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This month's cover provided by Komatsu.

Coming in October
Canadian Mining Journal looks at mining in Quebec and the Atlantic provinces. Plus a feature report on the environment and clean mining, and our semi-annual Equipment Maintenance & Repair supplement.

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Alisha Hiyate

What the gold rally means for Canada

Every September, *CMJ* publishes an issue focused on gold, but it's been a while since the picture for the yellow metal has been so bullish.

This August, we saw a new all-time high in gold at US$2,089.20 per oz. According to various forecasts, this could be just the beginning of an extended rally. In April, Bank of America raised its 18-month target for gold to US$3,000 per oz. And a month later, European investment and asset management firm Incrementum published its annual *In Gold We Trust* report, predicting US$4,800 per oz. gold – or potentially much higher – by the end of the decade.

In the current environment, where uncertainty around the pandemic and its effects on global health and the global economy reign, such predictions are sounding less far-fetched than they would have even during gold's last bull run, which saw a peak of US$1,921 per oz. in 2011.

Heck, even gold-phobic investors like Warren Buffett are coming around. The famous value investor created a market stir in August when he bought shares in Barrick Gold.

Canadian gold producers and juniors are already benefitting from renewed interest in the sector.

In Canadian dollars, August's record high translates to nearly $2,745 per oz., positioning gold mines in Canada to generate some serious cash flow – even with the extra costs incurred related to the COVID-19 pandemic. For a rundown of Canada's 10 largest gold mines, and pre-pandemic production figures and production costs, see page 19.

Notably, only one mine on our list is owned by a single-asset producer, with many of the others having changed hands through recent M&A. Look for M&A to intensify as miners look to replace reserves and grow production.

The No. 1 mine on the list, Canadian Malartic, was built by junior miner Osisko Mining, which, in just over six years, took the project from its first drill hole to its first gold pour. It's no surprise that the company (which reformed after a 2014 takeover of the original Osisko Mining) is looking to repeat the performance at its Windfall Lake gold project in Quebec.

The company is working towards a feasibility study next summer for Windfall, which is looking more and more like a company-maker. With every resource update Osisko has posted so far, the grade of the already high-grade deposit has actually improved – a rarity in gold exploration (see page 14).

Lastly, it should be said that, in addition to the gold price's spectacular highs in Canadian dollars, another Canadian advantage in the current environment is the relatively low case count of COVID-19 infections across the country – at least so far. The success in controlling the spread of the virus has allowed for far fewer and less severe interruptions to operations, very few cases and fatalities, and has helped mines operate while keeping employees and remote communities safe (see page 25). **CMJ**

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Health and safety obligations during COVID-19 – a mix of old and new

By Brad Smith and Shelby Rooney

The mining industry, like most industries, faces challenges arising from COVID-19. One challenge is compliance with health and safety duties. Compliance is a mix of the old (the *Occupational Health and Safety Act*) and the new – the unique legislation and duties specific to COVID-19.

The new obligations in Ontario arose under the Emergency Management and Civil Protection Act, passed by the provincial government in March. The purpose of the act is to promote the public good by "protecting the health, safety and welfare of the people of Ontario" in times of declared emergencies. This Act gave broad emergency power to make orders through regulations. As we have experienced, this authorized the shutdown of entire areas of the economy and imposed restrictions on those still operating.

The declaration of the emergency came to an end on July 24, but the *Reopening Ontario (A Flexible Response to COVID-19) Act* continues many of the orders and regulations that were created during the emergency.

Some of the orders set the rules for the reopening of the economy for areas in Stages 1, 2, and 3. The regulations for all three stages contain a general compliance provision that states:

1 The person responsible for a business or organization that is open shall ensure that the business or organization operates in accordance with all applicable laws, including the *Occupational Health and Safety Act* and the regulations made under it.

2 The person responsible for a business or organization that is open shall operate the business or organization in compliance with the advice, recommendations and instructions of public health officials, including any advice, recommendations or instructions on physical distancing, cleaning or disinfecting.

Failure to comply with an order of the *Reopening Ontario Act* can result in fines up to $100,000 or imprisonment up to one year for an individual, $500,000 or imprisonment up to one year for an individual who is a director or officer of a corporation and $10 million for a corporation. The Court has discretion to increase these amounts based on any financial gain from the offence.

The "old" obligations continue under the *Occupational Health and Safety Act*. In particular, section 25(2)(h) of the Act requires an employer to "take every precaution reasonable in the circumstances for the protection of a worker."

The advice, recommendations and instructions of public health officials may be a reasonable precaution. Thus, failure to follow the advice, recommendations and instructions of public health officials may be a breach of both the *Reopening Ontario Act* and the *Occupational Health and Safety Act*.

The *Occupational Health and Safety Act* was amended in 2017 to increase the maximum fine for health and safety violations from $500,000 to $1.5 million for a corporation and from $25,000 to $100,000 for individuals.

COVID-19 may increase an employer's liability for health and safety infractions. Employers can manage this risk by following the advice, recommendations and instructions of public health officials and taking every precaution reasonable to protect workers.

Employers should implement policies and procedures encompassing public health advice and consider public health recommendations as requirements. Employers should pay particular attention to physical distancing, cleaning, and disinfecting requirements as well as ensure worker compliance with these policies and procedures. Employers should enforce measures around public health advice – including disciplinary action of workers who fail to comply. And, as always, exercise due diligence and document all actions!

The *Reopening Ontario Act* is one example of a substantial change to the workplace arising from COVID-19. Another example is the deemed "Infectious Disease Emergency Leave," which ends on Sept. 4, 2020. The Ontario *Employment Standards Act* was amended to deem employees on Infectious Disease Emergency Leave if they had been laid off due to COVID-19. The amendments to the *Employment Standards Act* essentially replaced temporary layoffs with a protected leave to avoid mass deemed terminations related to the pandemic. This had the effect of preventing a temporary layoff becoming a termination in or about June 2020 (depending on when the person was laid off). As of Sept. 4, when the deemed leave ends, employers have to decide the status of employees (for example, return to work or lay off).

Employers should be proactive and exercise due diligence to identify and fulfill their duties in these unusual times. **CMJ**

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Community protocols as a tool for better outcomes from resource development

By Carolyn Burns

Local communities that are affected by mining development do not always have an opportunity to provide meaningful input into project decision-making. Globally, there is an increased recognition that communities' rights must be respected and that communities should be treated as legitimate, equal partners in mining development. Treating communities as legitimate, equal partners is the critical starting point for governments, communities, and companies to work towards sustained positive outcomes for communities and society over the long-term. It lays the groundwork for relationships that are built on trust and mutual respect, and for decision-making processes that support positive outcomes for communities.

For projects affecting Indigenous Peoples, this is critical. In Canada, this legitimacy has been reinforced through the Crown's duty to consult and the growing industry commitment to free, prior, and informed consent (FPIC). While the federal government has adopted the UN Declaration on the Rights of Indigenous Peoples (UNDRIP), which requires free, prior, and informed consent, it has not yet been implemented through legislation (and that is a topic for a whole separate article). In the meantime, one province, British Columbia, has forged ahead and passed legislation to implement UNDRIP. Regardless, most global mining majors now commit to respecting and implementing FPIC. Yet making a commitment and implementing the practice are hugely different tasks.

To address that gap, communities are relying on their own tools. One such tool is a community protocol. Community protocols set out processes and requirements for formal decision-making and engagement both internally, within the community, and with external actors and stakeholders, like resource companies, government, NGOs, etc. These protocols articulate community-determined visions, values, priorities and expectations. They also set out rights and responsibilities for the community and external actors under customary, state, and international law. There are generally five different topics covered in a community protocol.

1 **Community visions, values, priorities.** A community protocol is an opportunity for the community to clearly articulate how natural resource development supports the community's long-term vision for the future. It can also illustrate how their values influence the way mining activity (or other natural resource development) is managed. The act of articulating these elements can be helpful for a community and be the catalyst to revisit or develop a clear vision and set of priories. It is helpful for other stakeholders to understand the perspective of the community as well. Some protocols include detailed maps and land use plans to illustrate how community development priorities are realized in practice.

2 **Context.** Expectations and requirements must build upon the existing legal framework for natural resource development. Often there are many overlapping legal agreements, historical events and sociopolitical contexts that shape mining activity. When a protocol includes a summary of the social, environmental, political and legal history, it connects the dots for community members as well as proponents and other stakeholders, and ensures that everyone is on the same page.

3 **Information sharing and engagement.** Protocols can support community engagement on the basis of free, prior, and informed consent. Protocols often include clear expectations for when the community needs to be informed about exploration activities, proposals from proponents and development processes. Getting this right makes engagement and negotiation smoother for all involved. It can also help stakeholders answer several questions, such as when do proponents inform communities of their activities? How do they do that? When and how do communities receive information about mining development and activities? Who is responsible for sharing this information with the wider community? What information do proponents and other stakeholders receive from the community? How and when do they receive that information? Likewise, protocols can include expectations for engagement, such as the cultural norms for meeting with elders and leaders. Ultimately, greater clarity around community expectations and priorities should help to improve relations and engagement, if companies and governments are willing to listen, and recognize it is in their interest to work with the community on an equitable basis.

4 **Negotiations, decision making and consent processes.** The main crux of the protocol is the process for how community decisions related to mining activities are made. This includes how negotiations happen and how consent is achieved. Including expectations for negotiations can be tricky because of the confi-

dential nature of our established negotiation practices. However, protocols can include what information must be shared and what consultation must occur with community members prior to negotiations, updates on the negotiation processes, non-negotiables and expectations for how the results of negotiations are shared. It is similarly difficult to be prescriptive about the consent process. However, a protocol can outline the community's approach to obtaining consent. For example, does consent require a referendum with a specific percentage of support, or, unanimous support from the leadership, or, evidence the leadership has incorporated input from the wide community? A clear process provides a road map so community members understand how decisions are made and how their input has been factored in. This can can help manage intra-community conflict and tension. A clear process limits the concern that one sub-group has influenced decision making and that decisions are made for the benefit of specific individuals.

5 Processes for managing impacts, sharing resources and respecting traditional knowledge. This can include expectations for how impacts assessments are completed as well as informing community members on impact management and opportunities, and reporting on commitments and targets. Many protocols include expectations for respecting traditional knowledge. This can include an advisory group that provides input to proponents; traditional cultural practices that are integrated into local hiring and procurement programs, environmental management programs and mine planning; and the identification and protection of sites with cultural significance prior to any approval of development.

The way a protocol is developed is just as important as what it includes. Protocols should be developed through a participatory process that is inclusive of the wider community. In many cases, the process of developing a protocol is just as valuable as the outcome. This proactive approach brings key topics to the forefront sooner in the process and reduces the likelihood of missteps by resource companies. Of course, the responsibility rests with the community for sharing the protocol with proponents, government, and other relevant stakeholders. Ultimately, protocols can be tools to make the relationship between communities, government, and industry more predictable, constructive, and balanced. In the long-term, protocols can help shape resource development to take place in a way that supports a community's vision for itself and its own priorities. **CMJ**

CAROLYN BURNS is director of operations at NetPositive, a non-profit that works with diverse stakeholders to help local communities see sustained positive outcomes from mining.

What a pandemic means for mining companies and their counsel

By Sander Grieve

I will spare you the now badly overused "without precedent." As the Chinese curse goes, "may you live in interesting times." As we roll through what feels like the 100th day of March, we have a range of new issues on the desks of counsel to mining companies. These include novel considerations in responding to the pandemic, new opportunities and new challenges. Miners and their lawyers have been engaging a broad range of these. My comments below highlight a few for your consideration and planning.

The novel

In terms of immediate responses, mining companies have been engaged in health and safety updates. What was drilled for in terms of disease response and safety protocols came in handy. Isolation, community protection measures and shutdowns of varying severity and duration have evolved around the world. Fly-in, fly-out projects faced particular challenges to demonstrate to their host communities that they were taking adequate precautions to ensure the spread of COVID-19 was not facilitated by miners. The opportunities to highlight skills in community relations, government relations and occupational health and safety showed many miners and mining lawyers in a great light.

It was interesting to track disclosure of the impact of COVID-19. As miners faced operational challenges they reacted with speed to announce procedures in place, impacts on guidance, and implications for operations. Some excellent disclosure emerged which allowed companies to highlight the decision in most jurisdictions that what they do is an essential service, a nice reminder that – to parrot advertising of the 1990s – we may not make the operating room, but we make the raw materials that make the equipment in the operating room, from surgical steel on up!

The best of disclosure I have reviewed highlighted the risk of transmission, and noted the true impacts of the pandemic on business may go beyond the disease itself, and arrive in the form of government and market reactions to the disease.

New opportunities

Ten years into a gold drought, the world seemed to have abandoned the gold hedge on currency and inflation, despite the challenges of quantitative easing infinity. The pandemic brought us a new version of QE∞. So rapid has been the advent of free money, writers on the economy seem to just be reeling without the time to name it (at least as far as I have seen to date).

Unnamed it might be, but QE-Steroids have injected gold and silver with new enthusiasm. BofA led in April calling for an 18-month gold price of US$3,000 per oz. The fundamentalists are celebrating and generalists are busily looking for a way to play. Equity raisings have kept lawyers, bankers and issuers busy tapping the new enthusiasm for the next round of financing. With the bulk happening since May of this year, there have been, according to Refinitiv, 49 equity raisings by Canadian gold miners, compared with 53 in all of 2019. The well, once dry, runs again. It isn't back to the roaring torrent of the early 2000s, but it is running for quality with a vigor unknown in recent years.

What this means is that equity is back. Financings, and even IPOs are out of hibernation. The competitors to equity have new challenges to demonstrate value or seek opportunity from those who equity still avoids. The rotation back to private placements and prospectuses has helped to challenge mobile phone and home internet infrastructure.

New challenges

Outside of gold and silver, there have been challenges similar to those faced by the broader economy. Mining companies and their counsel have been filling days seeking to qualify for relief by traditional lenders and working through emerging rules for new government support programs. Miners have been working with lending lawyers, restructuring specialists and government relations supports to find new ways to survive in an economy that's in a cocoon.

As miners feverishly draft disclosure for new offerings, assist with evaluation of M&A opportunities, and help their clients meet the challenge of the day, they are mindful that discipline continues to be the watchword of the COVID-19 era. They are also mindful that, as 1918 Spanish flu pandemic showed a hundred years earlier, this isn't without precedent, and as parts of the world drift back into lockdown, that this isn't over. The mining community needs to remain nimble to meet the challenges of these times and seize the opportunities as they arise. The interesting times are set to continue. **CMJ**

SANDER GRIEVE is a partner and head of the mining industry team at Bennett Jones, Toronto.

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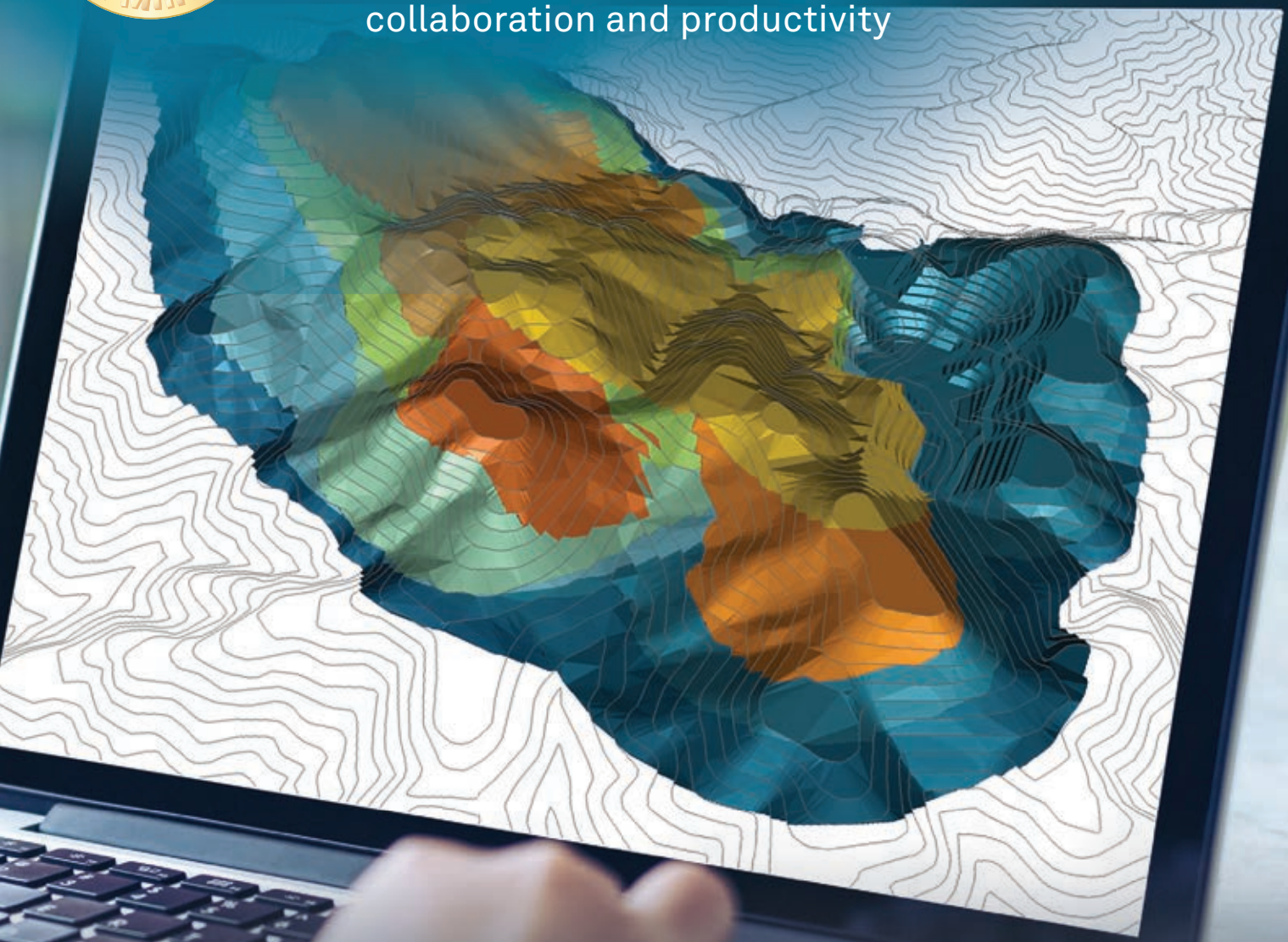

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Meeting new investor expectations with ESG reporting

By Thibaut Millet

When COVID-19 hit, progress on environmental, social and governance (ESG) factors was overshadowed by the necessary short-term focus on health and safety issues and the financial implications of the crisis. But as companies and economies start to recover, investors will be looking for companies with strong ESG performance as a proxy for a more resilient organization. Those that have strong governance, robust crisis management, enhanced and innovative talent management (not to mention strong health and safety practices) will be attractive prospects, both in terms of near-term opportunities and their long-term ability to withstand systemic shocks.

The thing is, COVID-19 is a full force ESG issue. It's displaced workers, added greater governance and processes and disrupted capital allocation. The ways businesses are responding – both socially and financially – need to be addressed and effectively communicated. Investors are asking questions about the steps companies are taking to manage these added challenges and are raising the stakes when it comes to assessing company performance using ESG factors. The *2020 EY Institutional Investor Survey* finds that 72% of investors conduct a structured, methodical evaluation of nonfinancial disclosures. That's a significant jump from the 32% who said they used a structured approach in 2018.

The mining and metals sector needs to take note. The majority of Canadian organizations are actively investing in ESG measures, but the disconnect is in effectively communicating those actions and their impact on the overall business strategy to stakeholders and investors. This is important not only to secure capital in a volatile market, but also to build and maintain licence to operate. Having a strong social licence will be critical in navigating the post-pandemic landscape.

So, how are mining and metals companies performing? Here are four opportunities to ramp up reporting to meet the expectations of investors and ensure ESG performance plays a critical role in the long-term response to the global pandemic.

- ***Refocus ESG priorities.*** Health and safety have long been top priorities for the sector, and the pandemic has only reemphasized their importance. Renewing health and safety functions to meet new elevated needs of operating in a pandemic – including policies like mental health and wellness, flexibility and community relations – will be critical. In the end, companies will be remembered by the way they treat their people and communities where they operate.

- ***Disclose the financial impact.*** While investors increasingly look to companies to disclose how they're addressing ESG, they also want to know how its impacts could affect the business itself. Companies need to measure the financial impact of ESG risks and opportunities on the business and clearly integrate measures into the companies' financial statements.

- ***Speak a common language.*** Complying with a common framework helps investors to compare apples to apples across sectors and make more informed decisions. Though, that's much easier said then done. There are currently multiple agencies that rate companies, which all use different methodologies and varying sources to information. While the industry works towards addressing standardization, organizations will need to find a framework that meets the unique needs of stakeholders and investors. An example of this is the World Gold Council's Responsible Gold Mining Principles (RGMP), which can be used as an overarching framework to marry some of these diverse approaches together.

- ***Don't let a lack of information lead to misinformation.*** Investors can often be deprived of important information about a business's potential to create long-term value due to the company's failure to disclose. By not including financial information about risks and opportunities in disclosures, investors will either turn to third-party analyses or form their own conclusions about the impact on the business. Don't let investors guess. Know what information stakeholders are after and address those concerns and measures in financial statements. Including greater insights into intangible assets can allow investors to look beyond current book value.

As society and regulators look to companies to play a leading role in rebuilding our global economies, investors will look at companies who are acting and reporting on ESG factors to build back better. Getting disclosures updated now can help companies to become more attractive as capital enters back into the sector, while building a sustainable licence to operate. **CMJ**

THIBAUT MILLET is the climate change and sustainability leader at EY Canada. For more insights and actionable items on ESG reporting, visit www.ey.com/en_ca/climate-related-reporting.

• HAULAGE | Rail-Veyor wins Mining Cleantech Challenge

Sudbury-based Rail-Veyor Technologies won first place in the fourth annual Mining Cleantech Challenge, which took place virtually on July 23. Alongside the winning title, the company received a US$5,000 prize, which Rail-Veyor announced would be used for education-based marketing.

With 13 companies representing the U.S., Canada, Australia, and the U.K. at the competition, Rail-Veyor's technology was chosen by mining executives and investors as the best. An international team of judges reviewed and voted on the winners at the first ever virtual Mining Cleantech Challenge, hosted by Colorado Cleantech Industries Association (CCIA).

"The Rail-Veyor Truly Autonomous haulage system is a natively electric solution so there are no diesel emissions to affect the workforce or community of a mine either underground or on surface applications," said Lisa Youngblood, Rail-Veyor's executive director of marketing and communications, in a release. "We are proud that the Rail-Veyor system is a cleaner choice for the planet than other standard bulk material hauling choices with the added benefit of significantly reduced opex costs."

Rail-Veyor Technologies' autonomous haulage system in action. CREDIT: RAIL-VEYOR TECHNOLOGIES

Helen El Mallakh, CCIA's executive director, elaborated on the relationship between clean technology and the mining industry: "Today, the mining industry is being called upon to provide the materials that are necessary to build a more sustainable global economy. In many ways, mining is at a pivot point and cleantech is the catalyst. That is why the technologies that are used in this sector are so meaningful and why events like the Mining Cleantech Challenge are critical in advancing the process."

Program sponsors and partners include Newmont, BHP, Fresnillo, Royal Gold, Ausenco, Clareo, Colorado School of Mines, Jolimont Global Mining Systems and Resource Capital Funds, among others. **CMJ**

• AUTOMATION | MineWare launches Phoenix AI drill platform

MineWare, a provider of mining equipment monitoring and automation solutions, has developed an industry-first artificial intelligence-based drill automation platform, Phoenix AI, to optimize aftermarket blasthole drill operations.

In autonomous mode, Phoenix determines the design hole depth based on the drill plan and uses AI algorithms to generate and adjust force to match ground conditions. The AI-based decision engine continuously monitors and responds to geologic faults, taking instant action to correct them in a nearly predictive manner as it works to ensure the highest quality blast hole.

In a release, Curtis Stacy, product manager for Phoenix AI, said the interoperable platform features advanced AI to help with common drilling issues and improve performance.

"Compatible with all blasthole drill makes and models, Phoenix AI is an independent system that allows machine operators to automate their entire drill cycle at the push of a single button, without compromising the OEM control system," Stacy said. "The new layer of technology helps drills work faster and smarter to improve machine performance, hole quality, detect and correct down-the-hole faults, optimize drill and blast outcomes, and drive efficiencies downstream."

By giving operators the ability to hand more control to the machine, Curtis added that drill and blast teams can eliminate operator variability, one of the major causes of poor hole quality and machine stress.

"Phoenix AI uses artificial intelligence to eliminate the need to even tune operational parameters on the machine," he concluded. **CMJ**

ALL EYES ON WINDFALL

Osisko Mining maintains scorching pace at Quebec gold project

By Alisha Hiyate

The Canadian Malarctic mine in Quebec was supposed to become the cornerstone asset of Osisko Mining as the company, which discovered and built it, grew into a bigger and better intermediate Canadian gold producer.

Having been forced to sell the last company he built with partners Sean Roosen and Bob Wares, after putting together an irresistable asset, John Burzynski has put some thought into how to defend his current venture, the new Osisko Mining, from a hostile takeover.

"Land mines," he jokes. "And barbed wire," Burzynski says, laughing. "I wish!"

Led by Burzynski as president and CEO, Osisko Mining 2.0 is once again in possession of a prized asset – the high-grade Windfall Lake gold project, located 200 km northeast of Val-d'Or, in the Eeyou Istchee James Bay region of Quebec.

And this time, gold is in the midst of setting new highs – making intermediate and senior gold producers even hungrier for ounces to replace their declining reserves.

With its latest resource update, in February, Windfall has grown to 5 million oz. gold in total – comprised of 4.1 million indicated tonnes grading 9.1 g/t gold and 14.5 million inferred tonnes grading 8.4 g/t gold. Building on a 2018 preliminary economic assessment (PEA) for the project, the company is drilling at a furious pace – it hit the million metre mark earlier this year – to prepare an updated and upgraded resource later this year, followed by a feasibility study next summer.

The exploration success thus far, combined with the Osisko team's past success and the hot gold market mean there are a lot of eyes on Windfall.

"Certainly, there's a scarcity value, not just nationally but internationally in terms of new gold deposits," Burzynski says.

But the new Osisko has some protection against potential hostile offers. The current gold rally means there wouldn't be much appetite among shareholders for an opportunistic bid. (In addition, Osisko Gold Royalties, which owns a 5% NSR royalty on Canadian Malartic and is led by Roosen as CEO and chair, holds 16% of the stock.)

But the main way to protect the company is just to stay the course.

"We'll just keep driling as quickly as we can to try and stay in front of all those guys," Burzynski says. "The only certain defence against a hostile takeover is a high share price and a high valuation on your deposit. I think we've been able to achieve that by drilling as much and as quickly as we could."

Urban-Barry greenstone belt

Osisko Mining acquired Windfall in 2015, when the founders of the origi-

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The portal to the underground ramp at the Windfall Lake gold project, in Quebec.
CREDIT: OSISKO MINING

Above: John Burzynski, Osisko Mining's president and CEO. (Osisko is a sponsor of the Raise the Arrow project to recover historic Avro Arrow artifacts.) Right: The Windfall Lake site. CREDIT: OSISKO MINING

nal Osisko decided to recreate the company with some assets from Osisko Gold Royalties, plus several other acquisitions. One of the acquisitions was of Eagle Hill Exploration, which had defined a 1.5 million oz. gold resource at Windfall.

An initial 50,000-metre drill campaign was planned just to decide whether to keep the asset as the new Osisko figured out where to focus its energy.

The company quickly determined that previous operators had misinterpreted the geology. That was easy to do as the Urban-Barry greenstone belt, where Windfall is located, has only seen a fraction of the drilling other camps in the Abitibi (Timmins, Val-d'Or) have seen.

"We did a little bit of age dating on the intrusives related to Windfall and some of the other local gold intrusive deposits and we found that they all fall within about

Drilling in 'fast-forward'

Since joining Osisko Mining in March 2017, Alexandria Marcotte, Osisko's vice-president, project co-ordination, has seen the project grow from five drill rigs up to 24.

With a target of 275,000 metres for this year – most of that focused on infill drilling with an eye towards next year's feasibility study – there are 250-275 people at the camp at any one time, making it happen.

She says the whole exploration team is excited to be part of the project.

"Usually it takes a decade" to put a mine into production, Marcottte says. "A lot of that is because it takes so long to drill, and that's what Osisko is good at: putting it in fast-forward – let's just get to the part where we mine."

While the team's original theory of looking for gold on the contacts of the porphyry intrusions has proven very successful in guiding the exploration program, some surprises have come out of the drill program, Marcotte says.

"One of the biggest surprises is really the grade," she says. "Usually you expect a bit of a dip in the grade as you infill, because high grade is hard to maintain – whereas for us it's actually gone up as we do the infill."

That drill program has also included Canada's longest drill hole – a 3,467-metre hole called "Discovery 1" that was started last May and only completed in late January.

"As you go deeper, it's logistics – it just takes time to get the core to surface," Marcotte explains.

Osisko geologists wanted to drill the hole to get a better understanding of the depth of the system and see if the source of the gold could be found.

The company asked its drill contractor, Major Drilling, to start at a challenging flat angle.

"If you want to drill really deep, typically you start very steep – at a -85, -75 degree angle," Marcotte says.

The first attempt, drilled at -56 degree angle, had to be abandoned after the hole deviated too much. But a second started several weeks later at a -51 degree angle was successful, with Major using 11 wedges to keep the hole on target.

Designed to test downplunge extensions of known zones on its way down to target, the hole did extend the Underdog and Triple 8 zones, while at depth, it hit large areas of 100 to 200 metres of roughly 1 g/t gold.

"We only ever see (that) around the high-grade zones," says Burzynksi, adding further drilling could show the area is somewhere near a downplunge extension of the Lynx system.

ABOVE: The team from Major Drilling after completing Canada's longest drill hole at Windfall Lake in January.

CREDIT: OSISKO MINING

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2.69 to 2.72 billion years old, so immediately that got us pretty excited because what it told us what was that Windfall is not a singularity; there was a belt mineralizing event along a similar feature like the Porcupine-Destor Break or the Cadillac Break," Burzynski explains.

Unlike the other Abitibi camps, Burzynski says the initial work Osisko did at Windfall indicated that mineralization isn't located along a primary fault, but between fault sets.

"In the minds of a lot of the old prospectors and mining companies in the Abitibi, if you were 100 metres away from the main break, you were too far away and had to get back to the break and start drilling again, because mineralization on any of the classic gold mines in Val-d'Or or Timmins is intimately related with the main break," he explains.

"What we initially saw at Windfall was that the bulk of the Eagle Hill resource was located between two faults – it looks like there's a large, regional synestral fault system, so you have extentional faults and intrusives that came into the open space."

The company has identified five main intrusive events, all with their own chemistry, and has found that the second mineralizing event is the one that's associated with the gold.

"If you identify that porphyry, you've identified the gold event," Burzynski adds.

With a better understanding of the geology (it classifies Windfall as an Archean intrusion-related gold system, with gold occuring as a contact-style mineralization) Osisko has so far defined the deposit along roughly 2 km of strike, and to a vertical depth of 1,500 metres. The mineralization occurs in lenses that are about 5 to 10 metres thick and stacked en echelon about 100 to 200 metres thick.

The current resource is contained in four zones – the Main zone, Underdog, Lynx and F zones.

The high-grade Lynx portion of the deposit, discovered in 2016, has accounted for the lion's share of resource growth at Windfall, with wider widths and an average grade of 11.3 g/t.

"Lynx appears to be the main feeder system and Lynx is parallelling what we call the Bank Fault, which would be the equivalent of the Cadillac Break or Porcupine-Destor Break for us, and we've been chasing that downplunge," Burzynski says.

While Windfall has been growing, there are many more targets (more than 100) on Osisko's 2,700-sq.-km land package to test. Once infill drilling is completed, the team will begin with three principal targets within a 5-km radius of Windfall, including Fox.

Upcoming feasibility study

A 2018 PEA forecast that Windfall as it stood then (at around 3 million oz. gold) would cost $397 million to build and produce an average of 218,000 oz. gold per year over a mine life of 8.1 years.

The study projected Windfall could generate an after-tax internal rate of return of 32.7% and, using a discount rate of 5%,

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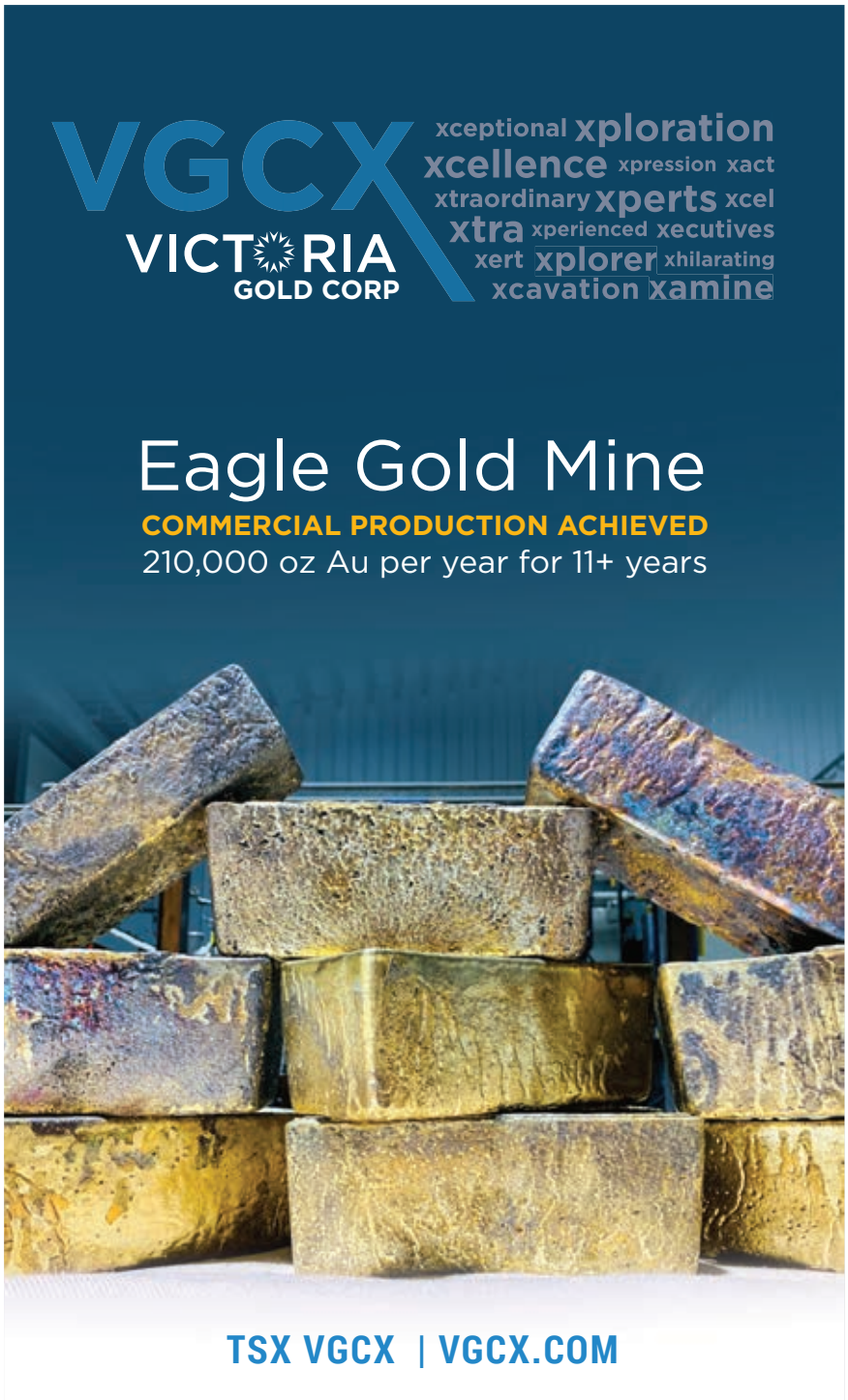

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Drill core from the 3,467-metre Discovery 1 hole completed at Windfall Lake this year. CREDIT: OSISKO MINING

a net present value of $413.2 million.

"When we did the PEA in 2018, we were assuming a US$1,300 gold price and 6.7 gram deposit, and Windfall had very strong economics," Burzynski says. "Now today at US$2,000 gold and 8.5 grams – it looks like it could end up at 9 – this is a very strong deposit."

The study looked at a 3,200 t/d underground operation using long-hole mining methods, and combined mining at Windfall with mining at the Osborne-Bell deposit near Lebel-sur-Quévillon, also owned by Osisko. Since Lebel-sur-Quévillon, 115 km west of Windfall, has excellent infrastructure, including power, the study envisioned building a mill there.

However, with the Windfall deposit continuing to grow, the upcoming feasibility study will include an onsite mill. And the February Grande Alliance infrastructure announcement between the Eeyou Istchee James Bay Cree and the Quebec government means the company will have power available onsite.

The 30-year Grande Alliance agreement covers road, rail, port and power infrastructure in the region, including a powerline from Lebel-sur-Quévillon directly to the Windfall site.

"One of the key things about the Grande Alliance is this was an idea put forward by the Cree First Nation, so they're in the driver's seat as to which areas they would like to see development in. I think that's going to make for much smoother sailing in terms of our timeline."

The power line should shave about $100 million off the project capex, Burzynski estimates, with another $100 million coming from underground development savings. The PEA had not considered existing underground infrastructure – the company has developed a 7-km underground ramp at the project, which ideally will become a production ramp.

Taking into account a three-month government-mandated closure related to COVID-19, the infill drilling necessary to complete the feasibility study resource should be complete by the end of 2019 or early 2020. With the feasibility on track for next summer, and permitting expected to take 6-12 months with another 12 months for construction, Osisko could be pouring gold at Windfall as early as the second half of 2023.

And with that comes a second chance for the Osisko team to create a new intermediate gold miner.

"Over the course of my career, we've seen a lot if not most of what were the famous Canadian mining houses disappear and nobody's really been focused on building new ones," Burzynski says. "When Bob and Sean and I got together almost 20 years ago that was the whole goal for Osisko."

He adds: "If it all works out the way we think it will, this could be a 250,000 oz. to potentially 300,000 oz. a year gold producer. And if we can find a few more Windfalls up and down the belt, you have organic growth within a district easily accessible to one milling operation that could be scaleable. That's a pretty good start to growing a new Canadian intermediate miner." **CMJ**

TIME TO SHINE

The Canadian Malartic open pit gold mine in Quebec, owned by Agnico Eagle Mines and Yamana Gold.
CREDIT: AGNICO EAGLE MINES

Amidst a growing gold rally, CMJ highlights Canada's Top 10 gold mines

As the price of gold reaches new record highs, investor interest in the operations and companies that actually mine the yellow metal is ramping up. In response, we've compiled a list of Canada's top 10 producing gold mines, based on figures from 2019.

Between them, the mines on the list – which are limited to operations whose main commodity is gold – were responsible for more than 3.5 million oz. of gold production last year.

1 » CANADIAN MALARTIC

Canada's biggest gold mine, owned by Agnico Eagle Mines (50%) and Yamana Gold (50%) produced 669,192 oz. gold last year at cash costs of US$606 per oz. on a byproduct basis. (The mine also produced 833,754 oz. silver.)

Located in Malartic, Que., 25 km west of Val-d'Or, the mine began production in 2011. Agnico and Yamana acquired the 55,000 t/d open pit operation in 2014 through a $3.9-billion takeover of Osisko Mining.

With a mine life that currently extends to 2027, the partners are keen to keep a good thing going through exploration and have budgeted a total of $24 million this year for 107,000 metres of drilling.

They also began construction on the Odyssey underground ramp, expected to take two years, in August. Watch for an exploration update on Canadian Malartic Underground in the third quarter, followed by a preliminary economic assessment (PEA) next year.

Proven and probable reserves at Canadian Malartic stand at 133.8 million tonnes grading 1.11 g/t gold for 4.8 million oz.

2 » DETOUR LAKE

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Kirkland Lake Gold's $4.9-billion takeover of Detour Gold was finalized in late January, making the company the owner of Canada's second-largest gold mine.

The Detour Lake open pit mine, located 300 km northeast of Timmins, Ont., produced 601,566 oz. of gold last year at a grade of 0.92 g/t gold.

This year, Kirkland Lake expects the mine to produce 520,000 to 540,000 oz. gold (taking effects of the COVID-19 pandemic into account) at cash operating costs of US$610-630 per oz.

The mine, which produced 1.8 million oz. of gold in the 1980s and '90s, was put back into production in early 2013. It curently contains proven and probable reserves of 15.6 million oz. of gold in 498.4 million tonnes averaging 0.98 g/t gold, and a 22-year mine life.

Kirkland Lake has begun a 250,000-metre exploration program at Detour Lake, focused on updating and expanding reserves and the mine plan.

3 » BRUCEJACK

The only mine on our list to be owned by a single-asset producer, Pretium Resources' Brucejack mine, 65 km north of Stewart, B.C., produced 354,405 oz. gold last year at cash costs of US$680 per oz. and an average grade of 8.7 g/t gold.

The high-grade, 3,800 t/d operation began commercial production in 2017.

With proven and probable reserves of 15.7 million tonnes averaging 8.4 g/t gold for 4.2 million oz. gold, the current mine life is 13 years.

Guidance for 2020 production has remained unchanged by the COVID-19 pandemic at 325,000-365,000 oz. of gold. However cash costs have been revised upwards to US$750-860 per oz. from US$725-830 per oz. of gold sold.

4 » LARONDE

The only mine on our list to be owned by a single-asset producer, Pretium Resources' Brucejack mine, 65 km north of Stewart, B.C., produced 354,405 oz. gold last year at cash costs of US$680 per oz. and an average grade of 8.7 g/t gold.

Agnico Eagle Mines' flagship LaRonde mine, located midway between Rouyn-Noranda and Val-d'Or, Que., produced 343,154 oz. of gold last year at a cash operating cost of US$464 per oz. (on a byproduct basis).

The 7,000 t/d underground operation also produced 883,000 oz. silver, 13,161 tonnes zinc and 3,397 tonnes copper. Production at LaRonde began in 1988, and the mine became the deepest mine in North America in 2016, when operations reached over 3,000 metres depth.

As mining goes deeper, the risk of more frequent and larger seismic events increases. To reduce the risk to workers, Agnico has deployed an LTE communication network at the operation to facilitate the adoption of automated technologies.

LaRonde currently has a mine life of nine years, with proven and probable reserves of 14.9 million tonnes grading 6.02 g/t gold for 2.9 million oz. of gold.

5 » ÉLÉONORE

From the time that Newmont became its official owner on Apr. 18, 2019, when its acquisition of Goldcorp closed, until the end of 2019, the Éléonore mine in the James Bay region of Quebec produced 246,000 oz. of gold. Newmont couldn't provide *CMJ* production figures for the first quarter, so we don't have an exact number for the full year. But based on their figures, and accounting for a more than one-month COVID-19-related suspension that began in late March, our best guess is that the mine produced around 328,000 oz. of gold last year.

In July, Newmont forecast 2020 production at the 7,000 t/d underground operation at 190,000 oz. of gold at cost of sales (CAS) of US$920 per oz. (That compares to pre-COVID-19 guidance of 355,000 oz. of gold at a CAS of US$760 per oz.)

Éléonore hosts proven and probable reserves of 8.3 million tonnes grading 4.84 g/t gold for 1.3 million oz. The mine achieved commercial production in 2015.

6 » PORCUPINE

Newmont's Porcupine operations consist of the Hollinger open pit, Hoyle Pond underground operations, and a mill in Timmins, Ont., as well as the Borden underground mine near Chapleau, which reached commercial production last fall.

Like Éléonore, Porcupine was added to Newmont's portfolio with the acquisition of Goldcorp, so we don't have an exact production figure. The operation produced 223,000 oz. gold from Apr. 18 to the end of 2019, and unlike Éléonore, mine operations have not been significantly interrupted by the COVID-19 pandemic, so we estimate 2019 production at approximately 309,000 oz. of gold.

For 2020, Newmont forecast in July that Porcupine would produce 325,000 oz. of gold at CAS of US$795 per oz.

Combined open pit and underground proven and probable reserves at Porcupine total 54.3 million tonnes grading 1.63 g/t gold for 2.8 million oz. of gold.

7 » RAINY RIVER

New Gold's Rainy River mine, located 65 km northwest of Fort Frances, Ont., produced 253,772 oz. gold and 282,053 oz. of silver last year. On a gold-equivalent basis, production was 257,000 oz. at total cash costs of US$910 per gold-equivalent oz.

In February, the company released a new mine plan to lower costs and deliver free cash flow beginning in the fourth quarter. The plan reduces the mine life by three years to end in 2028 and cuts reserves by 1.5 million oz. gold, but boosts profitability based on a US$1,275 per oz. reserve price.

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The mine is now forecast to produce an average of 289,000 oz. of gold per year at cash costs of US$665 per oz.

Proven and probable reserves (open pit and underground) now stand at 77.6 million tonnes averaging 1.06 g/t gold and 2.5 g/t silver for a total of 2.6 million oz. gold and 6.3 million oz. silver.

Commercial production at Rainy River began in October 2017.

In February, New Gold released a new mine plan to lower costs at Rainy River and deliver free cash flow beginning in the fourth quarter. The plan reduces the mine life by three years to end in 2028, but boosts profitability based on a US$1,275 per oz. reserve price.

8 » MACASSA

Kirkland Lake Gold's Macassa mine poured 241,297 oz. of gold in 2019 at operating cash costs of US$414 per oz.

Located in Kirkland Lake, Ont., the historic underground mine is one of the highest grade gold mines in the world.

Kirkland Lake began sinking a new shaft at Macassa with a 4,000 t/d hoisting capacity in 2018. The #4 Shaft, which will eventually allow the company to increase production to 400,000 oz. of gold annually, will be completed in two phases. The first phase, down to 5,450 ft., is expected to be complete in the second quarter of 2022 at a cost of $240 million. A second phase with an ultimate depth of 7,000 ft. and at a cost of $80 million, should be complete by the end of 2023.

The current mine life at Macassa is nine years, with proven and probable reserves pegged at 3.9 million tonnes grading 21.9 g/t gold for 2.3 million oz. The mill currently has a capacity of 2,200 t/d.

CONTINUED ON PAGE 38

Miners rise to the challenges of the pandemic

Vale's Voisey's Bay nickel mine in Labrador.
CREDIT: VALE

Canadian mine sites have done well to keep employees and communities safe

By Alisha Hiyate

As September starts and schools and more businesses open back up, safety is on everyone's minds. Six months into the global COVID-19 pandemic, how are mines in Canada doing at managing the risk of the virus to employees and communities?

COVID-19 cases and outbreaks at operations in Canada have been rare – in large part because the country as a whole has done a good job in keeping the case count low. But credit is also due to mining companies, which have generally worked together with employees, governments and communities to draw up new protocols and procedures to operate safely.

Myles Sullivan of the United Steel Workers union, which represents about 25,000 workers at mines across Canada, says working under the new protocols has been an adjustment for all involved, but it's been a successful transition.

"We've had problems and it hasn't been 100%, but overall, our members have learned a lot and I can say that the employers generally have worked co-operatively with our reps to make sure things are being done safely and properly," Sullivan says. "There's been a pretty good job all the way around on this thing from a large majority of the employers."

On the other side, Sullivan says mine employees have been equally vested in doing their part to keep operations safe.

"Our folks want to go to work, they want to be safe and they want to earn a living, so they take it seriously – they know if there's an outbreak it can impact the operations and their livelihoods."

While cases have been rare at mine sites in Canada, one worker at Impala Platinum's Lac des Îles mine, 85 km northwest of Thunder Bay, Ont., died in April after contracting the virus, and 25 others were infected. The USW represents workers at the mine.

"We were working (with Impala Platinum) before that happened, but it's a silent enemy that you can't see and when it's there, it's very contagious," Sullivan says. "Things are back online and have been good so far, so we're working co-operatively to keep it that way."

At Dominion Diamond's Ekati mine in the Northwest Territories, Ivan Landry, president of the Northern Workers Union Local 3050, and a millwright in the maintenance department, says the safety protocols in place – from distancing to screening and an isolation and quarantine wing in case of any infections – have been effective.

The mine was put on care and maintenance in March, with roughly 114 people on site in July; the company is going

CONTINUED ON PAGE 26

through a restructuring process and planning a restart, with full operations to resume in the fourth quarter.

"We're satisfied with what's been done and we are watching to be sure our workers have a safe place to work and return to," he says. "The next thing is to get more people back to work safely – so we're not spreading the virus to communities or to ourselves."

Workers are currently on a longer rotation of three weeks on, three weeks off, to reduce travel in and out of the site, which can be fatiguing, Landry says.

"It is a bit of a struggle," he says. "A lot of us have close friends and colleagues that are laid off right now and struggling financially. We feel for them and we're watching out for each other on site as well, and trying to be as positive as possible. We do have counselling and our supervisors are there for day-to-day concerns and fatigue."

Indigenous workers and communities

To avoid introducing COVID-19 into remote Indigenous communities, miners are taking different approaches in different regions of Canada, based on communities' wishes, which have evolved with the situation.

"Initially the communities were very concerned because it was such an unknown situation, with the news, the lockdown and the borders closing. People were afraid," said the Tlicho government in the Northwest Territories, in an emailed response to *CMJ*'s questions.

"But through numerous meetings with leadership, and then many people working with the communities, the fears calmed down. People are still cautious, and making sure that all the protocols are being followed."

Tlicho employees were called back to work at the Diavik and Gahcho Kué diamond mines in May. While they were paid for the time they had to stay home, the opportunity to go back to work was welcome.

"We would like to continue working, and continue the precautions that are in place. Diavik has integrated mobile testing into their project, and managed a case successfully," said the Tlicho statement. "It would be good to see all employees really obey what the mine says, with respect to self isolation in advance."

In Labrador, operations at Vale's Voisey's Bay nickel mine were suspended voluntarily for more than three months because of the concerns of Indigenous communites in the region.

"We have a fly-in fly-out operation and some 50% of our workforce is Indigenous, so the last thing we wanted was our Indigenous workers being exposed to the virus and carrying it back to the communtiies which were ill-equipped to handle it," says Cory McPhee, Vale's vice-president of corporate affairs, communications and sustainability.

The company resumed operations in July, and in August was back up to full production, with a full complement of employees, including Indigenous employees.

McPhee says starting back up was a joint decision with the support of both

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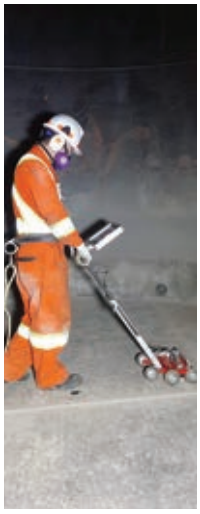

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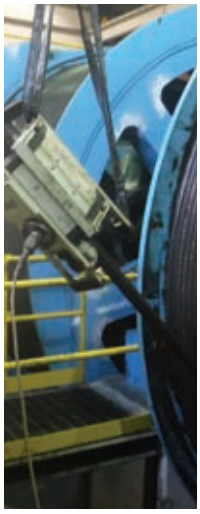

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That support came with the stringent health, safety and sanitation measures Vale put in place, including prescreening and medical monitoring for employees before travelling to the property and before leaving, physical distancing and masks. The company has also segregated the operations camp from the development camp for the Voisey's Bay underground project (first ore from underground is on track for the first half of 2021) to reduce unnecessary interaction between employees.

In addition, Vale has contracted a Newfoundland-based third party to establish a testing facility onsite using PCR (nasal swab) tests that will see everyone tested as they enter the camp and as they exit the camp.

Self-isolation rules vary by jurisdiction. However, once the lab is up and running employees will have confirmed PCR test results before they leave the site to go home.

"The other thing is in the spirit of the true partnership and the nature of the relationship, this is all subject to change," McPhee says. "If, all of a sudden, there's a second wave or cases start to materialize, then we'll have to reeaxamine everything that we're doing."

Perhaps the most cautious region in Canada has been Nunavut.

Baffinland, which operates the Mary River iron ore operation in the territory, sent Indigenous workers home with full pay in March, but in April reduced that to standby pay. The company does not yet have a return-to-work plan for Nunavummiut employees.

"Prior to our Nunavummiut employees returning to work, a number of risk management considerations will need to be resolved and we will continue to follow the advice and direction from the government of Nunavut, the Chief Medical Officer and the Public Health Agency of Canada. With that said, we are anxiously looking forward to the return of our Nunavummiut employees to Baffinland," the company said in a statement to *CMJ*.

Agnico Eagle Mines also sent home the Inuit members of its Nunavut workforce in March with no return date yet planned. (Its Indigenous workers in Quebec, however, are on the job.)

"Although all our employees are tested prior to coming to site, a fourteen days isolation would be required after each work rotation and is hardly compatible with the work schedules in place, logistics requirements and other impacts," said Martin Plante, Agnico's VP, Nunavut, in an emailed response to questions.

The company says it is working on a return-to-work plan that includes various scenarios.

Nunavummiut employees received their full salaries for the first month after they were sent home, and since Apr. 18, have received 75% pay.

To mitigate the salary impact, Agnico has started a pilot project in Baker Lake (the Good Deeds Brigade) whereby employees receive 100% of their salary in return for hours worked with non-profit, community-based organizations. **CMJ**

TEMPERATURE DETECTION CAMERAS

for Employee/visitor temperature Screening can quickly determine if someone has a high temperature. The Provix COVID Camera is equipped with an Infrared camera and a built-in body temperature detection module, which can rapidly determine a person's temperature when they stand in front of the camera. The COVID Camera can also authenticate an individual with facial recognition software if an existing photo database exists. The COVID Camera ships with the software and a mounting stand.

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Sorting through the heap

A hot gold price has miners dusting off heap leach projects. But not all projects should make the cut.

By CostMine staff

The business of mining has always been a romantic dream; gold is the shiniest of them all. These are exciting times for gold producers as the gold price has increased from an average of US$1,160 per oz. in 2015 to over US$1,900 per oz. in 2020, briefly breaking above US$2,000 per oz. in early August.

The number of projects currently in the pipeline have increased by over 16% in the last five years as a direct result of the hot gold market. Worldwide, heap leaching accounts for about 46% of all gold currently produced, and the rising gold price is making heap leach projects more attractive.

A recent study by CostMine focused on the costs and challenges when developing gold heap leach projects. This study looked at 375 projects worldwide that currently recover gold from heap leach technology, or anticipate doing so, either as the sole source of gold production or combined with milling of ores by other processes. The average grade at 275 of these projects and operations ranged from 0.11 to 6.91 g/t gold, with an average of 0.7 g/t gold.

With rising gold prices, it is expected that more projects will become economic. But how does the miner or investor evaluate these projects, and what are the costs?

Cost considerations

It sounds simple: mine the ore, find a place to stack it up and then sprinkle with a cyanide solution, and recover the gold from the cyanide. Easy right? Not so fast. Every mine is different and many of these ores will require special treatment to maximize the gold recovery.

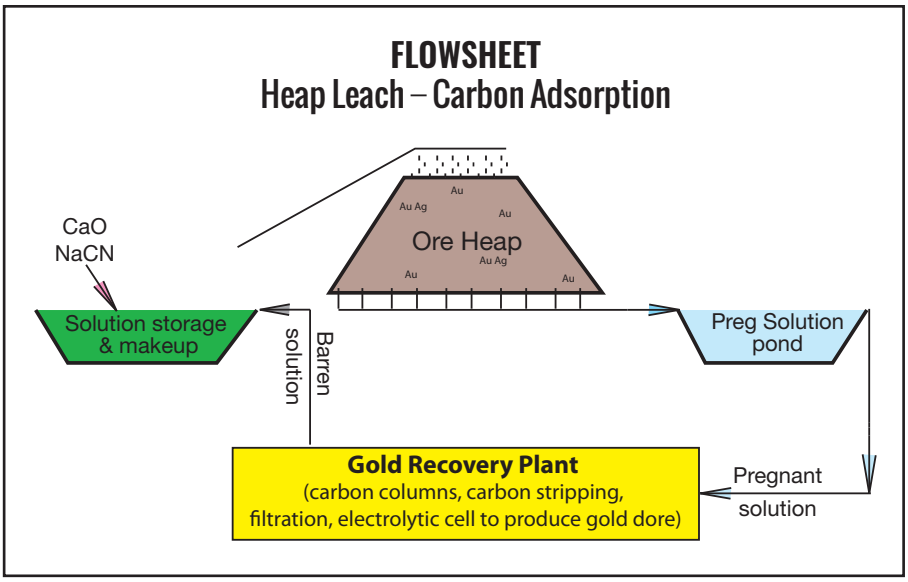
There are multiple factors that have to be addressed when evaluating a heap leach project. Some of these include the basics of extracting the ore from the mine and then determining the appropriate leaching and recovery methods.

One of the advantages of heap leaching versus conventional milling and using either carbon-in-pulp (CIP) or carbon-in-leach (CIL) for gold recovery is the lower cost. However, along with that lower cost comes a lower recovery rate. Gold recovery is also usually only about 55% to 75% compared with roughly 90% recovery in an agitated leach plant. Therefore, heap leaching shines where ores are lower grade and cannot justify the higher capital and operating costs in

methods such as CIP and CIL.

Another factor to consider is the time that it takes to produce gold from a heap leach. Heap leaching can take anywhere from a couple of months to several years, compared to the 24 hours required by a conventional CIP or CIL process.

CostMine's *Gold Heap Leach Cost Estimating Guide*, published this year, serves as a valuable reference to evaluate the cost, feasibility, design and operations for gold heap leach operations. The guide contains cost models of mining and processing, in addition to addressing several technical topics on gold heap leach not available elsewhere.



Example

For this article we will focus on the capital and operating costs from one of the production rates available in the Guide, using the following assumptions.

This gold heap leach project is assumed to be an 15,000 t/d open pit mine in areas of moderate relief with warm summers and snowy winters in North America.

The following construction activities are included for this example model:

Surface Mine:

- Drilling, blasting and excavating of ore, waste and overburden
- Hauling of ore by truck out of the pit and to a mill site
- Hauling of waste and overburden out of the pit and to a dump site
- Construction, installation and operation of facilities and equipment necessary for equipment maintenance and repair, electrical systems, fuel distribution, water drainage, sanitation facilities, offices, labs, powder storage, and equipment parts and supply storage

Heap Leach Pad and Pond Construction:

- Site excavation, contouring, and preparation
- Underliner and leak detection system
- Pad and pond installation using synthetic liners
- The equipment and supplies required to distribute barren solution to the heaps and to collect and return the pregnant solution

Merrill-Crowe Plant:

- Reagent delivery and preparation systems
- Pumping and piping infrastructur designed for caustic use
- Pressure clarification circuit
- Deaeration system
- Plate and frame filter recovery circuit
- Make-up solution preparation and storage system
- Plant building

Our model also recognizes that as we mine deeper into the pit, the stripping ratio changes, which is reflected below.

CONTINUED ON PAGE 30

15,000 tonne per day gold heap leach operation
Total resources: 63,000,000 tonnes
Gold grade: 0.70 grams per tonne
Average gold recovery: 72%
3:1 average stripping ratio over the life of mine
2019 US Dollars

CAPITAL COSTS

	TOTAL	INITIAL	SUSTAINING
Surface Mine	$140,200,000	$70,700,000	$70,700,000
Leach Pad and Ponds Construction	$22,100,000		
Pad Loading - Run-of-mine	$51,900,000	$22,100,000	$29,800,000
Merrill-Crowe Plant	$50,100,000		
Total Capital Costs	**$264,300,000**		

OPERATING COSTS

	YEARS 2-4	YEARS 5-7	YEARS 8-10
Surface Mine (per tonne of ore)	$5.58	$7.64	$13.00
Pad Loading - Run-of-mine	$1.08	$1.08	$1.08
Merrill-Crowe Plant	$6.46	$6.46	$6.46
Miscellaneous	$1.30	$1.50	$2.00
Total Operating Costs (per tonne of ore)	**$14.42**	**$16.68**	**$22.54**

Gold heap leach pad in Nevada.

CREDIT: WIKIMEDIA COMMONS/METALLOS-COMMONSWIKI

The increase in waste production also requires additional equipment, supplies and staff as the mine matures. Overall, the average stripping ratio for the life of mine is 3 tonnes of waste for each tonne of ore.

Stripping ratio

- Years 2 through 4 — 1:1 waste to ore
- Years 5 through 7 — 2:1 waste to ore
- Years 8 through 10 — 4:1 waste to ore
- Years 11 through 13 — 6:1 waste to ore

Development assets (buildings, haul roads, etc.) are designed for the fleet size during the final stage of production.

The following is scoping level estimate of the project outlined above.

At this point, we turn to the impact on the economic viability of this theoretical project by running a sensitivity analysis on the gold price using the Apex for Economic Analysis Software for Mining Projects, available from CostMine. It is no surprise that as the price of gold goes up, the potential profitability for heap leach operations increase.

But as the gold price rises and miners dust off projects that were not profitable a few years ago when the price of gold was lower, it is important to note that the price of gold fluctuates widely and a careful analysis of historical gold prices is crucial to selecting a gold price that will at least break even in leaner years to ensure the potential success of the project.

As the sensitivity analysis shows, this theoretical project would not be considered at a gold price of US$1,000 per oz. As noted above, the 2015 gold price averaged just US$1,160 per oz. For the last 15 years, the price of gold has averaged US$1,137 per oz. Based on the analysis above, would this project make the cut?

As cost estimators, considering the gold price is just one of the many factors that can make or break a project. While we simply looked at the gold price in this article as a variable, so many other factors need to be analyzed to develop a successful gold heap leach mine. Investing in mining is expensive and it is clear that miners and investors need to take the long view on all costs and factors when evaluating projects. **CMJ**

■ *This data and more can be found in CostMine 2020 Gold Heap Leach Cost Estimating Guide, available at www.costmine.com. Please contact us for more information at info@costmine.com..*

SENSITIVITY ANALYSIS

GOLD PRICE (USD TROY OUNCES)	SUM OF CASH FLOWS	PRESENT VALUE @ 15%	PAY BACK (YEARS)	INTERNAL RATE OF RETURN (IROR)
$1,000	-$83,895,544	-$132,058,457	50.01	-0.01%
$1,150	$37,758,472	-$75,534,045	10.49	3.17%
$1,300	$131,544,020	-$33,990,090	7.03	10.00%
$1,450	$225,333,420	$6,021,772	5.28	15.84%
$1,600	$319,118,968	$45,887,678	4.25	21.15%
$1,750	$412,485,429	$85,694,354	3.56	26.17%
$1,900	$505,727,629	$125,483,469	3.06	30.98%
$2,050	$598,969,829	$165,272,584	2.69	35.67%
$2,200	$692,215,860	$205,063,333	2.40	40.27%
$2,350	$785,458,060	$244,852,448	2.17	44.81%
$2,500	$878,700,260	$284,641,562	1.98	49.30%

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SCREENS & CONVEYORS

p34 MAJOR offers screen maintenance advice for mines and quarries

TÜFENTOBEL ROPECON®

FLEXIBLE SOLUTION FOR BACKFILLING WITH POSSIBILITY TO RELOCATE DISCHARGE POINT

Since the year 2005, a RopeCon® system has been transporting inert material along a long-stretched valley at the Tüfentobel landfill site, which will eventually be backfilled. The belt is being extended in several stages. It discharges the material directly where it is to be used. Finally, in March 2016, a novel concept was implemented which has further increased the flexibility of this RopeCon®.

A brief history of the project: RopeCon® as a means to transport inert material forms part of the expansion project of the Tüfentobel landfill site with the aim of developing new landfill space. 5.3 million cubic metres of additional volume have been gained by backfilling the long-stretched valley. Without the expansion, the site's capacities for taking up inert material would have been exhausted by 2004. With the new landfill space, operation of the site has been secured for several decades.

The expansion project investigated, among other things, different aspects of the transportation concept. The following goals had been defined: subsequent recultivation of the landfill site in several stages, low operating costs, safe operation, minimal exposure of residents to emissions, and optimal logistical delivery conditions.

The transportation concept considered using a suspended conveyor system, RopeCon®, to transport the inert material from one dumping point near the landfill site entrance to the opposite end of the valley which is to be backfilled. The RopeCon® essentially consists of a continuous flat belt with corrugated side walls and supporting axles arranged at regular intervals. Running wheels are fitted to either end of the axles and travel on a track of steel ropes. These steel track ropes are guided over tower structures, similar to a conventional ropeway system. The whole system is thus elevated off the ground and can easily cross obstacles or difficult terrain. The belt performs the haulage function and is driven by a drive drum at one end and guided around a return drum at the other end.

Relocating the discharge point of Tüfentobel RopeCon® in various stages

Opposite: The first RopeCon® discharges directly onto a second one.

Above: The landfill site is situated close to residential areas

Left: Special tower designs have been developed to account for ground settlements.

was part of the overall project plan from the very beginning. The idea was to discharge the material at all times as close as possible to the location where it was to be used. The discharge point has been relocated several times already since the installation went into operation so as to keep transport routes as short as possible for both the trucks supplying the material and the bulldozers spreading it from the discharge point. In March 2016 a second RopeCon® was finally installed directly into the rope span of the original system, which now discharges the material onto the new conveyor at a height of approximately 20m. The new RopeCon® system can operate in both directions. This allows for two different discharge points which can be fed alternately. The second RopeCon® system requires no support structure of its own but rather uses the track ropes of the original system. The running wheels of the second installation return onto the track ropes on a set of rails. An important advantage of the extension concept was that even during the assembly work the original system could be kept in operation to the greatest extent possible. Long shut-down periods were thus avoided. ■

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Doppelmayr®

TIPS FOR EFFECTIVE SCREEN MEDIA MAINTENANCE

By Lars Bräunling

It doesn't matter how much material is produced in a day if it is contaminated or not sized correctly. Though screen media is a minor cost when compared to larger equipment in a mine or quarry, it is a crucial part of any operation's profit machine. One unexpected break and thousands of dollars can be lost in terms of downtime and repairs.

For that reason, mines need to put a large focus on proper screen media maintenance, including selection, installation, preventative maintenance and storage. Best practices result in fewer changeouts, less unplanned downtime, higher quality product and a more efficient operation.

Where it used to be as simple as choosing the right size of woven wire for their material, operations now face a choice of dozens of different styles and brands of screen media. And while it may be tempting to think a cheap, off-the-shelf option will get the job done, managers should take a moment to think about what the wrong choice could mean. Not choosing a screen media suitable for an individual application could mean unexpected breaks, ruined piles from contamination, and overall expensive downtime.

Work with a screen media manufacturer to figure out what media is the best fit for each area of the screen deck. In some cases, a heavy-duty option may be necessary to take the punch at the feed end, followed by something durable but with more open area.

However, in many applications, high-vibration wire screens are suitable for the entire deck. An operation could choose higher gauge or double wire screens for high tonnages at the feed end and increase open area for the rest of the deck to boost stratification. Sometimes referred to as self-cleaning screen media, this media can be especially beneficial in an application with a lot of fines and clay deposits or where an operation has had difficulty with contaminated piles caused by too much organic material. The high-vibration qualities also tend to go far in solving issues with blinding and pegging.

Don't slack on installation

It's not uncommon for an operation to send the newest crewmember to complete the undesirable job of screen media change-outs, but the task benefits from someone with a bit more experience. The best screen media in the world won't do any good if it's installed incorrectly. This could mean improper tensioning or even installing it the wrong way around, something that happens more often than it should. The resulting issues can include accelerated wear, panels broken too soon and inefficient screening.

While specifics vary depending on the type of media, there are a few overall best practices for screen media installation. To start, clean and check the condition of components that touch the screen, make sure that the screen panel matches what

LEFT: Proper screen media installation can prevent issues such as accelerated wear, panels that break prematurely, and inefficient screening. ABOVE: Prolonged screen life starts with proper installation. Consider looking into screen media installation and maintenance training seminars.

CREDIT: MAJOR

was ordered, and install the screen based on instructions from the manufacturer for that particular type. During installation, make sure each support bar touches the screen and that the tension matches manufacturer recommendations. Some manufacturers include a "do's and don'ts" sheet with screen media to make the process easier. Also, crews should make sure they are following safety procedures, including having more than one person working on the installation and using the lock out procedure to prevent the equipment from being turned on while personnel are working on it. Certain types of screen media are safer to install than others, including shrouds of metal to cover the sharp hooks, no sharp edges and a lighter weight than standard woven wire.

Consider looking into screen media installation and maintenance training seminars to prolong screen life. Manufacturers often offer the service either through site visits or via a nearby dealer. The benefit will be a crew with shared knowledge of proper installation that could be worth thousands in unexpected downtime prevention.

Keep your eye on the screen

Once installed correctly, it's still best to check screen media at least weekly to make sure tensioning is proper and the panels aren't showing unusual signs of wear. A little bit of extra time during routine preventative maintenance can have a noticeably positive effect on profits.

While checking tension, also look at the clamp bars themselves. Check for wear, corrosion or cracks and examine the rail for straightness, which is necessary for even tension. Examine all nuts and bolts and replace any that are worn, stripped or corroded. Shaker bolt threads with excess build-up can be cleaned by running them across a wire wheel. Also, replace clamp bars that are thin or caving in to greatly improve screen media wear life and be sure to choose OEM versions for proper operation.

Screen box diagnostics systems can help prolong media life and improve screening by checking and monitoring a machine's health. Use a vibration analysis system to inspect the machine for balance and excessive vibration, which can lead to screen media failure or unintended machine wear. Vibration analysis systems are becoming easier to use. Some of the newest include only a single sensor, no wires and work quickly with a smartphone.

When it's time to remove and replace the screen media, pull off the bar rail or crown liners and inspect the steel bar rails for wear or warping. Best practice is to replace the bar rail liners during each change-out for longer screen media life.

Storage matters

Just like it's best to keep the expensive new car out of the harsh elements to lengthen its lifespan, so too should screen media be kept out of harm's way to maximize its effectiveness. Leaving the media in a pile near the screen box structure is convenient, but can lead to wires rusting, something that can reduce durability. Another common issue is screen media on the ground simply being run over by heavy equipment. Wire screens also get damaged when stored standing upright. The best solution to prevent damage during storage is a simple rack that allows crews to hang the screens from the hooks. This prevents damage and improves accessibility by allowing personnel to find the right screen without sifting through a pile of panels. Also, keep extra panels covered and in a well-marked area out of the path of heavy equipment.

Though minor compared to the rest of a mine site, operations benefit from staying proactive with screen media maintenance. From choosing the right media for the job and installing it correctly, to proper storage and preventative maintenance, treating screen panels right can mean less downtime, fewer headaches and more profits. **CMJ**

– Lars Bräunling is MAJOR's director of product technology (www.majorflexmat.com).

ON THE MOVE

Executive, Management and Board Changes in Canada's Mining Sector

TOP MOVES IN THIS ISSUE

Victor King

Victor King is now the VP of exploration with **B2 Gold**. King has 30 years of management experience in the mining industry and has worked throughout Africa on numerous exploration, development and mining projects. He joined B2 as exploration manager, West Africa in 2014, after the company's acquisition of **Volta Resources**, where he served as COO. In his new role, King will be responsible for overseeing and managing B2's exploration projects and identifying new opportunities for growth.

David Garofalo

David Garofalo has been named chairman, CEO and a director of **GoldMining**'s subsidiary, Gold Royalty. Garofalo has also joined the advisory board of GoldMining as well as the board of **Canadian Goldcamps**. Garofalo has more than 30 years of leadership experience in the resource sector. He served as the president and CEO of **Goldcorp** until the producer's sale to **Newmont** in April of 2019. Between 2010 and 2015, Garofalo was the president and CEO of **Hudbay Minerals**.

Greg Bronson

Greg Bronson has been named president and CEO of **Zanzibar Gold** as the company looks to advance its newly acquired Sonora gold project in Mexico. Bronson is a geologist with almost 30 years of experience in areas that include mineral exploration, resource estimation and drill program design. He has worked for **Noranda Exploration**, **Rockgate Capital** and **Sentinel Resources**, among others.

MANAGEMENT MOVES

» Geologist **Matti Talikka** has been named CEO of explorer **Aurion Resources**.

» **Barrick Gold** has appointed **Aoife McGrath** VP of exploration for Africa and the Middle East, and **Leandro Sastre** VP of exploration for Latin America and Asia Pacific.

» **BHP** has appointed **Ragnar Udd** as president of Minerals Americas, effective Nov. 1. Udd is currently BHP's acting chief technology officer.

» **Grant Ewing** is now the CEO of **Blue Star Gold**.

» **Geoffrey Fielding** is now a special advisor to **Brigadier Gold**.

» **Alex Terentiew** has been appointed as the president and CEO of **Canadian Goldcamps** (formerly **Supreme Metals**).

» **Clean Air Metals** has named **Allan MacTavish** as VP and project manager for the company's Thunder Bay North project.

» **Cobalt Blockchain** has announced that **Peter Copetti** has joined the company as executive chairman and CEO, with **Lance Hooper** and **Jim Blake** stepping down from the board. Hooper remains president and COO, while Blake will continue to provide corporate secretarial service. **Peter Hooper** is stepping down as CEO, but will continue to serve as a director and in an executive advisory capacity.

» **John Mansanti** has resigned as president and CEO of **Crystal Peak Minerals** and as a director. **Dean Pekeski**, the VP of project development, has been named interim president and CEO.

» **Anthony Paterson** has been appointed CEO and president of **District Mines**; **Marc Branson** has resigned as the company's CEO and president but will continue to serve as a director.

» **Joanna Pearson** will be joining **Endeavour Mining** as executive VP and CFO, effective early 2021. In the interim, **Henri de Joux** will continue as interim CFO and executive VP.

» Uranium producer **Energy Fuels** is making changes to its management team to reduce costs. These include departures of **W. Paul Goranson** as COO and **Matt Tarnowski** as chief accounting officer.

» **Robert Winton** has joined **Excelsior Mining** as general manager and senior VP of the Gunnison copper project.

» **Peter Smith** has stepped down as president and CEO of **Fancamp Exploration** for personal reasons.

» **Mark Trevisiol** has been named VP of project development with **First Cobalt**.

» **James Tuer** is now the president, CEO and a director of **Fjordland Exploration**, replacing **Richard Atkinson** who is now chairman of the board.

» **Matt Badylak** has been named executive VP and COO of **Galiano Gold** following the passing of **Josephat Zvaipa**.

» **Paul Cromie** is now the exploration manager, Australia, with **Kincora Copper**.

» **Jose Tomas Letelier** has retired as director of corporate affairs and sustainability with **Los Andes Copper**. **Ignacio Melero** will be joining Los Andes to fill the vacancy.

» **Michael Lavigne** is now president and a director of **Magellan Gold**; **Gregory Schifrin** has also joined the board.

BOARD ANNOUNCEMENTS

» **Brien Sirola** has resigned from the board of **55 North Mining**.

» **Michael Winn** has stepped down from the board of **Alexco Resource**, but will remain a strategic advisor to the board.

» **Roy Spencer** is stepping down from the board of **Arctic Star Exploration**.

» **Roger Norwich** has been named a director of **Asante Gold**.

» **Wayne Hubert** is now the executive chairman of **Austral Gold**'s board; **Eduardo Elsztain**, the company's largest shareholder, remains on the board as non-executive vice-chairman. **Raul Guerra** has also been named corporate VP of exploration.

» **Joel Warawa** is now a director of **Bam Bam Resources**.

» **Miloje Vicentijevic** has resigned as a non-executive director of **Benz Mining**.

» **Daniel Vickerman** is now an independent director of **Blackrock Gold**.

» **Garry Clark** has been appointed to the board of **Brigadier Gold**.

» **Brian O'Neill** has stepped down as a director of **Cameo Industries**.

» **Matt Halliday**, **Canada Silver Cobalt Works'** president and COO, has been appointed to the board. In connection with this appointment, **Marc Bamber** has resigned as a director.

» **Jim Clucas**, a director of **Casa Minerals** and **INV Metals**, has passed away.

» **George Gale** has been named non-executive chairman of **Cascadero Copper**.

» **Jonas Lauren Norr** is now on the board of **Crest Resources**.

» **Alex Klenman** has joined **Cross River Ventures** as a director.

» **Philippe Chave** is now a director of **Dynacor Gold Mines**.

» **Blair Wallace** has been appointed to the board of **Eco Oro Minerals**, and will serve as co-executive chairperson, together with **Courtenay Wolfe**, the current co-executive chair. This appointment follows **Rebecca Berrebi**'s resignation from the board.

» **Benoit Brunet** has joined the board of **Falco Resources**.

» **Scott Morrison** has joined the board of **Firestone Ventures**, following **John Kowlchuk**'s resignation.

» **Stuart Harshaw** has joined the board of **FPX Nickel**.

» **Lyle Davis** is stepping down from as chairperson of **Giga Metals**, but will remain on the board. Director **Anthony Milewski** is now the non-executive chair.

» **Dwayne Melrose** has joined the board of **Golden Tag Resources**, replacing **David Rigg**. **James Levy** has also resigned from the board.

» **Warren Gilman** has joined the board of **Gold Royalty**, a subsidiary of **GoldMining**.

» **Brian Stecyk** has resigned from the board of **Gold Rush Cariboo**.

» **Glencore Canada** has exercised its right to appoint **Ken Klassen** to **Group Eleven Resources**' board of directors.

» **Quentin Yarie**, **Craig Scherba** and **Kevin Tanas** have resigned as directors of **Honey Badger Exploration**. The board has appointed **Chad Williams** and **Rejean Gosselin** to fill the vacancies, and along with incumbent director **Chad Gilfillan**, are expected to be among management's director nominees at the company's upcoming AGM.

» **Nunu Ntshingila** and **Martie Janse van Rensburg** have joined **Ivanhoe Mines**' board as independent directors.

» **Meridius Resources** has appointed **R. Marc Bustin** to its board. The board has also determined to change the company's name to **BMEX Gold**.

» **Monica Ospina** has joined the board of **Monarca Minerals**.

» **David Watkinson** is now on the board of **Oakley Ventures**.

» **Peter Schloo** has been named a director of **Pacific Empire Minerals**, with **Keith Henderson** stepping down from the board.

» **Rejean Gosselin** and **Michel Fontaine** are now on the board of **Puma Exploration**.

» **Pierre-André Viens** has joined the board of **Sphinx Resources**.

» **Gary Robert Thompson** has resigned from **Stuhini Exploration**'s board.

» **Michael Konnert** has joined **Summa Silver**'s board of directors. Konnert is CEO and founder of **Vizsla Resources**. **Hani Zabaneh** has resigned from the board.

» **Miguel Inchaustegui** has stepped down from **Turmalina Metals**' board to assume the role of Minister of Energy and Mines with the Peruvian government.

» **Joseph Ovsenek** and **Stephen Scott** have joined **Victoria Gold**'s board of directors; **Jacques Perron** did not stand for re-election.

» **Archie Lang** has resigned from the board of **Western Copper and Gold**.

» **John Jacobsen** is now on the board of **Yorbeau Resources**.

» **Tyrone McClay** and **Juan Duarte Bravo** have joined the board of **Zanzibar Gold**.

» **Douglas Mason** has resigned as president of **Magnum Goldcorp**; he remains CEO and a director. **Peter D. Berdusco** has been appointed as president and a director.

» **Paolo Toscano** has joined **Marathon Gold** as VP of projects.

» **Ben Gelfand** has resigned as a director and as CEO of **Meryllion Resources**. **Frank Kordy** has resigned as a director, interim CFO and corporate secretary. **Jeremy Edelman** and **David Steinepreis** have been appointed as replacement directors, and **Guy Charette** has been named an additional director. Edelman has also been named the company's CEO, while Steinepreis has been appointed CFO; **Michael Kozub** is now corporate secretary.

» **Minera Alamos** has hired **Chris Sharpe** to serve as the company's VP of project development. The company has promoted **Federico Alvarez** to COO.

» **Max Keogh** has been appointed project manager for **NV Gold**'s Exodus gold project; **James Maxwell** has joined the company's newly established Exodus technical committee.

» **Andreas Rompel** has been appointed VP of exploration for **Q-Gold Resources**.

» **Liz Wall** has been named executive director of sustainability for **Royal Road Minerals**.

» **Shandong Gold**, a Hong Kong-based, publicly listed mining company, has named **Mark Wall** as CEO of **Streamers Gold Mining**, its wholly owned subsidiary. In May, Shandong announced a purchase of **TMAC Resources**. Wall was most recently at **Nevada Copper** and also spent 12 years at **Barrick Gold**, where he was senior VP and operations officer.

» **Christopher Bradbrook** has stepped down from his roles as president, CEO and director of **Superior Gold**; Bradbrook is the founder of the company and has been its president and CEO since 2017. **Tamara Brown**, a director of the company, has assumed the interim CEO role.

» **Teck Resources** announced three senior executive appointments. **Harry Conger** has been named the company's executive VP and COO. **Jonathan Price** has been appointed as senior VP and CFO, effective Oct. 1., succeeding **Ron Millos**, who is retiring. **Nicholas Hooper** has been named senior VP, corporate development, succeeding **Andrew Golding**, who is also retiring.

» **William Stormont** has joined **Tectonic Metals** in an investor relations role.

» **Treasury Metals** has announced that following its acquisition of the Goldlund gold project, the newly constituted board of directors has started a formal search for a CEO; **Greg Ferron** will continue to serve as CEO while the search is underway.

» **George Bee** has been appointed president of US Gold. Bee spent 16 years with **Barrick Gold**, where his roles included serving as the senior VP for the Frontera district in Chile and Argentina, and mine manager at **Goldstrike**.

» **Sebastien Plouffe** has stepped down as VP of public relations with **Vanstar Mining** and as a director.

» **Raj Gill** has joined **Wesdome Gold Mines** as VP of corporate development.

9 » HEMLO

Barrick's Hemlo mine, located about 35 km east of Marathon, Ont., produced 213,000 oz. gold last year at total cash costs US$904 per oz.

The company projects 2020 production will be in the same range – between 200,000 and 220,000 oz. of gold – but at a lower cash cost of US$800-850 per oz.

Hemlo, an open pit and underground operation with a 10,000 t/d mill, has produced more than 21 million oz. of gold over more than three decades of continuous operations.

Proven and probable reserves currently total 1.3 million oz., with proven reserves of 910,000 tonnes grading 4.94 g/t gold and probable reserves of 9.7 million tonnes grading 3.82 g/t gold.

The last mine on our list, Meliadine, is also the newest operation, with commercial production beginning in May 2019. The mine, located in Nunavut, produced 191,113 oz. of gold in 2019 at cash costs of US$748 per oz.

10 » MELIADINE

The last mine on our list is also the newest operation, with commercial production beginning in May 2019. Agnico Eagle Mines' Meliadine mine, 25 km north of Rankin Inlet in Nunavut, produced 191,113 oz. of gold in 2019 at cash costs of US$748 per oz.

The mine, which had been forecast to produce 350,000 oz. gold this year before the pandemic hit, saw reduced mining activities between late March and early June due to COVID-19.

Mining activities returned to normal levels in June, with a mill expansion to 4,600 t/d from 3,750 t/d scheduled to be completed by the fourth quarter. For the first six months of the year, Meliadine produced 129,350 oz. of gold at total cash costs of US$915 per oz.

The underground and open pit operation has a mine life of 12 years, with proven and probable reserves (open pit and underground) of 20.7 million tonnes at an average grade of 6.1 g/t gold for 4 million oz. **CMJ**

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