs, higher productivity, and improved environmental performance, the battery electrification of mining vehicles (BEVs) in the industry is at a turning point after years of talk but not much action. Even though the switch to battery electric vehicles is slow, mining companies are embracing battery powered technology as they see the benefits outweigh the higher initial capital costs. The two key drivers are the cost of ventilation as mines dig deeper to extract ore, and the push to remove diesel fine particulate from the underground work environment.

The BEV story for MacLean started in 2016 with the launch of their fleet electrification program at MINExpo. Since that time, the company has built up significant experience on the frontlines of the BEV revolution in underground mining. By the end of 2019, more than 30 MacLean BEVs will be working underground in Canada, at nine minesites across Ontario, Manitoba and Newfoundland and Labrador. To date, the MacLean BEV production support fleet has amassed some 40,000 hours of operation and has provided a deep well of operating data. It has also provided a range of pioneering design knowledge that has incorporated into component modifications and maintenance practice and safety response protocol enhancements. MacLean is now taking its 'EV-proven, EV-ready' message to the mining world - for production support mining vehicles, considering the benefits of incremental BEV introduction to allow for workforce training and supporting operator buy-in, which will pave the way for broader fleet electrification down the road.

Battery powered mining equipment is proving a boon for mining companies. Not only does the BEV switch produce zero emissions, it also generates the key knock-on effect of reducing ventilation energy requirements and those associated costs. MacLean's instantly mine-ready battery electric fleet solution incorporates onboard charging that plugs into mines' existing electrical infrastructure, along with liquid-cooled and data-rich battery technology, to deliver a low heat, low noise, and low maintenance mobile equipment option. With no additional charging infrastructure investment required, an option to lease the batteries from MacLean so that end-of-life battery management issues are avoided, along with the comfort of a going with a proven technology, the risk of the BEV switch to mining companies is low and the reward is high.

For more information on MacLean BEV operating data and cost benefits, please reach out to: [info@macleanengineering.com](mailto:info@macleanengineering.com).



Metso's VisioFroth camera in action. The company says that when used properly, this technology can deliver a 1% increase in recovery grade. (Image: Metso)

Harvey said that the Weir team have noticed a pattern among customers that are having trouble with their froth pumps.

"By using more flocculants and other chemicals designed to improve mineral recovery, they're exacerbating existing problems in circuit design and reducing the returns they're looking for," he explained.

One of the main challenges in froth pumping is dealing with air in the pump. Air tends to centrifuge in toward the eye of the impeller where it can build up into an air lock. In addition to reducing the pump's efficiency, this also reduces the flow through the pump and increases the slurry level in the suction hopper. The increased slurry level may push the pocket of air through the pump, causing surging and vibration which can damage the pump bearings, impeller and shaft.

Harvey explained: "The best way to manage air in a froth pump is to invest in a froth pump with a Continuous Air Removal System (CARS), which we have in our Warman AHF, MF and LF pumps."

The system allows air to move from the impeller eye into a collection chamber at the rear of the pump through a vent hole in the impeller. A flow inducer then removes the air through a vent pipe. It's also important to position the pump's discharge pipe at the top of the pump, or at a 45° angle to allow air trapped at the top of the casing to escape.

"We are currently working with several customers reviewing our CARS technology to improve the performance of our Warman pumps in applications with high volumes of air in the froth," Harvey told *E&MJ*. "These are difficult applications that require a depth of understanding of slurry behavior in the entire pump and piping system."

Another common issue occurs when hoppers designed for slurry pumping are used in froth pumping applications. Slurry hoppers require turbulence to prevent the mineral content from settling, but turbulence in a froth pump prevents the air from escaping and can lead to blockages.

Tanks designed specifically for froth pumping promote continuous circular movement, where solids and liquids are sent to the outside of the sump for further transport while air centrifuges into the center where it can be removed. This movement can be encouraged by introducing the slurry from the top of the tank at a tangential angle, and conical designs, rather than those with a flat or rounded floor, further improve the flow of minerals.

Harvey explained that to prevent blockages, the intake pipe, which links the tank to the pump should be large diameter and slope downward toward the pump. This design allows escaped



air to separate and travel back up the pipe where it can escape from the sump, rather than building up into blockages.

“The shorter your intake pipe, the harder it is for blockages to build up. However, in addition to a maintenance spool and isolation valve, it’s a good idea to leave enough space for a water injection port, which is useful for flushing out any solids build-up,” he added.

“To make maintenance easier, a dump valve can be included on the suction side of the pump, between the pump and the isolation valve. This will allow you to drain slurry from the pump and discharge pipe system when stopping the pump for maintenance.”

### Clever Chemistry

The third piece of the puzzle, one which is often overlooked, are the reagents used to froth and collect the minerals of value.

While the recovery of coarse particles may be an Achilles heel for many flotation equipment manufacturers, the reagents necessary for these applications have been available for some time. *E&MJ* caught up with the team at reagent specialist Solvay to find out more.

“Coarse particle recovery provides a viable option for lowering comminution costs, achieving higher plant throughput, and improving tailings and water management,” Tarun Bhambhani, mineral processing principal scientist at Solvay, told *E&MJ*.

“We have long known how to design reagents for coarse particle flotation. However, the physics of traditional flotation cells presented a constraint in the use of these reagents to achieve flotation of these particles. Over the past two decades, flotation cell manufacturers have cleverly overcome some of those physical limitations and have designed cells that can float particles >300 µm efficiently. It has enabled us to utilize these novel chemistries, which are now in production under the AERO CP series and are being evaluated at plant scale.”

Ore complexity is often associated with lower grades, and mines need robust reagents to treat the different minerals and ore types coming through the plant. Bhambhani explained that Solvay’s metallurgists spend considerable time optimizing and



A Warman froth pump from Weir Minerals. Pumps are often overlooked in flotation circuit optimization but they are crucial to a smooth running operation. (Image: Weir Minerals)



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re-optimizing customers' reagent suites using collectors, frothers and modifiers to help manage the complexity.

"In addition, we see problematic species like arsenic, talc, clays and others occurring more frequently," he said. "These can impact the process, mainly by reducing concentrate grade, and plants may incur financial penalties when some of these are present. The use of selective collectors, frothers and modifiers is critical to improve the separation efficiency of a client's ore in order to maximize their net smelter return."

Mineral processing marketing manager, Eammon Guitard, added that Solvay is seeing more requests for customized reagent blends that are robust across a number of ore types.

"Each mineral has different degrees of affinity for the various reagents, and each reagent has different degrees of affinity for the various minerals," he told *E&MJ*. "A reagent formulation needs to be sufficiently robust to target all value minerals, while not targeting non-values as best as possible."

For this reason, operations almost always use multiple collector formulations and carefully selected dosages and addition points.

Another important area of interest is frother formulation; frothers and the froth phase are often neglected but can have a significant impact on metallurgical performance.

"We're seeing a growing number of requests to investigate frother performance in our customer's plants," said Paulo Martins, Solvay's business development manager for frothers. "We've found that laboratory testing is not a good indicator of frother performance at an operational scale, but operations face risks by trialing new frothers in the plant because it's difficult to identify proper frother composition in real time. This complexity makes it challenging for mines to effectively evaluate products in an operation."

"Because of these challenges, it's paramount for mining operations to align themselves with reagent providers who deeply understand flotation chemistry, applying holistic approaches that evaluate the role of chemical, physical and operational variables on flotation outcomes."

Frother selection can be a complex process and, as a result, many operations today are using suboptimal formulas. Solvay is

making the process easier by digitizing its FLOTATION MATRIX 100 methodology. This focuses on flotation optimization and includes a logic-based product "select-a-guide" tool to identify the appropriate building-block chemistries.

The company has also developed state-of-the-art dosing equipment that allows for more precise blending and control of frother building-block chemicals, and real-time adjustments based on plant results. In turn, plants benefit from improved operational stability and metallurgical performance.

### Collaboration Key to Optimization

Solvay recently worked with a large mining operation in North America to develop a frother called OREPREP F-717. The teams presented their work at the SME 2019 meeting in Denver in February.

"The central idea of our frother projects starts with identifying underlying operational needs. The OREPREP F-717 was tailor-made to allow stable conditions for the rougher operation, with better mobility and, at the same time, improve recovery of coarse particles and solve the sporadic over frothing," Guitard told *E&MJ*. "If one applies a simplistic approach, these goals would be antagonistic, but a deeper understanding of the chemistry combined with the plant details enabled us to develop a solution."

Thanks to the new frother, the teams saw an immediate increase in coarse particle recovery and improvement in circuit control at the mine.

Solvay continues to develop novel reagents and concepts based on specific industry needs and challenges. The team said that one of the biggest requests they are currently seeing from customers is improved solutions for sodium hydrosulfide (NaSH) replacement in Cu-Mo separation.

There are several issues with NaSH, including stench, risk of exposure to highly toxic hydrogen sulfide gas, performance deficiencies when treating difficult ores, and logistical challenges in handling large volumes.

Esau Arinaitwe, mineral processing innovation director at Solvay, explained: "Replacing NaSH-based options with non-toxic, dose-efficient polymers has been a longstanding quest, and our R&D team is evaluating several options."

"Solvay introduced its AERO 7260 HFP depressant technology several years ago as a safer and sustainable alternative to NaSH. It can replace up to 60% of the NaSH used and is now in commercial use globally. This wasn't enough for our clients, as the goal was to replace 100% of the NaSH used. Our latest innovation is our AERO NR 7360 Series depressants, which aims to replace 70%-100% of the NaSH used in Cu-Mo separation."

Arinaitwe said these depressants are chemically stable, highly effective sulfide depressants making them safer, practical, and sustainable alternatives for Cu-Mo separation since they substantially reduce and/or completely eliminate the consumption of NaSH. The technology is still in the trialing phase with the goal of commercialization in early 2020.

Other reagents for which non-hazardous, dose-efficient and cost-efficient alternatives are also being developed include NaCN, dichromate and metabisulfite (MBS), and Solvay is also looking to improve operational efficiency with novel reagents. For example, the company is developing reagents for fine particle flotation and the next generation of selective, targeted collectors.



Solvay's recently launched frother dosing equipment enables customers to fine-tune formulations to achieve desired plant performance. (Image: Solvay)

# EXPERIENCE THE WORLD'S BEST-READ MINING MAGAZINES

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# Over, Under, Sideways, Down

*Drones now can fly complex missions almost anywhere – with or without human guidance – and provide the big data streams needed for up-to-the-minute operational planning*

By Russell A. Carter, Contributing Editor

It's hard to pinpoint exactly when UAVs — unmanned aerial vehicles, commonly referred to as drones — gained a solid foothold in the mining industry. Prior to 2010, drone usage was just a minor blip on the industry radar screen, with a few producers such as Barrick Gold and Freeport-McMoRan, some exploration companies and, in the U.S., a government agency or two engaged in early-stage experimentation with simple drone-based surveys. Commercial drone usefulness was hindered by technological and regulatory hurdles: available UAV models fell into the hobbyist category at one end of the spectrum, with limited durability, flight time and payload capability; or conversely were high-end models that were expensive and required extensive operator experience. Regulations pertaining to commercial drone operations were restrictive or vague in Australia, Canada and the United States.

That all changed in 2015-2016 when both the U.S. and Australia relaxed and clarified their regulatory frameworks for

commercial drone operations. Canada revised its drone rules in 2019. Meanwhile, drone technology has advanced in terms of physical performance, operational flexibility and sensor efficiency. UAVs are now flying longer, higher and even deeper than mining-industry early adopters would have imagined. Companies currently active or interested in UAV operations can choose their level of participation, from do-it-yourself, in-house efforts carried out on a limited scale, to comprehensive turnkey drone-service packages. At least one company, Israel-based Airobotics, markets a completely automated setup that employs a “drone in a box” concept using self-deploying UAVs operating from self-contained on-site stations from which they take off, land and repower themselves with little need for human interaction.

Software solutions providers quickly recognized the vast data-management and analysis opportunities offered by the cheaper, quicker and highly targeted mission options offered by drone operations, with companies such as Hexagon jumping on the bandwagon and incorporating tools for handling large volumes of point-cloud data in its 2015 License to Explore package. Maptek, focused on 3D laser scanning and surveying products, hedged its bets in 2014 by investing in DroneMetrix, an Australian technology startup that developed innovative aerial photogrammetry mapping solutions. In recent years, the push to make drones smarter in pursuit of autonomous operation under various site conditions has fueled a nascent startup boom focused on development of AI capabilities that allow drones to accurately perceive their environment, enabling them to navigate and map while analyzing information in real time. In short, allowing them to fly in uncharted spaces and make efficient use of the massive data sets that they collect without need of human interpretation or input at every step.

Today, advances in drone performance, combined with expanded drone-service packages that include flexible, scalable

options, make the decision to embrace drone usage less uncertain than it was just a half-decade ago. As might be expected, larger miners with broader needs for drone capabilities are leading the way. A study conducted recently by the market-intelligence group GlobalData indicated that 60% of 200 mine sites contacted during a survey had invested in drone technology, but within that group of respondents, the results skewed heavily toward major mining companies (70% had invested) versus small- to mid-sized companies (37% invested).

At least one large equipment OEM also has invested materially in drone-based solutions for worksite aerial surveying and other visual data-based tasks. In March, Komatsu Australia and Skycatch, an industrial data collection and analysis company, announced a partnership to boost Komatsu's “Everyday Drone Solution,” which comprises Skycatch's Explore1 high precision UAV, Edge1 integrated GNSS base station and edge compute module, and the Viewer, an online data visualization and analysis tool, packaged into a commercial-grade kit.

The announcement followed a purchase of 1,000 DJI-built drones by Komatsu in 2018 as part of its Smart Construction platform development. Although that solution is primarily focused on construction-project equipment monitoring applications, Komatsu also offers the Everyday Drone service for companies more interested in its 3D site surveying capability and has seen this service expand to include mine-site surveying in Australia. Komatsu also has participated, along with Freeport and several other industry partners, in developing a list of AI-related projects focused on preparing the mining workforce of the future to understand and manage mining's big-data requirements and benefits, including drone-related operations, as part of a \$1.25 million grant awarded to the University of Nevada-Reno from the U.S. National Institute for Occupational Safety and Health.

Prospective users looking for an optimum in-house drone strategy need to de-



An Exyn A3R drone equipped with a navigational package that allows it to safely avoid obstacles takes off for an underground mine mapping mission.



Komatsu has teamed with Skycatch, which specializes in data collection and analysis, to offer an ‘Everyday Drone’ solution for customers interested in performing 3D site surveys. The system is based on Skycatch’s Explore 1 high precision UAV, shown here.

decide how much they can afford to invest in equipment and personnel costs, determine the best approach for the size of the site(s), identify accuracy requirements and establish optimal data collection and turnaround time goals for delivery of final survey products. As an alternative to what can be a lengthy process, drone-service providers are adjusting their pricing models and service options to give current or potential customers a broader range of choices. Kespri, for instance, now offers customers several drone options to choose from to fit multiple use cases, company standardization goals and flexible scheduling needs. Customers have the option of using Kespri-managed drones, their own DJI drones, or hiring a DroneBase pilot to collect their site data. DroneBase is a California-based company that provides experienced UAV pilots who execute specific missions according to the customer’s package purchase, and also offers a variety of data management solutions based on customer needs.

In September, DJI and Delair, a French company, announced a partnership to collaborate on enhanced and integrated solutions for UAV-based visual data collection and analysis. According to the two companies, the relationship will strengthen Delair’s ability to serve key industry sectors that are increasingly relying on visual data, including mining. Customers will have access to one-stop shopping and freedom of choice in utilizing Delair’s cloud-based solutions to help derive insights from drone data, including industry-specific analytics tools optimized for specific use cases such as creating digital twins, field inventory calculations, vegetation encroachment, automatic defect detection, automatic stockpile

detection and volume measurements, along with any application which is based on AI object detection for asset management.

Delair, established in 2011, has expanded through its acquisitions of former competitor Airware in 2018 and Gatewing from Trimble in 2016. Intel invested an eight-figure sum in Delair in 2017 to help it further develop its analytic tools.

### Carry More, Do More

In the past, a crucial part of the decision-making process to implement UAV usage has been whether to use multirotor or fixed-wing drones. Multirotor drones offer the advantages of lower initial hardware costs, higher accuracy in some applications, and generally more operational flexibility, while fixed-wing UAVs can cover more ground per flight, have a less-complex design and can be configured to carry a heavier payload. Conversely, fixed-wing units are usually more expensive, can’t provide the hover capabilities provided by multirotor UAVs for special survey requirements, and traditionally need level terrain for takeoff and landing, although the latter problem has been eased by development of vertical- and short-take-off-and-landing (VTOL/STOL) UAVs such as the Fusion model from the French drone builder Héliéco. The hybrid Fusion UAV, according to the company, can scan up to 725 hectares (1,800 acres) during a single flight and can take off and land vertically and automatically. It provides maximum payload capability of 1.6 kg (3.5 lb) and features carbon fiber, Kevlar and composite construction with removable wings for convenient transportation.

Polish drone builder FlyTech introduced a VTOL module for its fixed-wing BIRDIE

model earlier this year, allowing users to operate the drone in its original configuration or add autonomous vertical takeoff and landing capability as required according to mission or terrain characteristics.

Arizona, USA-based Krossblade Aeronautics released the second version of its Skyprowler 2, which uses an innovative “switchblade” design to function either as an aerodynamically-smooth fixed wing or versatile VTOL vehicle during flight according to mission needs. It also can operate as a conventional multirotor UAV by removing the wings before flight.

A steady flow of technological advances has expanded remote sensing functions for UAVs in general, allowing drone-based survey and mapping operations to benefit from improved modularity, miniaturization and intelligence, while non-imaging sensor technology improvements have increased UAV control capabilities while in flight. And as UAV models proliferate, changes to their physical measurements are moving in two directions: Smaller but increasingly capable UAVs are ideal for carrying out inspections inside structures or confined spaces, and as we’ll see later, in underground workings. Meanwhile, larger UAV models are more stable in rough air and can carry larger sensor arrays.

As an example, Microdrones GmbH, a German supplier of aerial mapping solutions, just announced the release of several integrated UAV systems based on the company’s md4-3000 heavy-lift multirotor platform, as well as a new software package for efficient processing of geospatial data. The mdMapper3000DuoG VHR integrates a 100-megapixel camera and a vibration-free quick connect mount for direct georeferencing capabilities with one-pixel mapping accuracy from a 1,000-ft drone altitude.

Dr. Mohamed Mostafa, director of md-Solutions at Microdrones, commented: “This system is a game-changer for Microdrones as now we can compete in some of the same arenas that photogrammetry pro-



Fusion is a winged drone designed for long-distance photogrammetric surveying. Its innovative vertical takeoff system (VTOL) allows for takeoff and landing at all types of sites.



Microdrones' mdMapper3000DuoG VHR is the company's flagship mdMapper system, featuring a 100-megapixel digital camera.

professionals relied on manned aircraft for. You can fly the mdMapper3000DuoG VHR at a height of 1,000 ft and achieve triple the image quality and double the Direct Georeferencing in just half the time without all of the traditional manned aircraft expenses."

Other new models include the mdMapper3000DuoG, featuring a 42.4-megapixel camera paired with a nadir mount. Its Direct Georeferencing system, according to the company, acquires high-density,

high-accuracy data faster than PPK (Post Processing Kinematic)-based mapping systems. It can be upgraded to VHR or LiDAR capabilities with the additional payloads, firmware and software.

According to Microdrones, Direct Georeferencing is a highly efficient method for connecting aerial images to their geographic positioning on the Earth's surface. By measuring the true 3D coordinates and orientation angles of any sensor (with the use of a GNSS receiver and an Inertial Measuring Unit) DG allows for direct map production. DG surpasses the accuracy of traditional methods such as traditional aerial triangulation, RTK and PPK.

Microdrones' mdMapper3000 PPK can acquire dense and accurate data with just one to three ground control points. Also featuring a 42.4-megapixel camera and nadir mount, the system is upgradeable via firmware to Direct Georeferencing.

It's also possible to go smaller — much smaller — when payload capacity takes a back seat to convenience and immediacy of need. For example, drone maker DJI recently announced the launch of the Mavic Mini, a folding drone that weighs only 249

g (8.7 oz) and features a built-in camera for capturing high-definition photos and video. With a flight time of up to 30 minutes, Mavic Mini builds on the technological innovations developed in DJI's range of folding Mavic drones, from the original Mavic Pro through Mavic Air and Mavic 2.

Mavic Mini's camera, incorporating a 1/2.3-in. sensor and mounted on a three-axis motorized gimbal, captures 2.7K video at 30 fps, 1080p at 60 frames per second, or 12-megapixel photographs. An HD live feed is delivered to the dedicated remote controller via Wi-Fi. Its ease of use and simplicity combine to make it a handy tool for quick inspection and evaluation flights when convenience and time, rather than technological sophistication, are crucial.

The Mini will automatically return to the launch point if it loses connection to the controller or reaches critically low battery level. It can be used with DJI's new DJI Fly app, which provides a simplified interface for flying and features pilot tutorials and pre-set editing templates. QuickShot pre-programmed flight maneuvers provide an easy way to capture video from a variety of heights, angles and directional maneuvers.

COMPANY PROFILE-PAID ADVERTISEMENT



U.S. Tsubaki Power Transmission LLC is a leading manufacturer and supplier of state-of-the-art power transmission and motion control products and is a global leader in roller and conveyor chain production. U.S. Tsubaki is the largest global subsidiary of Japan's Tsubakimoto Chain Co., which was founded in 1917. Today, Tsubaki's products are marketed in more than 70 countries. U.S. Tsubaki's corporate headquarters and main distribution warehouse are just outside of Chicago in Wheeling, IL, and it has full manufacturing facilities in Holyoke, MA, and Sandusky, OH. In addition to this it has service centers strategically located in Rialto, CA; Houston, TX; Atlanta, GA; Philadelphia, PA; and Anoka, MN; Milwaukee, WI.

The TSUBAKI name is synonymous with excellence in quality, dependability and customer service. An intense focus on research and development, along with constant modernization of its production facilities are among the key components in Tsubaki's ability to successfully meet the ever-changing needs of the marketplace. Leveraging its vast, international network of corporate and industrial resources, U.S. Tsubaki offers customers the finest power transmission products in the world as it strives to be the "best value" supplier in the industry.

Tsubaki's global presence affords the company unprecedented opportunities to market advanced new products and technologies, and to utilize the intellectual assets of what it characterizes as "some of the brightest minds in business and engineering from around the world." This strength, combined with its continuous improvement of quality and processes, has U.S. Tsubaki poised for lasting growth now, and well into the future.

U.S. Tsubaki's industrial group is currently comprised of four business units: the Roller Chain Division, Engineering Chain Division, Power Transmission Components Division (which includes Sprockets) and the KabelSchlepp Cable & Hose Carrier Division.

The Roller Chain Division provides some of the most versatile products on the market. Tsubaki innovations have yielded popular problem solvers such as selflube Lambda® series chain, corrosion resistant Neptune® chain,

fatigue resistant Super Chains, and rugged Energy Series® oil field chains. Attachment chains used for conveying a variety of products are also available in a range of configurations.

U.S. Tsubaki's Engineering Chain Division starts with high-performance base materials to ensure increased wear life. They offer heavy-duty chains designed specifically to meet the demanding needs of a vast array of industries—all designed to prolong wear life under rigorous operating conditions.

U.S. Tsubaki sprockets are built from top-grade, heat-treated carbon steel to offer long wear life, resist abrasion, and withstand heavy shock loads. Alloy and stainless steel sprockets are also available for extra corrosion resistance and food-grade applications. Precision manufacturing at their ISO-certified facilities ensures that every U.S. Tsubaki sprocket stands up to critical design specifications and meets the highest quality standards.

Power Transmission Components products include all Tsubakimoto products other than chain and sprockets. A partial listing consists of belts, cam clutches, actuators, dampers, overload protection and reducers.

The Cable & Hose Carrier Division supplies steel, high-grade stainless steel, solid plastic cable carriers and hybrid cable carriers with aluminum stays and plastic side-bands, in standard sizes or tailor-made to an individual customer's exact size and application requirements.

It is an ISO 9001:2000 and ISO 14000 registered company.

Recent developments from sensor suppliers also point to a future bonanza of drone-based data collection made possible by smaller, more efficient imaging components and advanced position sensors that are necessary for precise UAV flight control. For instance, Atmos UAV, a Dutch drone manufacturer, announced availability of its new MicaSense Altum sensor, which integrates a radiometric thermal camera with five high-resolution narrow bands, producing thermal, multispectral and high-resolution imagery from just one flight. According to the company, its Marlyn fixed-wing VTOL surveying platform is currently the only drone in its class capable of carrying the new high-end sensor.

Trimble introduced the UAS1, a compact, high-precision Global Navigation Satellite System (GNSS) board specifically designed for unmanned aerial systems. The UAS1 is designed to allow system integrators to easily add satellite-based positioning with potential for upgrades.

The 336-channel GNSS solution provides centimeter-level, real-time kinematic (RTK) positioning, tracking L1/L2 frequencies from the GPS, GLONASS, Galileo and

BeiDou constellations. Trimble CenterPoint RTX GNSS corrections are also supported, which enable precise positioning without the use of a base station via a subscription service. CenterPoint RTX allows users to achieve better than 2-cm horizontal and 5-cm vertical accuracy.

### A Piece of the Puzzle

UAVs fit perfectly into the mosaic of technologies that the industry eventually will piece together to achieve its long-term safety and productivity goals, including: 1) Removing workers from hazardous environments, and eventually from most active mining sites; 2) Increased use of Artificial Intelligence in exploration and other phases of mineral discovery and development; and 3) Totally autonomous operations.

UAVs have been used for years to conduct tasks such as stockpile measurement and remote mapping — allowing companies to eliminate the need for humans to enter risky areas — and new applications continue to emerge. Blast Movement Technologies (BMT), an Australian company, recently announced the availability of its



At less than 250 g, Mavic Mini is exceptionally portable and is in the lowest weight class of drones, which in many countries may exempt it from certain regulations.

Flight Enabled Detector (FED), a UAV that can fly over a blast muck pile and detect BMM (Blast Movement Monitor) locations post-blast. BMMs are small, brightly colored balls sold by BMT that are positioned in a blast pattern before a blast and move with the blasted rock. A built-in transmitter can be activated to transmit a depth and location signal that is received by the FED-mounted detector, providing data that can be used with BMT's Explorer software to define ore polygons after blasting.

The FED is based on the DJI Matrice M600Pro platform, fitted with a unique BMM detector and GPS to find and report the position of BMMs. It serves as an alternative detector for mines that either

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BMT's FED (Flight Enabled Detector) comprises a multirotor drone fitted with the company's Blast Movement Monitor detector.

do not allow or prefer not to use mine personnel to walk the post-blast muck pile. According to BMT, FED usage to retrieve blast movement data resolves a variety of safety and environmental considerations and in many cases allows for faster access and a broader range of data acquisition following the blast stand-off period.

Exyn Technologies, which develops autonomous aerial and terrestrial robot systems for complex, GPS-denied industrial

environments, recently reported a successful mission to map previously inaccessible areas in a historic underground gold mine. The data collected during the mission provides precise locations of 70-plus-year-old underground workings and stopes, as well as structural geological information, which would likely have been unobtainable due to area-access risks.

U.S.-based Exyn was brought in on the project to help Ascot Resources, a Canadian junior exploration company, gather hard-to-access data from long-inactive mine workings dating back to the 1940s. Certain parts of the mine's layout, particularly old stopes, were unsafe to access by mine personnel.

"At Ascot we are looking to use the facilities available at a former producing mine to extract new resources that we are currently drilling. Exyn came to our site to show us the autonomous capabilities of their drone technology, and we were very impressed with the timeliness and quality of the data acquired," said John Kiernan, COO of Ascot Resources. "Looking forward, we think this technology will be used to safely explore and evaluate the condi-

tion of underground mines, while also potentially providing cost savings in mine surveying and ventilation monitoring."

Exyn's autonomous A3R drones were able to create a comprehensive map of the mine's workings using LIDAR mapping technology. The map, when cross-referenced against existing mine layouts and core drilling data, will enable Ascot Resources' teams to determine where additional gold and silver resources might be inferred.

Exyn said its multi-sensor data fusion pipeline allows each robot UAV to optimally assimilate measurements from a variety of onboard sensors, including 3D LiDAR, cameras and inertial sensors to generate a robust state estimate of itself and surrounding environments. When combined with the company's real-time navigation software stack, the UAVs can safely avoid collisions with both stationary and moving obstacles during missions. Moreover, said the company, its UAVs are also able to do real-time Simultaneous Localization and Mapping (SLAM) to enable highly accurate map generation.

The company's exynAI package is available for license and can be integrat-

COMPANY PROFILE-PAID ADVERTISEMENT

## Tsurumi Submersible All Stainless Steel, Corrosion-resistant Pumps

Since its foundation in 1924 in Japan, Tsurumi Manufacturing Co., Ltd. has been engaged in the manufacture, supply and sales of pumps, environmental devices and related equipment, with submersible pumps being key products.

Tsurumi offers "LH-14/LH-W-14 series corrosion-resistant pumps," which are suitable for drainage of corrosive liquids in mines. For all parts of Tsurumi submersible corrosion-resistant pumps that are exposed to fluids, 316 stainless steel is used, which provides excellent corrosion resistance. Using this material can protect the pumps from corrosion, enabling handling of corrosive acidic liquids and chemical liquids of a low pH value. Particularly, Tsurumi has devoted energy to development of submersible pumps made of 316 stainless steel casting. The pumps made of stainless steel casting provide durability to withstand harsh applications in which pumps made of aluminium, stainless steel and cast iron may suffer damage in several days or several weeks. Use of stainless steel casting considerably improves product reliability, in comparison with use of stainless steel, in applications that need heavy-duty work.

The LH-14/LH-W-14 series is a submersible stainless steel casting high head corrosion-resistant pump designed for handling aggressive and corrosive liquids. The all wetted parts are made of 316 stainless steel, enables it to withstand demanding conditions found in construction, aggregate and mining applications. The LH-14 series has a single impeller, and the LH-W-14 series has dual impellers. The LH-14 and LH-W-14 series are available in a wide product lineup, covering a discharge bore diameter of 80 to 200 mm, motor output of 11 to 110 kW, and maximum head of 51.8 to 184 m.

These pumps, as well as Tsurumi's general drainage pumps, are equipped with an anti-wicking cable, motor protector, SiC dual inside mechanical seals



LH-14 series  
(Single Impeller)



LH-W-14 series  
(Dual Impellers)



with silicon carbide faces, and Oil Lifter, with extensive research and a track record accumulated over many years combined into Tsurumi original technologies. And the material used for rubber parts such as the mechanical seal, oil seal, O-ring and packing, is FPM (FKM), which provides high resistance to heat and chemical exposure. With these features, Tsurumi pumps are designed to provide high reliability and excellent durability, enabling continuous operations for long periods.

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*The OO series is indicated with our series code in this text.*



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ed other drones or robotic platform. Exyn's branded A3R drones comprise a commercially available off-the-shelf drone airframe outfitted with its autonomous flight and mapping payload. The company explained that it specifically designed exynAI as a flexible solution capable of extending robotic automation to any number of platforms. For drone applications, it provides a sliding scale of control that ranges from fully autonomous, pilotless flight with collision avoidance to pilot-assisted flight with sense-and-avoid technology. Exyn offers a subscription model that includes the robots, software and updates, and also sells directly to customers.

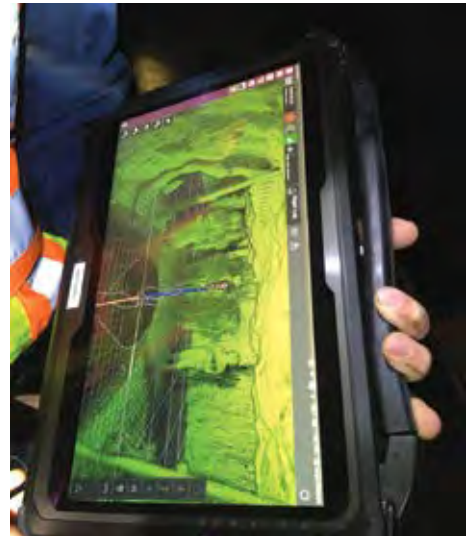
Emesent, a Queensland, Australia-based drone autonomy and data analytics startup, also offers an autonomous payload package for underground survey and mapping. The system, called Hovermap, is built around a Velodyne VLP-16 Puck Lite LiDAR sensor. This scanner uses 16 channels and gathers 300,000 points per second. Hovermap's implementation of the sensor also rotates it in order to achieve a full 360° x 360° field of view. Emesent said Hovermap's SLAM tech-

nology and autonomy technologies were hatched from five years of R&D at CSIRO, the Australian national research organization. Emesent was spun off from CSIRO as a venture-funded company in late 2018.

For use as a mapping-only payload, the Hovermap system can be mounted on any vertical take-off and landing (VTOL) drone that can lift the 1.8-kg payload. However, if full autonomy is required, it's necessary to mount Hovermap on a DJI A3 autopilot-enabled drone. The company claims that its SLAM processes data up to four times faster than other implementations and can include GPS when available to assist with SLAM calculations.

### A Changing Picture

Just as it's hard to identify the exact point in time that drones gained a foothold in mining, it's equally hard to predict what their ultimate role will be. Right now, they're indeed a game-changer when it comes to conducting frequent, limited-area surveys and inspections and eliminating the need to have workers enter risky environments. With further gains in sensing, maneuverability, payload capacity and autonomous



Exyn says its AI solution can be adapted to achieve robotic automation on a number of platforms, including fully autonomous flight with collision avoidance for drones.

capabilities supported by advanced AI platforms that work for both airborne and surface vehicles, the typical mine site of the future may present a very different picture from what we see today — and it's likely that picture will be taken by a drone.



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# Narrow-vein Gold Miner Mandalay Improves Ore Recovery with Remote Controlled Loaders



After installing RCT's guidance automation package on a single LHD in 2015 with good results, a gold mine recently added the guidance system to two other LHDs and reported benefits ranging from operator safety improvements to reduced shift changeover time and less unplanned machine downtime.

In a recent case history provided by RCT, the Australia-based automation and control specialist company explained how one of its customers, Canadian mining company Mandalay Resources, benefited from implementation of remotely controlled loaders in a narrow-vein mining operation in Australia.

Mandalay owns and operates the Costerfield gold-antimony project southeast of Bendigo in Victoria. The operation extracts ore via a single-portal underground mine, using narrow-vein methods. The mine produces up to 80,000 equivalent ounces per year (oz/y) in gold and antimony in gravity gold and a concentrate containing approximately 54% antimony and 60 grams per metric ton (mt). The nature of narrow-vein mining dictates that ore drives must be minimal in cross-section to reduce dilution.

Costerfield's drilling and blasting program was designed to maximize ore recovery by throwing the ore toward the draw point. However, historically, the site could only recover 75% of the ore because remaining ore sitting in the stope void was out of reach of the underground loader. Manually operated loaders were not allowed to work beyond the stope brow.

Mandalay investigated implementing a loader that could be managed remotely to extract additional ore and to safeguard equipment operators from hazardous sit-

uations at the mine face. In 2015, Mandalay engaged RCT to install its ControlMaster Guidance Automation product on a Sandvik LH203 Loader. The automated loader enabled Mandalay Resources to retrieve significant amounts of ore that were previously unreachable.

In recent years, RCT has increased the autonomous fleet at Costerfield by commissioning ControlMaster Guidance Automation on a second Sandvik LH203 as well as a Sandvik LH151D. The machines are managed from Fiber Optic Control Stations (FOCS) at secure locations in the underground mine protected by Laser Guard Containment Units as well as stations on the mine's surface.

"Removing operators from the machine is the best outcome as it eliminates their exposure from one of our highest risk jobs, which is working at a stope brow," said Jayson Guzzo, major projects and innovation manager at Costerfield. "The small loaders we use are very rigid, which has the potential for repetitive strain injuries. They also have open cabs and, in this environment, dust, machine exhaust and debris can be an added safety concern."

In mid 2019, Mandalay decided to install a digital mine communications network to accommodate future technological growth. "Given that we are a narrow vein operation, we may have to

access ore a significant distance from the mine access point, so we are looking at going to a digital platform so we can run a fiber backbone and autonomously operate machines over a vast distance," Guzzo said.

"In a traditional mine you might spend a whole week bogging a single stope before moving, but at Costerfield, we might bog 3 or 4 headings in one shift, so the number of sites that we have to have set up at any one time are multiple. Hence a digital system will significantly speed up the process of commissioning new drives."

Mandalay reported that ControlMaster Guidance Automation allowed the mine to carry out bogging and firing operations simultaneously, saving substantial time that was previously spent clearing personnel to a safe distance. The system enabled the company to reduce shift changeover time by two-thirds. According to Guzzo, the site has experienced less unplanned machine downtime.

"At Costerfield the drives are roughly 2 meters wide so Guidance Automation keeps the machines off the walls and stops them bouncing around the tunnels so the damage to the machines is a lot less and results in significantly reduced unplanned maintenance time," he said.

## Collaboration Aims to Enhance Exploration Data-analysis Efficiency

Micromine announced recently that collaboration with Imdex, another mining software provider, has joined together



Output files from Imdex's ioGAS program (above) will be directly importable to the newest version of Micromine's 3D mine design and modelling software.

detailed geoscience analytics with sophisticated 3D modelling and mine design software to enhance the geological modelling workflow.

Micromine has worked with Imdex for several months to integrate output from Imdex's ioGAS solution into the next major release of its 3D modelling and mine design software, Micromine 2020, which is scheduled to be launched in late 2019. The collaboration means geoscientists will be able to directly import ioGAS (.gas) files into Micromine 2020 software to map and model geological domains.

Micromine Product Strategy Manager Mark Gabbitus said the ability to import the files and related geological and geochemical interpretative analysis into Micromine 2020 was a boon for both companies and their customers. "Micromine and Imdex recognize it's in everyone's interests to enable the efficient transfer of data between packages," he said.

Although Micromine 2020 is still under development, Gabbitus confirmed some of the key features that would integrate with ioGAS, including:

- In-built ioGAS symbol library so that data imported into Micromine looks exactly as it did in ioGAS;
- Downhole data that can be brought from an ioGAS .gas file directly into Micromine as points where attributes (e.g., material type) can be modelled or displayed alongside geological logging to validate boundaries and contacts; and
- Downhole data displays that effectively show how geochemical properties differ between logged geological units.

The company said that in Micromine 2020, drillhole traces can be easily created from downhole points contained in an ioGAS .gas file; this data is then saved as a drillhole database in Micromine.

Micromine stated that with more than 10 years of development, Imdex's ioGAS software has resulted in optimized workflows and convenient tools that incorporate industry best practice in interpretive techniques. The exploratory data analysis software offers detection of patterns, anomalies and relationships in users' geoscience data. According to the company, it has more than 350 commercial clients and 20 government organizational users.

Micromine said it would continue to work with Imdex and its ioGAS team to further refine the integration before Micromine 2020 is released to the market.



Application of a new mapping technology can provide a number of benefits in a mine setting, according to ASI, including better-defined dump and road edges, canals, ditches and other negative-space terrain features.

### Algorithm Improvement Adds to Autonomous Vehicle Safety

Autonomous Solutions, Inc. (ASI) said it has improved an algorithm for autonomous vehicles to detect drop-offs and other large "negative" obstacles often found in areas in which automated off-road vehicles typically operate.

"ASI has developed a method for mapping point cloud occlusions in real-time," said Taylor Bybee, Perception Tech lead at ASI. "[This] provides additional accuracy and safety when integrated into an autonomous vehicle obstacle detection and avoidance system."

For safe navigation through an environment, autonomous ground vehicles rely on sensor data representing 3D space surrounding the vehicle. Often this data is obscured by objects or terrain, producing gaps in the sensor field of view. These gaps, or occlusions, can indicate the presence of obstacles, negative obstacles, or rough terrain.

Occlusions can be defined as a blockage that prevents a sensor from gathering data in a location. For example, occlusions can be seen as shadows in LiDAR data. Because sensors receive no data in these occlusions, sensor data provides no explicit information about what might be found in the occluded areas. Information about the occlusions must be inferred from using an occlusion

mapping algorithm to provide the navigation system with a more complete model of the environment.

"While sensor data itself doesn't tell us what's in the occluded areas, occlusions can represent negative obstacles like drop-offs or areas behind large obstacles," said Jeff Ferrin, CTO at ASI. "It's important to identify these areas for obstacle detection and avoidance to work properly."

Application of this new technology can be useful in settings with dump edges at mine sites, steep road edges, canals, ditches, hills or stairs for indoor or urban environments. The occlusion mapping algorithm has three main components. The first is a sensor field of view (FOV) model that describes what obstacles the sensors are expected to detect. This component is designed for point cloud sensors such as 3D LiDAR, Flash LiDAR, structured light and stereo cameras.

Second, an occlusion map is maintained and updated using the sensor FOV model and current sensor data to provide a probabilistic estimate on areas that have not been detected within the sensor FOV. The third component is the integration of the occlusion map into an autonomous vehicle navigation system. It is designed to work with and complement existing obstacle detection and avoidance systems, according to ASI.

# Vale's Carajás Mine Adopts Komatsu Hauler Fleet



Komatsu announces 37 930E haulers would be deployed to Vale's Carajás iron mine, above. Inset, to train locals on operating the haulers, Komatsu opens a training center near the mine. (Photos: Komatsu)

Komatsu reported it will deploy 37 930E ultra-class electrical haulers that will be part of an Autonomous Haulage System (AHS) at Vale's Carajás iron mine. The haulers will leverage Komatsu's AHS FrontRunner technology. The goal is to have all the trucks operating autonomously by 2024.

As part of the deployment program, Komatsu opened a training center near the mine in August. The center provides operations and maintenance training to upskill local people on the new technologies.

Leadership at Komatsu said the development reflects the miner's commitment to sustainability. "We look forward to our continued work together to support the skill growth of local workers and ensure a successful deployment that is designed to increase the safety and productivity of this operation," Masayuki Moriyama, president, mining business division, Komatsu, said.

The move puts AHS at 10 mine sites in four countries, Komatsu reported.

## NioCorp Gets DuPont Sulfuric Acid Plant

DuPont Clean Technologies announced NioCorp Developments Ltd. selected a MECS sulfuric acid plant for its Elk Creek Superalloy Materials Project in southeast Nebraska.

DuPont leadership said the technology was ideal for the project. "Emissions control is a fundamental part of what we do, so we are delighted to assist NioCorp in achieving its environmental goals," Eli Ben-Shoshan, president, DuPont Clean Technologies, said.

NioCorp has obtained the major federal permits needed for construction of the project. The three minerals NioCorp plans to produce, niobium, scandium and titanium, are considered critical by the U.S. government.

The project is one of the few new critical metals mines to have reached the funding and construction stage in the U.S.

## Suncor Taps Microsoft for Cloud Platform

Suncor announced a multiyear strategic alliance with Microsoft for the latter's cloud solutions and services. The two will collaborate on innovation projects, Suncor reported.

Suncor will leverage the Microsoft Azure cloud platform, which is expected to enable rapid deployment of new technologies to improve safety and productivity through artificial intelligence, machine learning, enhanced automation and machine health monitoring.

Suncor leadership said Microsoft was the ideal partner due to its dedication to global innovation best practices. "This is an example of how we are driving to improve our business in ways that were not possible before: to make our people safer, increase reliability and productivity, reduce costs and improve sustainability," Mark Little, president and chief executive officer, Suncor, said.

## 2,500-TPH Reclaim Hopper for Stockyard

Transmin reported a Bonfiglioli-driven reclaim hopper was delivered to an iron ore export stockyard to be fed by 50-ton-bucket-capacity front-end loaders and to put 2,500 tons per hour of ore onto a conveyor.

The low-profile, relocatable machine features custom-engineered Bonfiglioli combination Trasmital planetary and HDO



The latest low-profile feeder reclaim hopper under construction by Transmin. (Photo: Bonfiglioli)

helical bevel drives that achieve high-torque densities in a compact space. The machine weighed 90 tons and was mounted on a skid frame. It incorporated a standalone electrical control system and an over-band tramp metal magnet located above the feeding conveyor belt to achieve a lower space requirement.

Leadership at Transmin said the Bonfiglioli unit was selected due to cost, delivery time and reliability.

## Siemens to Acquire Edge Tech From Pixeom

To boost its Industry 4.0 solutions offerings, Siemens reported plans to acquire Edge technology from U.S. company Pixeom. Siemens reported the move is meant to drive forward the expansion of its Digital Enterprise portfolio.

Siemens reported it hopes to add components for Edge runtime and for device management to its Industrial Edge portfolio. The goal is for appropriate apps to analyze data locally at the machine and send relevant data to the higher-level Industrial Edge Management System for global analytics.

Leadership at Siemens said Edge Computing can “open up new scope” for automation. “With Siemens Industrial Edge, we are creating an open-edge ecosystem that offers benefits for companies of any size,” Ralf-Michael Franke, CEO, business unit factory automation, Siemens, said.

## New Nunavut MacLean to Support Agnico Ops

MacLean Engineering announced it partnered with the Rankin Inlet-based Nunavut Investments Ltd. to create Nunavut MacLean Inc., an Inuit-owned business registered on NTI’s Inuit Firm Registry. Nunavut MacLean will provide a long-term platform for supporting MacLean



BKT's carbon black plant produces 60,000 tons in Q1 2019. (Photo: BKT)

specialty mobile equipment at Agnico Eagle’s underground mines in the Kivalliq region of Nunavut.

There are more than 30 MacLean mining vehicles servicing Agnico Eagle’s Nunavut operations at the Meliadine underground mine and Amaruq Whale Tail underground project. The Agnico Eagle fleet of MacLean mobile equipment in the Kivalliq spans the range of production support mining vehicle categories.

## Epiroc Partners With Orica on Automation

Epiroc partnered with explosives provider Orica to jointly develop a semiautomated explosives delivery system. The system will be developed to address growing demand from miners working in increasingly hazardous and challenging underground operations, the former reported.

Leadership at Epiroc said the development was a critical move toward automating the entire drilling and explosives charging process. “It is a vital part of both Epiroc’s and Orica’s vision of making the mining operation as safe, productive and cost efficient as possible,” Helena Hedblom, senior executive vice president, mining and infrastructure, Epiroc, said.

## BKT’s Carbon Black Plant Operational

BKT reported its carbon black plant within the Bhuj production site will run at 100% capacity in 2021. At the end of the Q1 2019, the plant had a carbon black production output of 60,000 tons, increasing to 80,000 tons in Q2.

Around 50% of the carbon black produced at the new plant is being used in BKT’s tire manufacturing process, while the other remaining 50% is sold on the market.

BKT reported it is the only company in the Indian tire industry with its own carbon black production plant. Leadership at the company said the plant would bear results. “Not only does the new plant provide us with manufacturing independence, but it also ensures a better quality of our raw materials, since we have now precise upstream control over the entire process,” Rajiv Poddar, joint managing director, BKT, said.

## Fluor Joins AC-Tek Exclusively

Fluor Corp. signed an exclusivity agreement with Advanced Conveyor Technologies Inc. (AC-Tek). Under the agreement, the companies are exclusive partners for conveyor projects in key global mining geographies.

The agreement includes Fluor subsidiary Virta Inc., a new bulk material handling systems company.

Leadership at Fluor said the agreement combines the expertise of two established leaders in the materials handling space. “This exclusivity agreement improves Fluor’s value proposition for mining and metals projects as well as opportunities in other key markets like chemical plants and



Nunavut Investments Ltd. is owned and operated by Patrick Tagoona, above, a Rankin Inlet resident and entrepreneur. (Photo: MacLean Engineering)

ports and terminals,” Leonardo Kaid, vice president, global business development and strategy, Mining & Metals, Fluor, said.

Fluor and AC-Tek have collaborated on a significant number of overland conveyor projects since 2007.

## Partnership on Water Project for Atacama

TRENDS Industrial and the Sustainable Minerals Institute International Center of Excellence Chile joined to build an optimization supply model for the use of desalinated water in the Atacama Region of Chile. The agreement allows both parties to share knowledge and information to build the model, which will be available for regional authorities, companies and other key stakeholders.

Both parties have been researching opportunities to develop multiuser water supply systems with shared infrastructure.

Leadership at TRENDS Industrial said the model would be for a system allowing users to lower costs and minimize impacts. “Economies of scale are taken advantage of, reducing the impact on the territory and improving efficiencies, as we have been seeing in large-scale mining projects in Chile, which have chosen a collaborative approach,” David Mulligan, CEO, TRENDS Industrial, said.

## Multotec Taps Turbo as Agent in Turkey

Multotec announced it selected Istanbul-based Turbo Ltd. as its new agent in Turkey. Turbo landed the role because of its infrastructure and technical expertise, Multotec reported.

Leadership at Multotec said it has a renewed focus on the region and intends to expand its footprint there significantly. “Over the years, Multotec equipment has been installed in the chrome, gold and coal sectors, and through the appoint-

ment of Turbo we will be able to extend our reach and include a larger range of proven Multotec solutions to the mining and minerals processing industry in Turkey,” Bart Malan, Multotec’s international business development manager for Eurasia, said.

While Multotec historically marketed cyclones and spiral concentrators in Turkey, the future will see it market a growing range of equipment, including samplers, screening systems, flotation components, pumps and magnetic separators, the company reported.

Multotec plans to work with Turbo to set up a mineral testing laboratory in Turkey, Malan said.

Turbo focuses on high-quality after-sales service, and its Istanbul workshop is certified by the Turkish Standards Institute, Multotec reported.

## Hawk Measurement, FLO-CORP Merge

Hawk Measurement America merged with FLO-CORP to form a complete flow, level, and asset monitoring solutions provider.

Leadership at Hawk Measurement America said the merger will streamline innovation while establishing a manufacturing base in the USA. “By combining HAWK’s award-winning measurement technology, together with FLO-CORP’s measurement monitoring solutions within a subscription-based platform, we are increasing our ability to provide unmatched customer support, innovative technologies and system solutions,” Jack Evans, president, Hawk Measurement America, said.

The private company will operate under the HAWK brand.

## Tires Direct to Sell Magna Tires in US

Magna Tyres Group announced a strategic partnership with Tires Direct in the U.S.

The latter will distribute the former’s tires from Magna distribution warehouses in Los Angeles, California; Atlanta, Georgia; Dallas, Texas; Jacksonville, Florida; Coldwater, Ohio; Clayton, North Carolina; and Chicago, Illinois.

Separately, Magna reported it opened a sales office in Fort Lauderdale, Florida, U.S. The expansion was necessary due to the growth and huge demand for the Magna brand in the U.S. and in line with the plan to become the premium second-tier tire brand on the continent, the company reported.

Separately, Magna Tyres announced two OBO establishments have changed names. OBO Tyre Hardenberg became Magna Tyres Factory, and OBO Reifen Leipzig became Magna Tyres Germany. The company reported the name changes will improve brand awareness and lead to clearer positioning of the company.

## Brazil’s Engecampo to Sell McLanahan Solutions

McLanahan Corporation partnered with Engecampo to distribute the former’s mineral processing solutions in Brazil. Engecampo offers engineering services and products for a variety of industries in Brazil.

Leadership at McLanahan said the two companies share values, philosophies and responsibilities. “Engecampo has a long history of delivering successful outcomes, through first class value and solid engineering in the Brazilian market,” Neil Hunt, managing director, McLanahan, said.

## Outotec Research Center Turns 70

The Outotec Research Center (ORC) in Pori celebrated its 70<sup>th</sup> anniversary. The center is credited with developing Outotec Flash Smelting. Its labs conduct tests on raw materials for customers. Testing capabilities include nine labs and pilot plants.

## Total gets 3 Houghton Oil Lines

Total Lubrificants acquired from Houghton International its aluminum hot rolling oil, steel cold rolling oil, and tinplate rolling oil activities, including the associated technical support services, in North American and European markets.

Total leadership said the move will strengthen the company’s position in the



Turbo CEO, Can Ozdemir, with the company’s team of engineers and support staff. (Photo: Multotec)

lubricants market. “Geographically we are strengthening our strong presence in Europe and expanding our activities and market penetration in North America, especially in the USA,” Philippe Charleux, senior vice president, lubricants and specialties, Total, said.

### RPMGlobal Turns 50

RPMGlobal reported celebrating its 50<sup>th</sup> anniversary in business. The company describes itself as the largest publicly traded company of its kind. Leadership of the company reported it reached the milestone by remaining true to its founding principles. “What the company has achieved since the launch of its first mining solutions product, Talpac, more than 40 years ago is testament to our passionate employees and strong executive leadership who continue to drive the company forward,” Richard Mathews, CEO, RPM-Global, said.

### Rolls-Royce to Restructure Brands

Rolls-Royce Power Systems reported it will rebrand itself. Four subsidiary

companies will be renamed. MTU Friedrichshafen GmbH will become Rolls-Royce Solutions GmbH. MTU America Inc. will become Rolls-Royce Solutions America Inc. MTU Onsite Energy GmbH in Augsburg will become Rolls-Royce Solutions Augsburg GmbH. MTU On-site Energy Systems GmbH in Ruhstorf will be renamed Rolls-Royce Solutions Ruhstorf GmbH.

### Thompson Pump Awarded for Disaster Relief

Thompson Pump and Manufacturing Co. announced it won the 2019 Engineering News-Record Award of Merit in the Water/Environment category for its work in Puerto Rico during the immediate aftermath of Hurricane Maria. The 13-person Thompson Pump crew’s efforts helped save an entire community from a potentially catastrophic flood and provided safe drinking water to more than 200,000 people, the company reported.

In the days after of the deadly Category 5 hurricane, Thompson equipment and personnel lowered the water level at the overflowing Guajataca Dam, and



Thompson Equipment was put to use in disaster relief efforts after Hurricane Maria hammered Puerto Rico. (Photo: Thompson Pump and Manufacturing Co.)

helped move water to be treated and made potable.

Leadership at the company said the destruction encountered was unimaginable. “Without hesitation our team, both on the ground in Puerto Rico and home in Florida, immediately got to work to make sure we could do whatever was possible to help the people through this extremely challenging time,” Bobby Zitzka, national sales manager, Thompson Pump, said.

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# Outotec Unveils Modular Backfill Plant



The plant's compact footprint reduces the cost of civil works and increases flexibility of plant location, according to the company.

Outotec introduced a Modular Paste Backfill Plant (MPB 80) designed to be a cost-effective solution for underground non-ferrous mining applications with low-range backfill throughput requirements.

A high-quality backfill system, the company noted, is vital to ensure mine integrity and the safety of personnel, as well as to minimize the volume of tailings that need to be directed to tailings dams on the surface. With a dedicated paste backfill plant, mines can produce high-quality paste at a lower cost than is possible with modified concrete plants and larger, previous-generation paste backfill plants.

Outotec said the MPB 80 plant is an ideal alternative to installing a concrete batching-style plant that has been reconfigured for producing paste backfill.

The MPB 80 plant features a combined paste mixer and hopper in place of separate units, enabling significant reductions in both plant size and maintenance requirements. In addition to reducing the plant footprint, the unique process design significantly reduces the need for cleaning, meaning the plant can run for multiple shifts without having to shut down, according to Outotec.

The MPB 80 is suited for mines with an ore production capacity of 700,000 million metric tons per year (mt/y) to 1 million mt/y. It is preassembled off-site

and delivered in large, pre-engineered modules, resulting in a significantly shorter interval between order placement and installation and startup, Outotec noted. Modules include:

- Tailings dewatering: Dewatering of the tailings to form a filter cake using vacuum disc filtration.
- Tailings conveying: Conveying module for transfer of dewatered tailings to the mixing module.
- Binder storage and metering: Bulk storage and continuous, accurately metered delivery of binder material to the paste mixing module.
- Tailings and binder mixing: Primary mixing module where the filter cake, binder, and additional slurry are combined to generate high-quality paste with controlled solids content and rheology.
- Backfill distribution: Pumping module for distribution of paste to the underground discharge locations. (Only used when gravity distribution pressure is not sufficient.)
- Utilities: Ancillary module containing general plant electrification, water and air services.

## Titanium Anodes for Tankhouse

The company also reported in October it won a contract to deliver its branded Coated Titanium Anodes to a new tankhouse at a copper electrowinning plant owned by Glencore Nikkelverk AS Norway. The contract will include more than 5,000 new mixed-metal oxide-coated titanium anodes and its value, booked into Outotec's third-quarter order intake, is approximately €10 million (\$11.07 million).

The Nikkelverk refinery in Kristiansand, Norway, produces approximately 40,000 metric tons of copper per year. Outotec noted that the Coated Titanium Anodes were tested on-site for 5 years, and the results verified that the anodes will operate at a significant reduction in energy consumption and provide higher current efficiency than traditional lead anodes.

Outotec explained that the Coated Titanium Anodes provide lead-free electro-winning operations and increased occupational health and safety by eliminating lead and lead-sludge handling. The end result for Glencore Nikkelverk AS is green

technology electrowinning operations with higher quality copper product at lower energy consumption and operating costs.

"This is one more reference delivery of Outotec Coated Titanium Anodes in the copper electrowinning industry," said Kalle Härkki, head of Outotec's Metals, Energy & Water business area. "The energy-efficiency benefits and lower operating costs of our anodes enable Glencore Nikkelverk to improve their profitability in a sustainable way."

## Mixing-process Data Visualization Solution From Eirich

The Eirich Group, specializing in mixing and grinding technologies for bulk materials, recently highlighted its ProView process data visualization product, noting that it is a universal tool not tied to any specific platform, enabling efficient analysis of operating data. It can be used on a PC in the office or on a tablet or smartphone while on the move.

In many industries, monitoring the mixing process is necessary for quality assurance, particularly if plants are working automatically, without direct control by a staff member. Changes in the properties or quantities of raw materials, for example, result in changes in the mixer's power draw or in the moisture content of the mix. ProView enables simple and quick analysis of the process values in such situations.

Up until now, reading off operating data has been a laborious business. In most cases, data from the plant controller can only be downloaded using a USB thumb drive, and the operator is then required to import this into existing programs. It takes time and practice before usable displays and reports are achieved.

ProView process data visualization makes life easier, according to Eirich. All parameters monitored by sensors in the plant can be viewed in detail in diagrammatic form, on a PC in the office or on a mobile device. The data are stored locally, not in the cloud.

Eirich claimed that as browser-based software that is not tied to any specific platform, ProView works with any controllers, whether from Siemens, Rockwell or



Mitsubishi. Installation on the company network is easy, according to the company. The program is preconfigured for each machine or plant but can also be adjusted by the user at any time. This allows different presentations and selection structures to be created to suit customer preferences. Useful tools such as graphical navigation on the time axis, zoom and curve comparison add to the software's user-friendliness. Statistical parameters such as the mean and the standard deviation can also be displayed as standard.

With ProView, said Eirich, easy access to real-time and/or historical data becomes possible. Information is acquired that can be used directly by quality assurance, service or process engineering groups, and which in many instances makes optimizing production flows possible.

### Metso Freeze-proofs Lokotracks for Antarctic Project

Mine and plant machinery rarely function optimally in extreme cold temperatures, and when a crucial part or system breaks in severely frigid conditions, it might cost anywhere from two to six times more to

complete a repair than if the same thing happened in a warmer climate.

So, a recent announcement by Metso that it is in the process of delivering three freeze-proofed Lokotrack crushing and screening plants to a project site in Antarctica may be of interest to producers operating elsewhere in below-zero environments.

The equipment will be used for three years to crush an estimated 126,000 m<sup>3</sup> of aggregates materials for reconstruction of the U.S. National Science Foundation's (NSF) McMurdo research station in Antarctica. The equipment will allow crushing in temperatures as low as -40 °C.

The equipment sent to Antarctica — Lokotrack LT106 jaw crusher plant, LT200HP cone crusher and ST3.8 mobile screen — was retrofitted for extreme cold. The mechanics at Metso's Technology Center for track-mounted equipment in Tampere, Finland, also developed additional protection for the equipment.

"Every part sensitive to cold has been fitted with immersion heaters and extra insulation. The selected oils and other fluids are suitable for the Antarctic climate and the specially manufactured conveyor belts run even in extremely cold weather," said

Marko Salonen, project manager at Metso's Aggregates Equipment business area.

"Alongside the equipment, we prepared the maintenance and spare parts service in such a way that everything conceivable can be anticipated and serviced independently on site. Even the packaging materials were chosen in a way that ensured that nothing unnecessary would be transported to the unique Antarctic environment," added Salonen.

"We aim to work 16 hours a day and produce 250 tons of 63-millimeter crushed stone per hour," said Jeffrey Huffman, operations manager for Leidos, the NSF's prime contractor for the project. "We also want to include some degree of fines, to gain more compact material for the buildings' foundations."

The equipment's long journey began at Metso's facilities in Finland, then onward to Germany and from there to Port Hueneme, California, from where it will travel onward to Antarctica via Christchurch, New Zealand. The final leg of the journey will require an icebreaker leading two vessels carrying a total of 35 earthwork machines. The cargo is expected to reach the McMurdo harbor early in February 2020.

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# Narrow Vein Drill Series for Hard Rock



Sandvik launched the 2711 line of narrow vein drills, which the company described as simple and safe to operate.

The new class of drills provides accurate drilling, high performance, large coverage, enhanced safety, excellent mobility, and smooth tramming, the company reported. Equipped with Sandvik's Fleet Data Monitoring systems, they are designed to be used with Sandvik's range of underground drills, loaders and trucks.

The series consists of the DD2711 development drill rig, the DS2711 bolting rig, and the DL2711 and DL2721 long hole production drill rigs.

The DD2711 is a compact and flexible single-boom electro-hydraulic jumbo for mining development and construction in small- and medium-size tunnels with a minimum cross section of 2.7 m by 2.7 m. It is designed for underground hard rock applications that require high capacity and reliability in development blast holes ranging from 3.7 m to 4.3 m in length.

The DS2711 is a one-man-operated electro-hydraulic, fully mechanized bolter for rock reinforcement in underground hard rock mines. The operator works from

supported ground while protected under a FOPS-certified canopy structure. It is for small- and medium-size tunnels with minimum cross section of 2.7 m in width by 3 m in height. It is, in effect, a small, premium bolter, Sandvik reported.

Sandvik also released the LS312 flame-proof underground loader, with 12-mt capacity and powered by a Tier II, C7.1 mechanical engine. The loader is designed to meet major international safety standards. It offers relative cost savings on consumables, up to 20% diesel fuel savings, and a 15% reduction in service time over predecessor competition, the company reported.

The LS312 can be used with Sandvik's 57-mt hydraulic assist roof support trailer for relocating longwall equipment.

Separately, Sandvik announced the Rotary Blasthole Drill Selector app. The app provides users with a list of recommended drill rigs based on basic site condition and production requirement information. The app is accessible via desktop or mobile device and can be used as a website or as a mobile app. The app is available from the Sandvik website.

[www.rocktechnology.sandvik](http://www.rocktechnology.sandvik)



## Rugged, Lightweight, Compact Pumps

Atlas Copco Power Technique announced it introduced three electric submersible pumps. The WEDA S30 and S60 are designed for drainage and sludge pumping applications; the D80 is a drainage pump.

The 3-horsepower (hp) S30, with a discharge of three in., and the 9.2-hp S60, with a discharge of four in., can handle thick mud, pH values up to eight, and particle debris up to two in.

The 31-hp D80, with a discharge of up to six in., can handle clean or dirty water, pH values up to eight, and can pass small solids up to a half in.

The company reported the pumps are up to 30% lighter and 15% more compact than the competition. They feature rotation and phase failure protection, a high-quality chrome clog free impeller, and adjustable wear-resistant rubber diffusers. The pumps consume up to 20% less energy than comparable models, the company reported.

[www.atlascopco.com](http://www.atlascopco.com)

## Rope Shovels Get Drive Updates

Caterpillar reported it updated the AC electric drive system for the 7495 and 7495 HF Electric Rope Shovels, which ensures greater reliability, improved maintenance access, enhanced safety, and expanded ability to operate in extreme environments.

Updates include a liquid-cooled motion regulator cabinet for more efficient dissipation of heat. The new system enables shovels to operate at temperatures of -40° to 50°C, and at altitudes of 5,250 m without derating. The system also eliminates airborne contaminants in the cabinet and lengthens service intervals. A faster propel transfer switch cuts lag time by 75%.

New technologies enable consolidating two cabinets in the machinery house to create space for easier maintenance access.

The drive system design uses common motors in multiple applications. The new motors have higher power densities,



smaller frame sizes and optimized footprint, which aids access, Cat reported.

The new electric drive system will be on all new production 7495 and 7495 HF shovels beginning in late 2020.

[www.cat.com](http://www.cat.com)

## Tire for Backhoe Loaders

Camso launched the BHL732 multifunctional bias tire for backhoe loaders. Described as the next generation of the company's SL R4, the tire features a wraparound stepped thread design, extra-thick void guard for tread protection, massive tread lugs, extended center blocks, and heavy-duty sidewalls with enhanced rim flange protection, the company reported.

[Camso.co](http://Camso.co)



## Borehole Surveying Instrument

Devico launched the DeviGyro, which the company described as the world's smallest multifunctional borehole gyro instrument. The solution surveyed a 2,410-m in-and-out drill hole in 76 minutes, collecting 45,600 survey data points to accurately trace the drill hole path, the company reported. With the solution, users will be able to survey as they drill in overshot mode, and will also be able to do core orientation and gyro surveying in the same run.

[www.devico.com](http://www.devico.com)



## Screen for Mobile Impactor Plant

Kolberg-Pioneer reported it added a two-deck, 4-ft by 7-ft pre-screen option to its FT4250 mobile impactor plant. The new option allows users to scalp the feed, crush the material and post-screen all on one unit. With it, users can maximize scalping and minimize the undersized material passing through, reducing wear costs and increasing the

[www.e-mj.com](http://www.e-mj.com)



amount of final product by 30%, the company reported.

[www.kpījci.com](http://www.kpījci.com)

## Komatsu Trucks Get MEMS4

Michelin and Komatsu America Corp announced a program to offer the MICHELIN MEMS4 tire monitoring solution as an option on select electric-drive trucks built at the Komatsu facility in Peoria, Ill., U.S.A. Komatsu's 930E-5 will be the first model with it as an option.

Komatsu will factory-install the MEMS4 transceiver, antennas and related harnesses. MEMS4 will be integrated with the electronic display panel. Michelin will coordinate installation of the sensors in the tires at the customer's site.

Originally launched in 2006, the MEMS system can be found in thousands of rigid haulers around the world. Michelin reported the system provides increased safety and tire life; reduced unscheduled downtime, tire budgets and maintenance costs; reduced fuel consumption; improved truck availability; and savings on labor.

[michelinearthmover.com](http://michelinearthmover.com)

## Water Filter Offers More Capacity

Pall Water released the T96, which the company described as a turnkey mobile filtration solution. The latest addition to the Aria FAST product line, the water treatment trailer is designed to meet production demands within a smaller footprint, the company reported. It increases surface area for greater water treatment capacity. Features include 96 modules that maximize production, a plug-and-play design, built in compliance with current regulations, and the Aria SMARTBOX remote monitoring system.

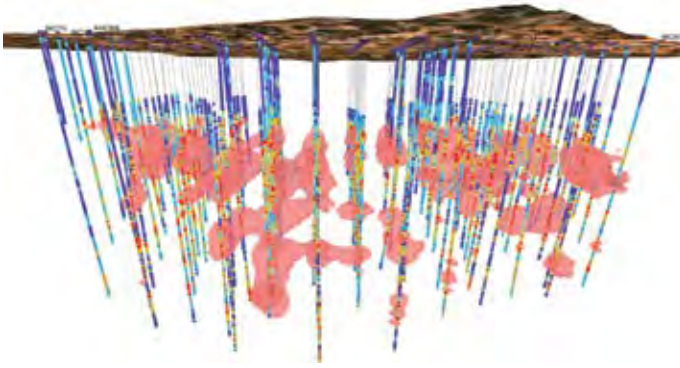
[www.pallwater.com](http://www.pallwater.com)

## Dust Suppression Formula

Reynold's Soil Technologies (RST) released the Guardian Roadbinder formula for road dust suppression. The formula is engineered to, when used in the building and maintenance processes, help negate the need for regular watering and to reduce repair work on unsealed roads. The company described the solution as the first of its kind on the global market.

[www.rstsolutions.com.au](http://www.rstsolutions.com.au)





### Drillhole, Geology Data Analysis Software

Seequent reported it released Target for ArcGIS Pro. The Esri-integrated solution simplifies the importing, viewing and analysis of drillhole and subsurface geological data within ArcGIS Pro to allow geoscientists, geologists and GIS analysts to make timely decisions on project viability and enable faster discoveries, the company reported.

The software allows users to: import, visualize and interpret drilling data; view drillhole data by numeric or categorical attributes in 2D maps and 3D scenes; create cross sections; incorporate subsurface datasets; navigate the subsurface quickly and easily using 3D navigation shortcuts; share and collaborate using Esri's online workflows.

It is available as a free and licensed version.

[www.geosoft.com](http://www.geosoft.com)

### E-learning on Digitalization

Voith launched DRIVE, an e-learning platform for companies with employees needing courses that impart skills needed in the digital transformation. DRIVE is designed to future-proof companies and to support them in harnessing the potential of digitalization, Voith reported. The web-based courses are industry-specific, can be customized, and seek to upskill employees of companies of any size.

[www.voith.com](http://www.voith.com)

### Warning System Lights

HELLA showcased the K-LED Reblution, an optical warning system light. The light emerges from a narrow, 8mm-high light band instead of through a dome. It generates a long-



range warning signal. HELLA also makes the Optical Warning Mini Lightbars. The 10- or 16-in. bars generate an intensive 360° warning signal. Depending on the mounting variant, the flat roof bars can be mounted with a bracket or a magnet and are suitable for both 12- and 24-volt (V) systems, the company reported. HELLA also spotlighted the LED Rallye 4000 Metal and LED Rallye 3003 auxiliary headlights. Capable of wide and long-range illumination, the headlights, rated for 12 and 24 V, feature a cooling fin.

[www.hella.com](http://www.hella.com)

### Pneumatic Torque Wrench

Snap-on Industrial reported its pneumatic-powered SpinTORQ 360 Continuous Rotation Torque Wrench is the only continuously spinning, low-profile torque wrench on the market that is 80% faster than ratcheting hydraulic wrenches.

The wrench can access

tight places. It locks into position when energized and stays in place until the tool stalls, the company reported. It is engineered for heavy-duty bolting and is designed to standard ANSI and API piping flange dimensions. Other features include three motor sizes, manual or auto control, and a secondary safety trigger.

[www.snapon.com](http://www.snapon.com)



### Graphene-enhanced Boots

First Graphene Limited reported successful prototype trials with Steel Blue of graphene-enhanced boots. The boots were manufactured using First Graphene's PureGRAPH 10 graphene powder, which are non-aggregated, uniform-sized nanoplatelets. The powder was dispersed evenly in thermoplastic polyurethane masterbatches to create the soles of the boots.

[www.firstgraphene.net](http://www.firstgraphene.net)



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## SpotSee to Release Wired Vibration Monitoring Device

SpotSee reported it will release in Q1 2020 an ethernet-wired version of its successful stand-alone machine vibration monitoring solution for immobile equipment, OpsWatch. With the release, “you will have a WiFi option as well as an ethernet-connected option,” Tyson Stuelpe, vice president, global sales and marketing, SpotSee, said. The latter “is in the final stages of development.”

The need for wiring occurs when the equipment the OpsWatch device monitors acts like a faraday cage, blocking WiFi, or when the equipment is remotely located and connectivity is unavailable.

The company reported the wired version of the device would be ideal for some conveyors, elevators, rollers, kilns and motors. “It could also monitor compressors, engines, any part of the mining operation that involves reciprocating or rotating motor that is potentially going to fail during operation,” Kraig Nunn, technical sales manager, SpotSee, said.

Released in 2017, OpsWatch, described as a triaxial accelerometer, “mon-



itors low-level impact and vibration of equipment while in operation,” the company reported. It measures the values of vibration and transmits them to the SpotSee cloud. Users access the data using a web browser on a computer or a mobile device. The data is built into charts that clearly show any “changes in the impact and vibration signature in real time.”

The changes detected ideally can be seen as “early warning signs that part of the system being monitored is beginning to experience unexpected stresses and these stresses can eventually trigger system failure,” Spotsee reported.

The stand-alone device, which gets its electricity from the equipment it monitors, is 4 in. by 3 in. by 3 in. and can be attached with magnets, adhesives, screws or bolts. “It lends itself to be applied in multiple different locations, so it is very simple to attach,” Nunn said.

OpsWatch offers numerous benefits, according to SpotSee.

According to company literature, OpsWatch offers 10 times more transmit power than the competition to ensure superior radio link reliability. Part of that means it offers greater volume of data communication. It requires no battery, so there is no need for replacement and no battery temperature constraints.

With a low frequency floor, OpsWatch is capable of monitoring a wide range of equipment, including slowly rotating equipment, the company reported. “Lower frequency vibrations have higher damage potential.”

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Along those lines, OpsWatch can provide measurements as small as 7 mm per second, and as high as 2,000 mm per second.

Other benefits include alerts or notifications, and the ability to configure the unit through any WiFi-enabled device.

Nunn said the device is designed for applications in extreme environments. "It is basically sealed to IP 67, which means it is basically submersible in liquid up to a meter for about an hour," he said. "The devices can withstand temperatures between -40°C up to 85°C."

The WiFi-ready version is ATEX certified. Stuelpe said the wired version will be Class 1 Div. 2.

New to the metals mining space, OpsWatch has been field proven in the oil and gas space and at frac sand ops.

The company reported that it was deployed last year to a frac sand facility where it monitored a silo elevator. After "an unexpected impact strike was recorded," the OpsWatch "began recoding chatter," SpotSee reported. "Something was causing frequent low impacts that were not part of the normal signature of the equipment."

The maintenance team checked and discovered the elevator needed service. Afterwards, "the elevator was restarted and the chatter was no longer recorded and the facility avoided equipment degradation and potential failure," SpotSee reported.

Its use at the frac sand op proved that the device is well-suited for operations "that have the greatest cost of downtime," Stuelpe said. "Whether it is in the mines themselves or the trans-load facilities that are used to convey the sand, either one of those could contribute to missed shipments of sands and they get charged a very significant amount for that," he said. "The point is where you have that acute issue, those are really the places where it makes the most sense for those companies to make sure that they have vibration monitoring equipment to prevent the potential downtime."

Successful deployment at the frac sand op also proved OpsWatch allows remote operations to inexpensively continuously monitor large pieces of equipment, Stuelpe said. At such operations, located in the middle of nowhere, "they have huge pieces of equipment that often are being left unmonitored or they are monitored occasionally by handheld vibration devices," he said. "On a weekly, bi-weekly or monthly frequency, they will go in and monitor and take a vibration reading."

That is often enough right up until it is not. "The problem with that is we've seen that for something to go wrong, it can happen in a matter of hours, and so if you leave big gaps between your readings you can have equipment that goes down seemingly without any indication," he said. "OpsWatch presents a huge opportunity for these mines or other facilities."

In most cases, OpsWatch pays for itself with the first prevented downtime event, Stuelpe said. "Our devices go for \$2,000 to \$2,500 a piece; so, obviously the return on investment can happen extremely quickly just by preventing that type of failure," he said. "The ROI could be in no time at all."

Both versions help SpotSee expand its marketshare, Nunn said. "It is expanding our capabilities to fixed equipment where previously all our devices have been for monitoring transport."




And it expands those capabilities to remote, rugged sites, Stuelpe said. "That is where we think OpsWatch fits in best."

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# Nickel Prices Drop 20% During November

During the last month, palladium continued its steady march toward \$2,000 per ounce (oz), while gold slipped below the \$1,500/oz level. For December 4, the *E&MJ* Price Index is reporting a palladium price of \$1,858/oz piercing the \$1,800/oz level, which is a 3.4% (\$61/oz) increase over last month. During the same period, gold prices fell 2.4% from \$1,509.60 to \$1,474.10. Platinum and silver also decreased 4.3% and 6.8%, respectively.

As far as price swings, the big news was with non-ferrous base metals and with nickel in particular, declining 20.2% from \$16,595 per metric ton (mt) to \$13,250/mt (or \$7.54/lb to \$6.02/lb). Lead prices dropped 12.7% from \$2,176/mt to \$1,900/mt (or \$0.99/lb to \$0.86/lb). Tin and zinc had posted modest gains of 2.4% and 6.6%, respectively, while aluminum and copper held steady.

Nickel prices on the London Metals Exchange (LME) strengthened dramatically in Q3 2019, closing close to \$8/lb at the end of September, which would be a \$2.40/lb increase over \$5.60/lb at the beginning of the quarter. Higher prices were based on speculation that Indonesia would implement a nickel ore export ban at the beginning of 2020, two years before the ban was scheduled to take effect. Nickel prices were also influenced by continued strong demand from China's stainless steel sector. Prices reached a high of \$8.45/lb on September 2.



Since the start of the fourth quarter, however, nickel prices have declined due to softening demand and inventory level changes. Combined, these factors suggest increased nickel price volatility in the near term. The combined nickel inventories on the LME and the Shanghai Futures Exchange (SHFE) at the end of Q3 2019 totaled 179,500 mt, down 1% from the combined total of 181,000 mt at the end of the second quarter. Total inventory levels have now decreased significantly since the start of the fourth quarter, declining by approximately 49%. This decline has been attributed to inventory stockpiling by stainless steel producers in advance of the Indonesian

ore export ban. As of October 30, 2019, combined nickel inventories on the LME and SHFE were roughly 92,000 mt, the lowest level since 2012.

According to CRU, stainless steel demand is expected to grow at an average annual rate of approximately 4% through 2022. Demand for nickel from outside the stainless steel sector — particularly Class 1 nickel — is also expected to accelerate. Class 1 nickel, which contains 99.8% nickel, along with cobalt, are key metals needed to manufacture electric vehicle batteries. A shortage of Class 1 nickel is anticipated over the coming years as no new Class 1 nickel projects have been developed.

## E&MJ PRICES INDEX

(December 4, 2019)

Precious Metals (\$/oz)		Base Metals (\$/mt)		Minor Metals (\$/mt)		Exchange Rates (U.S.\$ Equivalent)	
Gold	\$1,474.10	Aluminum	\$1,771.00	Molybdenum	\$20,680	Euro (€)	1.107
Silver	\$16.82	Copper	\$5,823.00	Cobalt	\$35,500	U.K. (£)	1.309
Platinum	\$907.00	Lead	\$1,900.00	Iron Ore (\$/dmt)		Canada (\$)	0.757
Palladium	\$1,859.00	Nickel	\$13,250.00			Australia (\$)	0.685
Rhodium	\$5,900.00	Tin	\$16,850.00	Fe CFR China	\$88.27	South Africa (Rand)	0.068
Ruthenium	\$250.00	Zinc	\$2,756.50			China (¥)	0.142

Gold and silver prices provided by KITCO Bullion dealers ([www.kitco.com](http://www.kitco.com)). Platinum group metals prices provided by Johnson Matthey ([www.platinum.matthey.com](http://www.platinum.matthey.com)). Non-ferrous base and minor metal prices provided by London Metal Exchange ([www.lme.co.uk](http://www.lme.co.uk)). Iron ore prices provided by Platts Iron Ore Index. Currency exchange rates were provided by [www.xe.com](http://www.xe.com).

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