

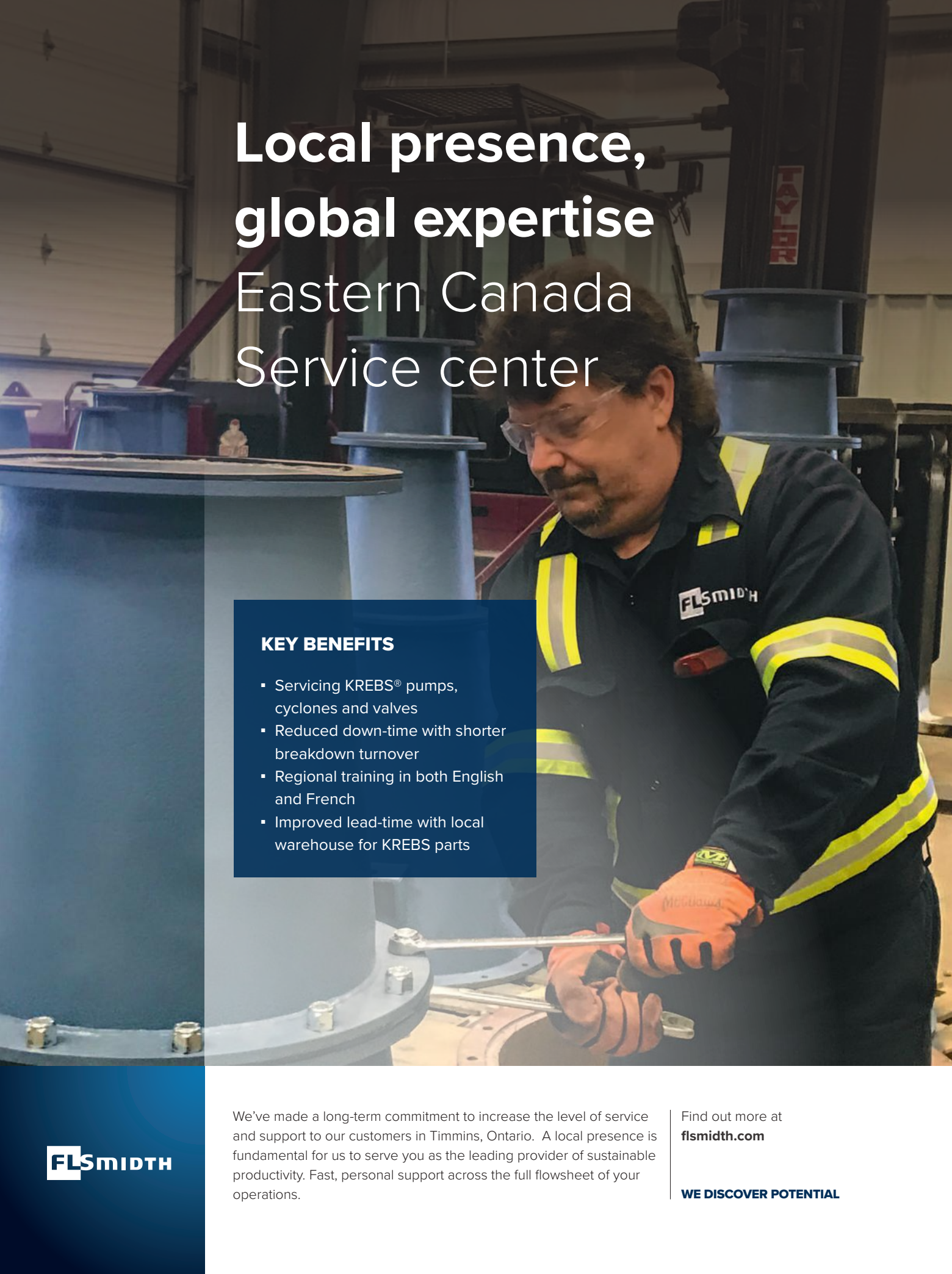
CIMMAGAZINE

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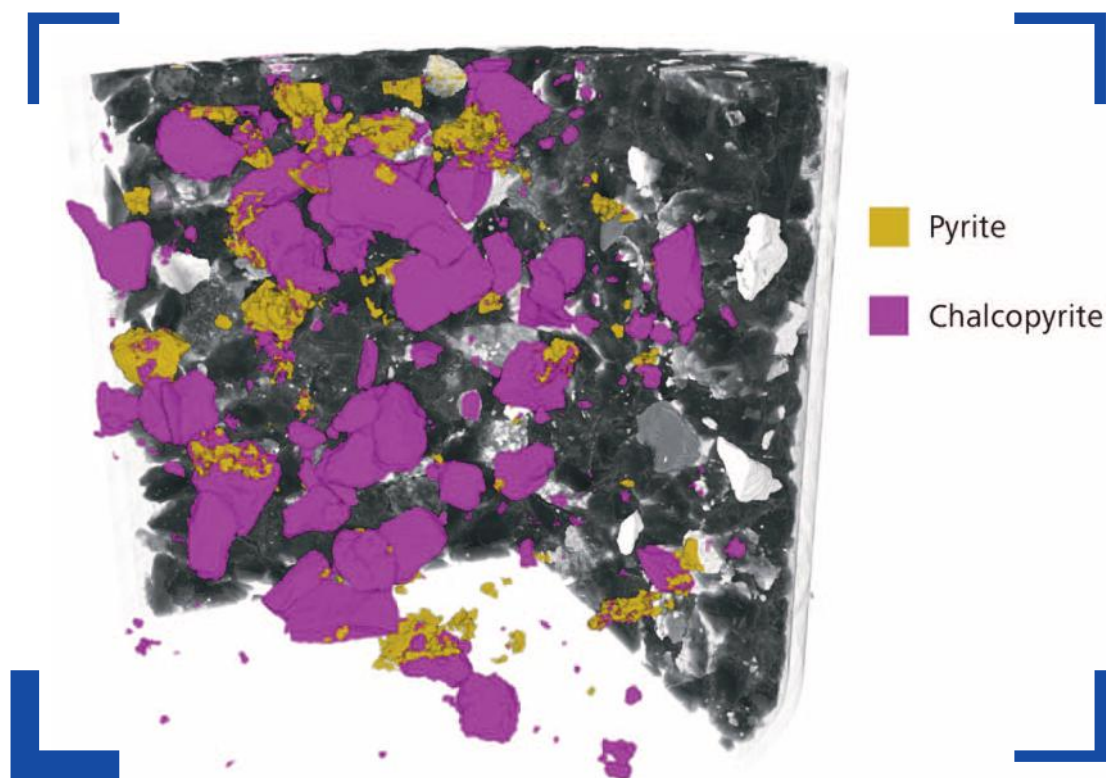
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Par Alexandra Lopez-Pacheco

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Seeing beyond

Lucky strikes

When we put together our editorial calendar each summer for the following year, we do our best to get a read on the mining zeitgeist and respond with a plan for our coverage that will, ideally, still be relevant some 18 months into the future when the final issue of the calendar is published.

Our “Net-Zero Challenge” department, as an example, was inspired by the cascade of miners announcing ambitious short- and long-term carbon reduction targets, a demonstrated interest from our audience for discussion on the subject, as well as the countless obstacles, some easily spotted and others likely hiding just over the horizon, on the way to that goal. That opens the door to a number of story possibilities.

I’m grateful to the exploration companies who spoke with us for our latest piece in the net-zero series “The thin edge of the wedge” by Kelsey Rolfe (pg. 24). As compared to massive mining operations, the activities of these companies are modest in scope and means, but the impetus to reduce the environmental footprint is the same. The market is asking for it and the explorers need to do their homework to understand the scale of their emissions, what can be feasibly reduced, and what can be done to mitigate the emissions that are inevitable, even if they are not compelled by regulation to do such accounting. From a miner’s perspective, carbon neutrality by 2050 really is not very far off, so scrutinizing any project through the lens of carbon intensity, no matter at what stage, sets the entire industry on a better heading than does deferring such attention because it is not yet a “material” concern.

There are other instances in the editorial calendar where fate works in our favour, as is the case with our feature for this issue focused on mineral exploration and development in Atlantic Canada. In a bit of serendipity, precious metals investor Eric Sprott took a nine-figure stake in the explorer New Found Gold

just as we were preparing this story for print. At the initial editorial planning stage, inspiration for the feature came, in part, from some unscientific trendspotting a few years ago during summer vacation in Nova Scotia, where the lead story in two small-town papers I happened upon focused on two separate gold projects in the province.

While the pandemic put the brakes on a lot of the exploration work in the Atlantic provinces, activity last year bounced back and early indications are that 2022 will be a banner year for the region.

What’s remarkable about the Queensway project, beyond the high-grade drill results, is that the property is located a short drive from a population centre and has relatively easy access to the power grid.

“We’ve always said Newfoundland is vastly underexplored when it comes to its gold potential,” Newfoundland and Labrador native and Sokoman Minerals CEO Timothy Froude told *CIM Magazine* writer Alexandra Lopez-Pacheco. “But few seemed to care much.”

That time has likely passed, and we look forward to sharing the stories around these projects as they develop.



Ryan Bergen, Editor-in-chief
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This issue's cover

Labrador Uranium has ongoing exploration projects in northern and central Labrador.

Courtesy of
Labrador Uranium

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BY JULY 1st

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Thriving in an unpredictable world

After two years tied to my hastily created, ergonomically incorrect, home workstation, I was ready to go out into the world, reconnect in person with friends and colleagues, meet new people and expand my thinking. This year's CIM National Convention & Expo in Vancouver was the perfect opportunity.

If you were able to join us at CIMBC22, lucky you! The thought-provoking keynote certainly challenged the thinking of those in attendance, and the opening panel with industry executives was inspiring. I learned that both sides of innovation (efficiency and creativity) are essential in addressing the complex challenges and opportunities we are collectively facing as an industry and as a society – like climate change, extracting/recycling the resources needed for a net-zero world, addressing skills shortages and collaborating with local communities to create sustainable prosperity.

This concept of thriving in a world that's increasingly unpredictable is equally valid for a national institute like CIM. For me, CIM is as much about community and the celebration of excellence as it is about the exchange of knowledge, promotion of best practices and engaging society. These five tenets have been in place for a very long time and continue to be relevant today – what is changing is how the tenets are embraced by our branches, societies and committees as we move forward. Let me give you an example: 40 years ago, CIM members eagerly looked forward to the arrival of the latest CIM publication by “snail mail”, enabling them to catch up on the latest technical innovations in peer-reviewed papers. Today this exchange of technical knowledge remains critical, but can be delivered via the internet, on demand. The tenet of exchange of knowledge is consistent, the mechanism by which this knowledge is exchanged is changing. CIM needs to ensure that our platforms, practices, and governance processes continue to evolve to facilitate the needs of industry, society, our partners and members.

The transition to a low-carbon future and global population growth means that metals and minerals are more important than ever and it's essential that all who can help realize these opportunities to ensure the world has the resources it needs feel welcome, included and represented in CIM. Increasingly, traditional discipline boundaries are blurring, as are upstream and downstream roles in supply chains (I heard the term supply webs recently), and this blurring of traditional mining roles can be seen as an opportunity to engage a much larger pool of talent. Looking beyond our traditional boundaries we're collaborating and developing solutions to improve safety, productivity and environmental performance.

As CIM heads towards its 125th anniversary in 2023, Angela Hamlyn, and members of the CIM Council will (hopefully – fingers crossed) be out and about at branch and society events and collaborating in person with supplier and industry partners. The success of the institute and our industry requires everyone working together.

Welcome home, it's good to see you in person again, and I look forward to serving as your president for the next year.

A handwritten signature in black ink that reads "Anne Marie".

Anne Marie Toutant
CIM President



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THE PROGRAM

The CIM Distinguished Lecturers program started in 1968 and has continuously provided a lineup of individuals who have shared their knowledge with the mining community for over five decades.

Every year, the lecturers are elected by their peers through the CIM Awards program and hold the title for a complete season [September to June].

CIM is privileged to count more than 260 of the industry's finest as its lecturers. Because the motto "once a lecturer, always a lecturer" defines our pride and dedication in ensuring that the learning curve is endless, a complete list of past lecturers is available at www.cim.org, where you can benefit from the ever-growing pool of expertise that the program has to offer.

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Easy lubrication

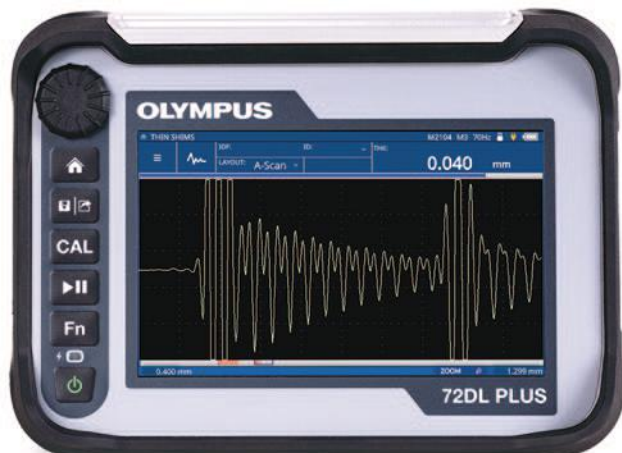
With the OnTrack SmartLube, **UE Systems** is relying on ultrasound to remotely monitor and deliver bearing lubrication. The single-point system assesses lubrication in real time through ultrasound sensors placed on bearings and delivers adapted amounts of grease based on need as opposed to fixed amounts at timed intervals. The OnTrack frees technicians from having to manually lubricate equipment, says UE Systems, increasing both efficiency and safety by keeping workers away from hazardous machinery and enabling them to instead monitor lubrication through the web-based program. “What we’ve seen is customers’ testimonials coming back to us and saying they’ve seen an actual reduction in grease consumption, probably about 30 per cent, and a 95 per cent decrease in lubrication tasks,” said John Paul Potestio, regional manager western Canada for UE Systems.

Versatile flotation

FLSmidth’s new REFLUX Flotation Cell commercializes flotation technology developed by University of Newcastle professor Kevin Galvin in an attempt to deliver a more efficient flotation than the market standard. Improved hydrodynamics, facilitated by inclined channels and high air fraction, allow for its bubble-liquid segregation to deliver higher recovery. The flotation cell is appropriate for implementation in any circuit and designed to reduce energy, water and air costs, according to FLSmidth. “It is versatile, but I think that it really will do very well in cleaning circuits because you’ve often got multiple stages of cleaning required. This technology will reduce not only the footprint in terms of the unit operation, but also the entire flotation circuit,” said Lance Christodolou, global product manager REFLUX technologies at FLSmidth.



Courtesy of FLSmidth



Thickness in-hand

Evident, formerly Olympus Scientific Solutions, recently launched its 72DL PLUS Ultrasonic Thickness Gauge, which is a portable thickness gauge capable of measuring up to six very thin layers of coatings at high frequencies and is available in standard frequency and high-frequency models. While traditional handheld ultrasonic thickness gauges worked in a frequency range of 0.5 MHz to 30 MHz, Evident says the 72DL PLUS can use transducers up to 125 MHz, capable of measuring thicknesses below 0.005 and 0.008 inches in plastic and metal respectively. According to director of global product-portable NDT at Evident Steve LaBreck, the 72DL PLUS takes what used to be considered a lab instrument needing hand calculations and instead displays the numbers directly in the palm of one’s hand.

Compiled by Sarah St-Pierre

Developments

U.S. Defense Production Act: Is it a big deal?

How the deployment of the measure by the Biden administration will impact the mining industry

By Sarah St-Pierre

On March 31, President Joe Biden invoked the Defense Production Act (DPA) to increase the domestic production of critical minerals and metals. While that may sound beneficial to the mining industry on first impression, the actual implications may not be immediately clear to those who are not already well-versed in American domestic policy. Confused? Here's what this all actually means.

First things first, what is the Defense Production Act?

The DPA was first enacted in 1950 as part of the United States' Cold War strategy following the outbreak of the Korean War. It grants the president temporary power to intervene in the national economy so that the production of certain goods, services and resources can be ensured or expedited as needed to promote national defence.

How do critical minerals fit in?

National defence, as it is commonly understood, is about limiting the adverse effects of potential hazards on the civilian population. In practice, it can range from military operations to the stockpiling of resources.

Title III of the DPA, which is the one invoked for critical materials, deals with the increase of industrial productive capacity and supply. Its section 303 refers to mining specifically by authorizing the president to make provisions for "the encouragement of exploration, development, and mining of critical and strategic materials, and other materials."

Why now?

The move comes in reaction to gas price hikes after banning the import of Russian oil to the United States. The situ-



Perpetua Resources believes the invocation of the DPA will help its Stibnite gold project act as a domestic source of antimony.

Courtesy of Perpetua Resources/Blaine Serrin

ation has spurred the administration to put together a relief plan.

Part of this plan involves improving American energy independence by accelerating the transition to domestically produced clean energy. Citing the need to boost the production of large-capacity batteries in particular, such as those found in electric vehicles, the White House invoked the DPA for critical minerals and metals.

What metals are included?

Lithium, nickel, cobalt, graphite and manganese are the metals named in the presidential memo issued to the secretary of defense as critical to battery production.

The critical minerals list recognized by the Department of the Interior, how-

ever, includes 50 minerals overall as of its 2022 renewal. Notable exclusions include copper, helium, potash and uranium.

What does it mean for the mining process itself?

Invoking the DPA will free up funding for the development of new and existing mining sites. The measure is expected to reduce the financial risks tied to new projects, enabling them to move forward more easily.

What the DPA will not do in this instance is provide loans or direct purchase by the government. It also does not remove the red tape or hurdles that come with mine development and operation. Federal and state requirements have not been waived when it comes to permit requirements and laws pertaining to the

environment, health and safety remain in full effect.

How has the announcement been received?

To industry insiders and experts, the lack of provisions around environmental permitting means that the deployment of the DPA is unlikely to speed up mining activity. It may still take many years for new projects to take off on domestic soil, with project approval time from the Bureau of Land Management (BLM) having been found to vary from the wide range of one month to 11 years.

Critics have called out the contradiction in the Biden administration announcing a push to subsidize projects it is already blocking through regulation. Namely, the deployment of the DPA comes a few short months after the BLM and U.S. Forest Service proposed to withdraw approximately 225,378 acres of federal land in northeastern Minnesota from min-

eral exploitation and mining development. Twin Metals, whose copper, nickel, cobalt, platinum group project would be affected by the withdrawal, has been vocal about its opposition to the proposition, which the company said will shut out a domestic source of raw critical minerals.

The National Mining Association has characterized the DPA news as limited in scope but that it sends an important message. "What we need is policy to ensure we can produce [mineral resources] and build the secure, reliable supply chains we know we must have," said president and CEO Rich Nolan.

Is anyone happy about this, then?

Despite some being unimpressed by the logistics of the DPA, some other companies have instead been quite welcoming of the announcement.

One of them is Trilogy Metals, whose Upper Kobuk project counts zinc, cobalt and copper among its indicated and

inferred resources. The company believes the DPA will allow its project to become a significant economic contributor in the Northwest Arctic.

Another example is Perpetua Resources, which has also applauded President Biden for invoking the DPA. Perpetua perceives the act as favourable to its Stibnite gold project, which would provide the only domestic source of antimony, another battery metal, if built.

What's the takeaway?

By invoking the DPA, the White House sets the tone that the production of critical minerals needs a domestic boost to stop relying on unreliable imports. The measure should incentivize the development of new projects and the expansion of existing ones by reducing their financial risks. However, without changing the status quo on environmental permitting, those developments are unlikely to occur at a fast pace. **CIM**

Barrick to resume Reko Diq project with Pakistani government

Development of the Reko Diq project is set to resume following an agreement signed on March 20 between Barrick and the governments of Pakistan and its Balochistan province.

The project, which is estimated to constitute one of the world's largest untapped copper and gold reserves, will be held 50 per cent by Barrick and 50 per cent by a combination of the Balochistan government and other federal and provincial government-owned entities. Antofagasta, a Chilean partner to Barrick in the venture up to that point, has exited the deal in exchange for US\$900 million, citing a change in its growth strategy now focused on the Americas.

Reko Diq had been suspended in 2011 and bogged down in arbitration ever since, after the government of Balochistan refused to grant the mining lease necessary for operations to move forward. The reasons cited at the time involved complaints about lack of transparency in the securing of the lease as well as too many concessions granted to the company, violation of government regulations and a lack of attention for national interests. The refusal came after Tethyan Copper



Work on the long-suspended project will begin anew thanks to a new agreement between Barrick and the governments of Pakistan and Balochistan.

Corp., the joint entity for Barrick and Antofagasta, had already invested US\$220 million in the project since an initial 1998 agreement with the provincial government.

The World Bank's International Centre for Settlement of Investment Disputes ruled against Pakistan in 2017, calling for a near-US\$6 billion penalty after finding that Pakistan had violated the terms of the Pakistan-Australia Bilateral Investment Treaty since Tethyan was registered in Australia. Barrick and the country's government have convened on an out-of-court deal, waiving the US\$11

billion incurred by Pakistan through penalties and other liabilities. The new agreement between parties ensures Barrick will receive not only the mining lease but also an exploration licence, surface rights and a mineral agreement stabilizing the fiscal regime applicable to the project for a specified period.

Now that the project is on track, Barrick said that full updates to its 2010 feasibility and 2011 expansion prefeasibility studies are its first orders of business. The 2010 study listed the project's total mineral resources at 5.9 billion tonnes of ore grading at 0.41 per cent copper and

Courtesy of Barrick

0.22 grams per tonne gold. Annual production was estimated to be 200,000 tonnes of copper and 250,000 ounces of gold from 600,000 tonnes of concentrate in a life of mine spanning over 50 years.

If all goes according to plan for Barrick moving forward, the company expects to be able to begin production within five to six years. "Reko Diq could also be the springboard for further exploration and other mineral discoveries along the highly prospective Tethyan Metallogenic Belt," said Barrick CEO Mark Bristow.

— Sarah St-Pierre

Ontario to aid northern industrial sectors with energy costs

Through its recently unveiled Northern Energy Advantage Program (NEAP), the Ontario government is aiming to strengthen northern Ontario's industrial sector by bringing down its electricity costs and building towards net-zero emissions. Under the program, which is a revamp of the former Northern Indus-

trial Electricity Rate (NIER) program, participating companies will receive rebates of \$20 per megawatt-hour on electricity costs.

By reducing energy costs for the industrial sector, the government said that NEAP will aim to foster well-paying jobs in northern Ontario and maintain global competitiveness, as well as build a stronger climate for global investment. To match these objectives, the new program widens the range of businesses eligible for partnership and increases government investment in the program from \$120 million per year to over \$176 million by 2025-2026.

NEAP builds on Ontario's new set of strategic priorities, which capitalize on critical minerals development, battery assembly and electric vehicle manufacturing, among other things. "Our government is building an integrated supply chain from exploration to electric vehicles – connecting the northern and southern Ontario economies for the first time," said Greg Rickford, minister of Northern Development, Mines, Natural Resources and Forestry.



Courtesy of Agnico Eagle

Agnico Eagle's Macassa mine is counted among the 28 facilities that will benefit from the Northern Energy Advantage Program.

There are currently 21 companies enrolled in the program including a number of mining companies operating across Northern Ontario. The NEAP rebates' individual caps will now be based on three-year average eligible electricity consumption by companies between 2017-2020, eliminating previous \$20 million caps.

The new program also introduces a new investor-class stream designed to provide time-limited enhanced energy cost benefits. The first company to benefit



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FROM THE WIRE

Compiled by Sarah St-Pierre

Suncor named **Peter Zebedee** as its new executive vice-president of mining and upgrading. Zebedee brings 25 years of experience in oil sands mining and upgrading to the position, in which he will lead related operations and oversee Suncor's involvement with the Regional Municipality of Wood Buffalo community.

MAG Silver has appointed **Fausto Di Trapani** as CFO, replacing **Larry Taddei** in the position as of May 20, 2022. Di Trapani brings extensive experience in mining production environments, large capital projects, financial management and control.

Discovery Silver has announced the appointment of **Tony Makuch** to its board of directors. Mr. Makuch has over 35 years of experience in the mining industry, having most recently served as CEO and director of Agnico Eagle.

The Canada Mining Innovation Council (CMIC) has introduced its board of directors for ReThinkMining Ventures, which was established to commercialize the technology in which CMIC has a vested interest. **Catherine Farrow, Nancy Guay, Tony Sprague, Roby Stancel and Carl Weatherell** have been appointed to the new board, with Weatherell serving as president.

Prime Mining has announced the appointment of **Chantal Gosselin** to its board of directors. Gosselin has 30 years of experience in mining operations and capital markets, having worked as vice-president and portfolio manager at Goodman Investment Counsel and as a senior mining analyst at Sun Valley Gold.

Christopher Stackhouse is Generation Mining's new vice-president, finance, replacing **Patricia Mannard**, who is retiring. Stackhouse was recently interim CFO at Guyana Goldfields, where he was involved in mine development and operation. **Rod Thomas** has stepped down as the company's vice-president, exploration, and will remain on its board of directors.

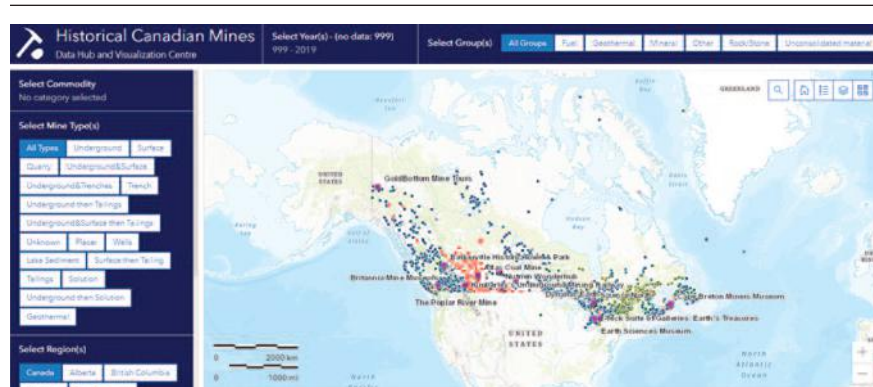
from this new class stream is Algoma Steel, which has obtained from NEAP the cost certainty it needed to build an electric arc furnace in Sault Ste. Marie. "We believe the ongoing support from the Government of Ontario through the enhanced NEAP program will play an important role in enabling us to modernize steelmaking and create a secure, stable future in Sault Ste. Marie," said Michael McQuade, president and CEO of Algoma.

The new program has been welcomed by mining companies in northern Ontario who are set to benefit, such as Vale Canada, Glencore and Agnico Eagle Mines. Agnico, for instance, stated that “The overall impact of [NEAP and NIER] has assisted [the Macassa mine com-

plex] in reducing our energy intensity and reducing our greenhouse gas emissions. This program has contributed to Macassa's ongoing improvements and at this point, Macassa is one of the least carbon intensive operations in the world."

Todd Smith, Minister of Energy, said, “Our government is supporting northern Ontario’s industrial sectors by reducing energy costs, providing the stability businesses need to support good paying jobs. [This] announcement reflects our commitment to help key economic sectors like forestry, mining and manufacturing maintain competitiveness and support new investments in the North.”

– Sarah St-Pierre



Donna Beneteau's database encapsulates over 14,000 mines from the 1700s until now.

Mapping Canada's mines

After almost a decade of work, a comprehensive database of mining's history in Canada has been released to the world

By Lynn Greiner

Canada's mining industry has a history that pre-dates even the formation of the country. Thousands of mines have come (and many have gone). So why, wondered Donna Beneteau, assistant professor in the University of Saskatchewan's Department of Civil, Geological, and Environmental Engineering, was there not a comprehensive list of Canadian mines, past and present?

In 2013, she began to gather data for what she calls her hobby project, hunting down information.

"It all started because when I went looking, there was nothing there," she said. "It took me a while, I just would play and find out where the data was about where mines were. And I built the whole big database by myself."

Today the database consists of more than 90,000 records covering over 14,000 mines. According to the data, the first mines in Canada are documented in the 1700s, the peak in the number of mines was around 1930 and since the 1990s, there has been a steady decline in numbers.

After being turned down twice for government grants to fund the work, she approached CIM's Underground Mining Society (UMS), of which she was chair at the time, and with the group's help was able to hire a summer student to validate what she'd collected. The project has now received support from the University of Saskatchewan (USask) College of Engineering, and the Canadian Hub for Applied and Social Research (CHASR) at USask as well.

A November 2019 article in *CIM Magazine* chronicled her journey to that point of the work in progress. Now, the project has come to fruition thanks to Beneteau's continued work in acquiring data for the parts of the country she had not completed (in 2019 she was still working on part of British Columbia and all of Alberta, Ontario and Quebec) and the talents of the team led by Tayyab Shah, geospatial research manager and specialist at the Canadian Hub for Applied and Social Research at the University of Saskatchewan, who built out the maps.

"It took a lot of time in the beginning," Shah observed. "Three to four months in brainstorming and designing the whole thing."

After the months of conceptualization, the team had to decide on a platform – it looked at Tableau (an analytics platform owned by Salesforce), Microsoft's Power BI, and Shiny (an R language package for building interactive web apps) before setting on ArcGIS, a mapping and analytics product from ESRI.

The result: The Historical Canadian Mines Data Hub and Visualization Centre ("The Hub"), a platform for accessing, storing, visualizing and continued collection of information on mines in Canada throughout history and up to the present day. It provides access to location information, as well as operational and production details, of mines that operated within Canada as long ago as 1774. Using the map tabs and filter settings, users can visualize trends in mining operations across the country over time, look at where various resources were found, view details on specific mines of interest or explore many other facets of mining.

"I thought this [project] was great, because it falls into something that a lot of young people would like to use to find out where things are happening," said mining engineer George Darling, who is now chair of the UMS. "[Beneteau] requested some funding to help with the database and help people put it together, and we said, 'Sure we'll fund it, it's a good project.' Now, it will be a wonderful database for all historical to present mining operations." He sees students or job seekers using it to determine what is being mined where, and by whom, and as a reference for papers. Companies looking for mergers and acquisitions could also use it to research the local landscape.

And more features are coming soon, Beneteau said, such as the ability to attach a file of additional data to each

mine on the map. She also hopes to add another layer showing museums and exhibits about mining, and one about key mining inventions, so people can learn about the field. And she is asking the industry to help fill in any blanks.

"I don't know what it will become," she said. "This was just my dream. And I'm willing to look after it and keep building it. But I want it to be CIM's, I want it to

be our community's. I don't want people to say Donna's database. I want it to be CIM's database, because I think it's going to take all of the industry to fill it in." **CIM**

The Hub database can be accessed via CIM.org. If you have questions and/or would like information on this project, you can send them by email to: minesdatabase@cim.org

Canada to make a sizeable investment in critical minerals

As part of its federal budget, the Canadian government announced its intentions to spend \$3.8 billion over eight years on boosting the country's sustainable production of critical minerals. The effort comes in the hopes of positioning Canada as a global leader within the electric vehicle supply chain.

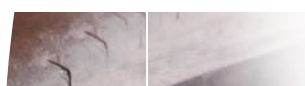
Among a number of measures and investments, Budget 2022 allocates \$1.5 billion to invest in new critical minerals projects and dedicates another \$1.5 billion to new infrastructure investments for projects in critical regions like the Ring of Fire. It also grants \$144 million to critical minerals research and development to support the responsible extraction and processing of critical minerals.

In terms of exploration, the budget also commits \$80 million to public geo-

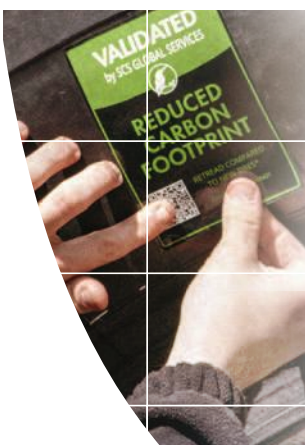
science and exploration programs to help find new deposits. The Mining Association of Canada (MAC) believes the measures in the budget will place Canada at the top of global exploration for critical minerals.

"The issue has been a lack of exploration and development of base metals over the last 15 years. And this budget will help turn that around, I believe," said Pierre Gratton, CEO of the Mining Association of Canada. He expects that exploration will be the first sector to see an uptick from the budget, as soon as 2022 or 2023. As reported by Reuters, Canada's critical mineral deposits are currently valued at \$340 billion, with further exploration making room for a potential increase in the figure.

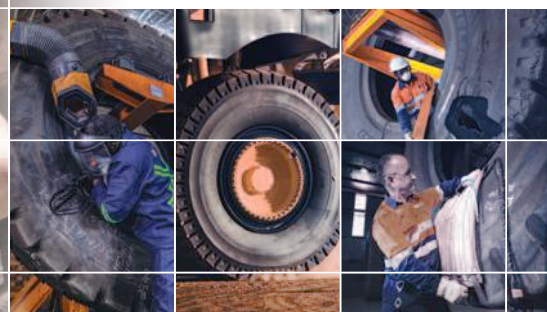
Gratton also expects further downstream developments around mineral processing, citing nickel sulfate as an example. "We mine a lot of nickel, but we don't actually turn it into nickel sulfate, which is what is used for batteries," he



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Cheetah Resources' Nechalacho mine is the first producing rare earths mine in Canada, with the government looking for more to follow.

said, noting his hope that major new infrastructure developments made possible by the budget will unlock this type of new activity.

The Prospectors & Developers Association of Canada also welcomed the measures outlined in the budget. The association was particularly pleased with the enhancement of the flow-through share mechanism which now doubles the Mineral Exploration Tax Credit (CMETC) to 30 per cent for critical minerals exploration.

Eligibility for the CMETC over the regular mineral exploration tax credit will be based on "reasonable expectation" that the minerals targeted by the exploration are part of the specified critical minerals list – copper, nickel, lithium, cobalt, graphite, rare earths and more. The tax credits will not be cumulative, and the specific mechanisms around the CMETC are yet to be revealed.

Regulations-wise, much like in the case of the Defense Production Act for the U.S., the spending does not entail the adjustment of any of the regulatory requirements for the mining industry.

Gratton thinks the lack of provisions around regulations is the budget's Achilles heel, with Canada being the only country in the world requiring impact or environmental assessments at both the provincial and federal level. "I have heard recently from several ministers that they too recognize that we can no longer be the country that takes five to 10 years to build a mine, to permit a mine," he added. When and whether the government acts to this effect will remain to be seen.

The budget does, however, allocate funds on additional resources for the Impact Assessment Act, as well as the incentivization of Indigenous participation in mining. By ensuring that the envi-

ronmental, social and governance (ESG) aspects of mining critical minerals also get bolstered, the budget is setting Canada up for a competitive advantage in global trade over countries like Russia (the third largest producer of nickel worldwide), and China once production ramps up.

Beyond just the critical minerals focus, the budget also has provisions for the implementation of more green technologies in the industry. An allocation of \$120 million to advance small modular nuclear reactors is included, as well as measures around further tax credits of 30 per cent and 60 per cent anchored around the use of net-zero technology and carbon capture respectively.

"The world economy is going green. Canada can be in the vanguard, or we can be left behind," Finance Minister Chrystia Freeland said when she presented the budget to parliament. With the 2022 budget, Canada's mining industry is set to be a critical part of the government's strategy.

– Sarah St-Pierre



Courtesy of Turquoise Hill Resources

If the deal is approved, Rio Tinto would control 66 per cent of the Oyu Tolgoi mine, with Mongolia controlling the remaining 34 per cent.

Rio Tinto makes proposal to take over Oyu Tolgoi

On March 14, Rio Tinto announced a non-binding proposal made to Turquoise Hill Resources, offering to buy the 49 per cent of the company's shares it does not already own. The proposed transaction would compensate minority shareholders of the Cana-

dian company at the price of \$34 a share in cash, representing a 32 per cent premium on the share value, for a total US\$2.7 billion value.

Both companies already work together closely on the Oyu Tolgoi mine in the South Gobi Desert in Mongolia, with Turquoise Hill owning a 66 per cent interest in the mine. The remaining 34 per cent interest is held by a Mongolian state-owned entity, with Rio Tinto in

charge of operating the mine itself. Oyu Tolgoi is Turquoise Hill's only mine.

Open-pit mining began at the mine in 2011, but underground operations were only recently approved to start in January 2022, due in part to changes in its mining plan after underground stability risks were uncovered in 2019. Those risks, along with the cost for mitigation, delays in production, reductions in assessed mineral reserves and accusations of mismanagement have all been sources of contention between the Mongolian government and both mining entities.

Due to rising operations cost estimates, the government saw its anticipated economic benefits dwindle, especially considering the US\$22 billion debt it will incur and with dividend payments not expected until 2051. Although the approval for underground operations to start was a breakthrough in relations between the three entities, Rio Tinto notes that inherent uncertainties remain in its development and funding.

According to Rio Tinto, the deal would simplify Oyu Tolgoi's ownership and governance structures, enabling the company to work directly with the Mongolian government. If successful, Rio Tinto will control a 66 per cent interest in the mine, with Mongolia controlling the remaining 34 per cent.

The first sustainable production underground is now expected in the first half of 2023. At peak production, Oyu Tolgoi is expected to produce 500,000 tonnes of copper per year on average between 2028 and 2036 from both open-pit and underground operations.

Turquoise Hill has acknowledged the proposal and will be establishing a special committee of directors not affiliated with Rio Tinto to review and consider it. Shareholders will be notified if the proposal moves further along, as the deal will require a two-thirds majority vote in favour to be accepted.

– Sarah St-Pierre

The financier point of view

Capital expenditures on mining projects grew in 2021 and the trend is expected to continue this year. According to the firm GlobalData, the estimated Capex of 20 major miners will rise 22 per cent to \$70.4 billion in 2022. In the past



The Capital Projects Symposium ended with a panel discussing what matters to financiers when evaluating a mining project. From left to right: Michael Samis, Paul Nielson, Shaun Usmar and Vikram Jayaraman.

when the money was flowing in, the sector has not always used it well, leaving many investors wary of funding the next generation of projects.

At CIM's recent Capital Projects Symposium in Toronto, the event concluded with a panel discussion about what really matters to financiers when it comes to backing or buying mining projects and companies. The symposium was created in 2020 to focus on improving project outcomes through the examination of development and execution methods, contracting models and financing options in the mining sector, and was held for the first time as an in-person event in Toronto in late March.

Moderator Vikram Jayaraman, DRA Global's vice-president, origination, led Michael Samis, principal at SCM Decisions, Paul Nielson, principal and head of development portfolio at Waterton Resource Management, Shaun Usmar, founder, CEO and director of Triple Flag Precious Metals and Alex Black, president and CEO of Rio2 Limited (who participated via video call), on a discussion that shifted the attention from project execution, to project financing.

Usmar shared his belief that the industry has turned generalist investors against mining by not fulfilling promises made in exchange for their money.

"We have broken a contract with generalist investors. We are less relevant," he said, asking, "Why should these pools of capital come to us?"

Usmar, however, is optimistic that once the "greed phase" of mining's eter-

nal boom-bust investment cycle kicks in, investors will be tempted by mining again, even if they are still wary. Usmar told the audience that once that happens, "the people in this room will have a role to play" to ensure investors know what they are getting into and that mining companies live up to the expectations they create.

Nielson addressed a question about how Waterton evaluated distressed companies prior to making purchasing decisions about them. "The answer is a combination of fatal flaw – yes or no. Is it irretrievably damaged? Or is it something that, with patience and capital, can be fixed? If it's patience and capital, that's our thing. Look at the industry: patience and capital is not what most people have."

He explained that it is hard to really evaluate what is happening in a distressed company because "if a company is going through a doom spiral, good data management isn't their priority." That leaves it up to the buyer to make a judgement call, based on experience, and to build in enough financial leeway to stave off the challenges that are sure to come.

Samis explained that, from his perspective, junior miners do a poor job of telling their own stories to investors and of explaining to those same investors how their capital will be used, and that this is something that they should change if they want to attract more money.

"That's what I find really surprised me with junior companies: they're all out there, explaining why they're such a great

Courtesy of Carolyn Gruske

deal. 'Hey, look, X dollars per ounce,' ...but you don't see many people talking about 'here's how we're going to go through the next few stages of exploration and design, here's what's going to kill our project. Here's how we're going to get capital. Here's how our design reduces the risk of the project.' And that's the story that I think is more interesting for potential investors."

He added that, especially in the cases of companies with marginal projects, hearing about what the plans are to reduce risks and manage the project in a "sensible manner" in order to "make some money for investors" should be the real focus of their marketing and sales pitches.

Black, whose Rio2 team is aiming to build a heap-leach gold mine in Chile with a staged approach, was asked his thoughts about capital deferrals and got a laugh from the crowd when he answered, "From a junior perspective, that's what it's all about."

He explained that the goal for juniors is to get a project going, and "to keep it as simple as possible." Black then offered up some of his own management philosophy. "As a CEO, I've never really been focused on NPV (net present value). Most junior companies focused on NPV are looking to sell their projects or companies, which ultimately, doesn't usually happen. I mean, the takeout ratio is very low in reality."

He added that what seems to work for him and his companies is focusing on the margins and making sure he does not have a marginal project, and then "looking into the optionality of what you have and getting it into production, and then going from that point."

After the initial questions to the panel was over, a more free-wheeling approach was taken to the discussion, leading to a return to the topic of injured investors.

"Genuinely, Nielson observed, "our industry has destroyed so much investor capital. When things are cheap, investors look ahead and say, 'they're probably going to get cheaper.'" – Carolyn Gruske

New reclamation requirements for B.C. mines

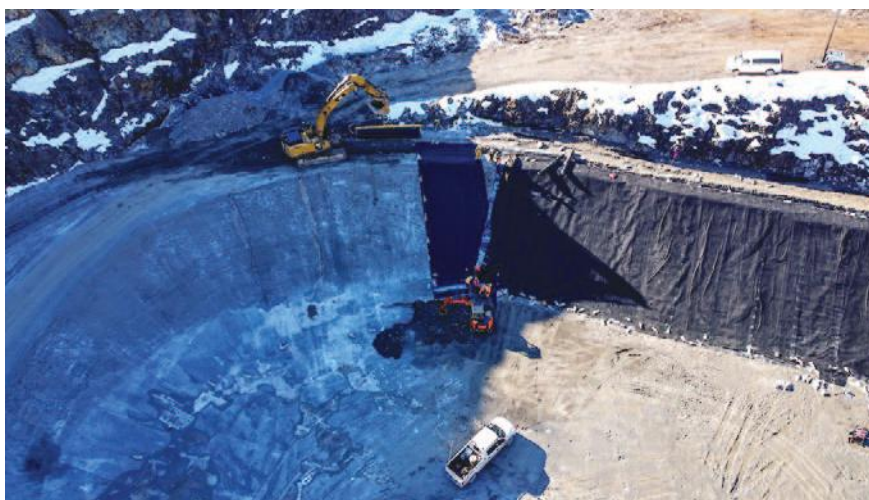
Mines at the beginning and end of their lives will now be required to pay more of their reclamation costs up front under a new interim policy in British Columbia

By Matthew Parizot

An interim change to British Columbia's mining reclamation security policy will see mining companies operating in the province become responsible for a higher share of the costs of reclamation.

When companies are applying for mining permits, they are required to submit a plan covering the reclamation of the environment impacted by the development and operation of the mine. Crucially, the companies are also required to place a security with the province based on a total liability cost of the reclamation. So, in the case that a company becomes insolvent and is no longer able to cover the costs of reclamation, the taxpayers will not be responsible for the difference.

The new policy, announced on April 5, is bringing some changes to how the liabilities are calculated, and how much of the upfront reclamation costs miners are responsible for. Under the new policy, any new mines and any mines that have less than five years of mineral reserves remaining will be required to post a full reclamation security equal to its liability. Additionally, when calculating the liabilities, the cost estimates will include both "conventional reclamation," such as re-sloping and re-vegetation, and



Courtesy of Ascot Gold

New mines (like Ascot Gold's Premier project currently under construction) will now be required to cover 100 per cent of its reclamation liability in its paid security.

environmental liabilities, such as water treatment, as well as the costs of operating and maintaining any necessary water-treatment plants.

According to the B.C. government, these changes have been made to "ensure owners of large industrial projects are bonded moving forward so that they, not B.C. taxpayers, pay the full costs of environmental cleanup if their projects are abandoned."

These changes are the result of a multi-year process, stemming from a 2016 report from the province's Auditor General on compliance and enforcement of the mining sector. The report noted that the Ministry of Energy and Mines (MEM) was not adequately ensuring that the costs of reclamation were being covered, saying that "MEM's compliance and enforcement program is limited," and noting that its financial security

deposits for the mining sector were under-secured by \$1.2 billion compared to the total costs of liabilities, having only collected \$0.9 billion out of a total liability of \$2.1 billion, a fact that was not known to the public at the time.

As it stands, mining companies are not always required to pay the full cost of their potential liabilities. Rather, the province uses a risk-based approach to determine how much of its liability a mining company is required to pay, based on the likelihood of the company defaulting. A 2017 report from consulting firm EY found that while MEM was considering the risk factors when determining the amount of security to hold, it had not defined the “acceptable threshold for each factor above which may lead the government to not require full security.” In other words, the standards were not set in stone and differed on a case-by-case basis.

The province has since done a better job of both collecting securities from mining companies and publicly reporting its figures, though a gap between securities and liabilities still exists. According to the 2020 annual report from the Chief Inspector of Mines, the mining sector owes a total of \$3.4 billion in liabilities, with the province holding \$2.3 billion in securities, for a difference of \$1.1 billion.

These changes under the interim policy have been designed to better mitigate that risk by requiring mines at their most vulnerable points – right as they begin operations and right as they are about to end operations – to have their liabilities 100 per cent covered. According to the policy, “new mines that are highly leveraged may be more susceptible to fluctuations in commodity prices. In the latter stages of a mine’s life when reserves are depleted, the likelihood of another operator acquiring the mine site in the event of a default is limited.”

This policy will not, however, require mines to cover liabilities based on projected life-of-mine costs, and will instead see its liability examined every five years per the previous policy. According to the province, this was done to promote long-term mines without penalizing companies that have “conducted exploration and planning to demonstrate the viability of long-term mining.”

Industry reaction to these changes has been muted, as the policy is still

being reviewed and updated, according to the province. Michael Goehring, president and CEO of the Mining Association of British Columbia (MABC), said that on first look, the interim policy included substantial bonding requirements that exceed most jurisdictions in the world. It appears to encourage long-term environmental stewardship and the responsible development of the metals and miner-

als the world needs to support the low carbon future.

Goehring also mentioned that MABC is reviewing the policy and consulting with its members, but also that B.C.’s mining industry provides more reclamation security than any other natural resource sector.

Should these changes be permanently enshrined into law, those securities stand to be even higher. **CIM**

Positive exploration outlook

Given the exploration sector’s performance last year, Kevin Murphy, principal analyst at S&P Global Insights, finds reason to be optimistic for 2022. “You can see that we’ve come a long way from the pandemic lows and have gone well up above there, so the industry is in a fairly good place overall,” he said, speaking at the discussion group hosted by the Management & Economics Society of CIM on March 30.

Murphy delivered a presentation on global exploration trends and the sector’s projected outlook for the current year. Using exploration budgets from companies across the world, he presented his insights on how spending is affected by metal prices.

In 2021, exploration budgets increased by 35 per cent to a total of \$11.2 billion. While the figure is 45 per cent below its last peak in 2012, Murphy nevertheless said the increase was heartening. In fact, he did not expect figures to get back in the 2012 range despite the prices now exceeding what they were then. “The industry sort of had its knuckles rapped by investors following the 2012 crash,” he said.

When looking at budget per commodity, Murphy pointed out that gold was the metal dominating the exploration focus, accounting for 55 per cent of budgeting in 2021. Copper also performed quite well, with zinc and diamonds underperforming. Lithium and cobalt were lacklustre exploration commodities last year following the weaker prices of late 2020 and early 2021, although lithium is expected to pick back up this year.

Drilling was up 68 per cent last year with 70,000 drillholes accounted for, representing a 172 per cent increase from the 2014 low of 25,400 holes. Murphy

further added that gold has also been dominating the lion’s share of drilling, accounting for 71 per cent of it over the past eight years.

Tackling the questions of who did the exploration and where, Murphy indicated that major miners continued to be responsible for the bulk of exploration despite the junior sector’s 62 per cent budget increase in 2021. Geographically, the most notable movements in exploration budgeting were a three per cent increase for Canada and a two per cent decrease for the whole of Africa, where key countries like Côte d’Ivoire and the Democratic Republic of Congo affected the trend.

A big concern that Murphy pointed to is the trend away from grassroots exploration over the past five to 10 years. This is a problem, he explained, given the mismatch between copper supply and demand if the lack of discoveries remains ongoing. “Once we get to around 2026, we’re looking at a problematic situation where we are relying on those [existing] assets [and] that we’re not confident [in our ability] to maintain supply to meet demand,” said Murphy.

As for the 2022 outlook, financing has so far this year not been up to par with last year’s “huge jump,” according to Murphy. “We are definitely watching [this], as this is the time of year that a lot of juniors tend to hit the market for their summer programs, especially in Canada,” he said.

Nevertheless, Murphy was cautiously optimistic. He predicted that continued strong metal prices should stand to benefit the exploration sector and that global exploration budgets will likely increase by around five to 15 per cent this year. Murphy expected that gold would remain the primary target of exploration, with good movement on energy metals such as lithium, nickel and uranium.

– Sarah St-Pierre



The thin edge of the wedge

Limited by geography and resources, exploration-stage companies turn to site-efficiency projects and carbon offsets to reduce GHG footprints

By Kelsey Rolfe

Troilus Gold is working with Tugliq Energie to conduct an inventory of all of its currently and historical GHG emissions, including those produced from drilling.

Fireweed Zinc has big plans for its upcoming summer drilling season. The junior miner is gearing up to conduct an updated preliminary economic assessment for its Macmillan Pass zinc-lead-silver project in southeast Yukon, with drill results from its Nidd property.

Doing so will mean generating greenhouse gas emissions the company has no way to reduce, as much as it would like to, said Pamela O'Hara, Fireweed's vice-president of sustainability.

Macmillan Pass is a collection of 13 properties over 940 square kilometres. The site, located about 200 kilometres north-east of Ross River, is accessible by road and its on-site airstrip. The company's 50-person camp, powered by a diesel generator, is set up at its Tom property; Nidd is a 20-minute helicopter ride away. The summer drill program will mean disassembling drills and flying the parts over in several trips, along with drill rods, personnel, fuel and any consumables. The company runs 24-hour shifts, so helicopters fly back and forth throughout the day at shift changes.

Given the project's remote location, massive scale and four-month season from June to October, there are no clean-energy alternatives, O'Hara said.

"There's no economically or technically feasible way for us to transition away from fossil fuels right now as a junior exploration company," she explained. "Having said that, we're planning to be in production in 10 years, and I think there will be tremendous advancements in the sector."

Fireweed's story is a familiar one for mineral explorers. As the mining sector faces increasing expectations to decarbonize, exploration-stage companies are caught between a very remote rock and a hard place. Faced with geographic, financial and technical barriers to reducing their emissions, many are turning to small optimization projects and offset programs to make a dent.

Keeping tabs

While many exploration-stage companies are thinking about reducing emissions, currently, they are rarely obliged to report or pay for them. The federal government's GHG emissions reporting threshold is 10,000 tonnes of carbon dioxide equivalent (CO₂e) per year, and as of 2019, industrial operations that

emit over 50,000 tonnes annually face an output-based pricing system for carbon. The Prospectors and Developers Association of Canada noted in its online GHG emissions guidance that exploration activities are "very unlikely" to hit an output-based pricing threshold, but a large-scale exploration drilling program of around 200,000 metres per year or operations with at least 10 drills could trigger monitoring and reporting requirements.

"PDAC members operating in Canada are encouraged to proactively measure the total direct emissions in CO₂e of their activities," the guidance says.

It is something Andy Randell, chief executive officer and principal geoscientist at British Columbia-based geological consultancy SGDS Hive, began doing after a client requested it. With no existing template for exploration-stage companies, Randell and the Hive team developed their own form of carbon accounting. It breaks emissions down into three categories: operational carbon from transportation and site equipment, portable engines, camp-power generation and more; human carbon from electricity, waste and paper usage at camp; and environmental carbon from vegetation clearings that reduce carbon sequestration.

Today, Hive offers carbon accounting for free to its clients. Randell also tracks the carbon footprint of the mineral exploration company he founded, Aeonian Resources, which has three projects in British Columbia. Aeonian's Koocanusa copper project near Cranbrook emitted 1,621.35 kilograms of carbon in 2021 as Randell's team completed a magnetic survey grid over a section of the property, expanded the property through staking and also prospected, mapped and sampled that new area. Now that the company has a better picture of its emissions, he said, it can start trying to cut them back.

Working within the boundaries

But there are still significant limits on what mineral explorers can do to reduce their footprints.

"Exploration companies do have some challenges," said Gabrielle Beauchamp, mining sector project manager at Tugliq Energie, a Quebec-based independent power producer focusing on renewable energy solutions for remote and off-grid applications. Temporary camp installations make it hard to commit to



permanent renewable energy infrastructure if there's no grid connection, she said, and northern explorers will have additional emissions from heating.

Kristina Hamernik, Tugliq's business development lead, added that mobile equipment remains a persistent challenge, with almost no options on the market for renewable-powered drill rigs, and other heavy equipment facing a tradeoff between battery weight and power duration. "The heavier and larger your vehicle, the larger you need the battery to be, and at some point, the two don't go hand in hand."

Exploration-specific variables can also affect the amount of greenhouse gas emissions at site, according to PDAC's guidance. Larger-diameter cores and deeper drill holes consume more diesel during a drilling program, and ground quality is "one of the most important impacts" on drills' diesel use. The association also noted that drill age and condition and crew skill levels play a role in emissions.

Hamernik noted that there are growing opportunities in the market for smaller-scale renewable power solutions. She said the company is working on a project for the federal Department of National Defence to demonstrate small-scale renewable energy solutions coupled with waste and water treatment for small, temporary camps, which could be useful to mineral explorers. There are also smaller-scale wind turbines in use with a less permanent structure and tilt-down ability for maintenance or bad weather, as well as containerized, mobile solar installations.

"There are certainly opportunities for integrating smaller-scale renewable [energy], even mobile [solutions]...but because of certain reliability factors, I think, there's a hesitancy," she said. "But with commitments becoming louder across the industry, I think now we'll see a bit more of a shift where, in the exploration phase, there's at least a bit of integration."

Small changes

For many small companies, cost is a real factor, Randell said. "We're at the Canadian Tire end of things, as opposed to going to a big industrial warehouse and finding something that's going to run net zero."

He said Aeonian has switched its gasoline supply to a more expensive and cleaner premium blend that emits less CO₂. The company also uses self-propelled track-mounted drills, so it does not have to use a dozer to move them around. It is looking at small solar chargers for phones, radios and other electronics that could reduce the amount of time its diesel generator is in use, and has considered the emissions implications of taking recycling into town or burning it in place. "Unfortunately, it's all thin edge of the wedge stuff," Randell said. "The smallest things are easiest to change."

Fireweed has introduced simple mitigation strategies, O'Hara said. It has an anti-idling policy for its vehicles to ensure an efficient use of fuel – something that is important to the junior from both an emissions and cost perspective. It also runs double-ended flights: the same plane takes personnel into site and ships drill core down south on its return.

Offsetting emissions

Troilus Gold, a Quebec-based junior miner that is developing the Troilus project on a legacy gold and copper mine that operated from 1996 to 2010, is taking a different approach to addressing its emissions. In late February, the company announced it

had hired Tugliq to conduct an inventory of its current and historical GHG footprint and to help Troilus create a roadmap to develop a carbon-neutral mine. Troilus plans to update its mineral resource estimate and complete a pre-feasibility study in mid-2022 based on its 2021 exploration program of 100,000 metres, and said it will continue regional exploration activities throughout the year.

The company was founded in 2018 when it acquired the Troilus claims. Catherine Stretch, vice-president of corporate affairs, who oversees the company's ESG initiatives, noted the site is connected to the Hydro-Québec grid, which supplies 83 per cent of the energy currently used on site, but it still generates emissions from drills, other site vehicles and its backup diesel generator.

She said the company plans to purchase carbon offsets to address its GHG emissions since 2018 and to work with Tugliq on a plan to reduce emissions going forward.

Aeonian is offsetting its footprint through tree-planting programs. Randell said the company uses British Columbia's carbon price of \$50 per tonne to calculate its rough cost of carbon, and then donates a commensurate amount to tree-planting charities. According to the tree-planting charity One Tree Planted, each tree can store roughly 10 kilograms of carbon per year for the first 20 years of its life, and Randell said the cost is roughly \$6 per tree. To offset Koocanusa's 2021 carbon emissions, he said it would have cost \$80 in carbon tax; the company donated \$97 to a tree-planting scheme.

"Putting an actual dollar amount on offsets is kind of dangerous in some ways, because it's so low that people might want to do the minimum. But I'm hopeful most companies will say, 'oh that's cheap, we could triple that easily.'"

Randell said he has also talked with Hive clients about using offset funds to purchase seeds to donate to First Nations, schools or programs that have native plant nurseries if they are in areas with forestry operations where tree-planting would happen anyway.

According to a 2019 guide to purchasing carbon offsets by the David Suzuki Foundation and the Pembina Institute, businesses and organizations can maximize their carbon offset dollars by emphasizing projects that are "additional" (which means that they would not exist without a market for offset credits to fund and drive them); and investing in "high-quality" projects like renewable energy and energy-efficiency projects, which create a permanent climate benefit.

On the horizon

While driving down emissions in the short term is a difficult ask, explorers are in a strong position to develop future mines with the lowest GHG footprint possible, Beauchamp said.

"Whenever we have an existing mine that's looking to reduce GHG emissions and having to do a retrofit of everything, it's more expensive than when you look at the exploration phase and you're looking to build the whole infrastructure," she said. "There's a huge advantage for miners in the exploration stage to look for some strategies to make sure they have very green energy infrastructure in place."

Stretch said some people in the mining space have reacted with surprise to Troilus's partnership with Tugliq, given the company is still in the exploration and development stage. But, she said, "I think this is the ideal time to do it and make it a part of the future. The decisions we're making right now could have impacts that could last for decades." **CHM**



What is economic reconciliation?

By Michael McPhie and Christy Smith

Relationships between the mining sector and Indigenous peoples within Canada and around the world vary across a broad spectrum – from respectful and mutually beneficial to antagonistic and harmful. Despite these diverse variations, the ways in which the mining sector engages with Indigenous communities is getting better and the future holds significant promise for those companies and individuals who understand how to build and sustain meaningful relationships.

In discussions addressing the current and historical injustices and harm inflicted by colonial powers on Indigenous peoples both in Canada and globally, there is an increasing focus on pursuing reconciliation to address this past and chart a path forward for a better future.

In its 2015 final report, the Canadian Truth and Reconciliation Commission (TRC) defined *reconciliation* as “establishing and maintaining a mutually respectful relationship between Aboriginal and non-Aboriginal peoples in this country. In order for that to happen, there has to be awareness of the past,

acknowledgement of the harm that has been inflicted, atonement for the causes, and action to change behaviour.”

Reconciliation covers a broad range of current and historical issues including the recognition of legal rights, government decision-making, land tenure and ownership, free, prior, and informed consent (FPIC) and key social issues including health, policing and education. For this discussion, reconciliation as it relates to the economy and the relationship between industry and Indigenous peoples is key.

What is meant by economic reconciliation?

There has been harm inflicted on Indigenous peoples worldwide through the unchecked exploitation of natural resources – without, in far too many cases, any material benefits returning to them. These same communities have also had to, in some cases, endure legacies of environmental degradation and negative social impacts that continue to this day.

Economic reconciliation is about acknowledging this harmful past, atoning for its causes and taking concrete steps to

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change the behaviour and actions of those involved in the resource-extraction industry today. This includes addressing critical issues such as the recognition of pre-existing Indigenous rights, FPIC, collaborative decision-making, the equitable sharing of benefits and sound environmental stewardship.

Today the Canadian mining sector is a global leader in building positive relationships between Indigenous peoples and industry. There is an increasing number of examples of truly respectful and mutually beneficial relationships being built across the country. For example, in British Columbia, the Tahltan Nation has partnerships and joint ventures in place with companies such as Newcrest Mining, Skeena Resources and the Sandvik Group. Osisko Development Corporation has been working closely with the Lhtako Dene Nation, Williams Lake First Nation and Xat'sull First Nation in the development of the Cariboo Gold Project. In Ontario, companies such as Alamos Gold, which is working with the Matachewan and Temagami First Nations at the Young-Davidson Mine, are demonstrating how respectful and mutually beneficial relationships can work. And there are many others.

What tools are necessary for advancing economic reconciliation?

The following are some key steps and tools that can be used to advance reconciliation in a tangible, authentic way:

- **Self-reflection** – Examining your own unconscious bias, perspective and understanding of Indigenous peoples and cultures.
- **Educating yourself** – Learning about Indigenous cultures and beliefs, the history of colonialism in Canada and elsewhere, the Royal Proclamation, the Indian Act and the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP).
- **Land and water** – Understanding Indigenous perspectives regarding environmental stewardship, Indigenous knowledge, cultural connection and time.
- **Effective engagement** – Learning how to engage in a harm-free way on a community-by-community basis.
- **Entering into agreements** – Understanding the role of legal agreements and trust in supporting productive relationships.
- **Learning from case studies** – Case studies across the resource sector in Canada provide valuable insights and examples of industry and Indigenous communities and businesses working collaboratively. This is an evolving space and one in which no one approach will be appropriate in every situation. However, by beginning with humility, understanding the source of your own beliefs and biases, investing in knowledge and understanding and being open-minded, there is a positive path forward.

What does “getting it right” look like?

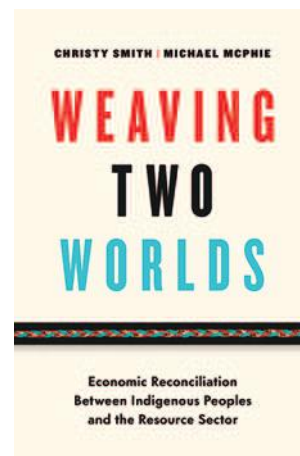
There are many people and organizations advancing reconciliation today such as Indigenous leaders who are charting a good path for their communities and industry leaders who recognize the importance of this work and who are finding their own way to contribute to a positive future. There is no one answer for defining what it takes to “get it right” when it comes to economic reconciliation. As there are more than 600 recognized First Nations, Inuit and Métis communities across Canada and thousands around the world, “right” is a relative term that can only be defined by the community in which a proj-

ect or relationship is being built. However, what is clear from recent examples of industry and Indigenous communities working together is that by starting relationships with respect and the recognition of rights, taking the time to understand different histories, perspectives and beliefs, being adaptable and open to new ways of doing business, doors to shared opportunity are being opened for all involved. **CIM**

Michael McPhie, M.Sc., QEP, serves as co-chair and founding partner of Falkirk Environmental, is the former president and CEO of the Mining Association of British Columbia and is an officer and director of several publicly traded and private resource companies.

Christy Smith, B.N.S., MBA, is a member of the K'ómok's First Nation on Vancouver Island and is a partner and vice-president of Indigenous and stakeholder engagement at Falkirk Environmental and vice-president of sustainability at TDG Gold Ltd.

Together, they are the authors of *Weaving Two Worlds: Economic Reconciliation Between Indigenous Peoples and the Resource Sector*, a collaboration of two voices – one Indigenous and one non-Indigenous – presenting different ways of knowing and understanding what economic reconciliation really means. Visit www.weavingtwoworlds.com



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A tool for managing renewable carbon

By Laura Benavides

According to a 2021 review conducted by PwC, mining companies with higher environmental, social and governance (ESG) ratings outperformed the market with 34 per cent average shareholder return over the past three years – 10 percentage points higher than the general market index. Aside from this, the demand for minerals that go into clean-energy technologies is expected to increase six-fold in the next 20 years. For minerals such as lithium and copper – which are imperative to the reduction of greenhouse gases (GHGs) in energy and tech markets – the stakes are only going to get higher.

Developing quantifiable ESG criteria is an opportunity for mining companies to differentiate themselves as well as achieve ESG goals. Managing the ESG criteria in any company represents the company's ability to manage renewable carbon and measures how much carbon it can reuse. There is not a lot of criteria available for managing carbon; however, one reliable tool that can be easily adopted by the industry to set transparent standards for socially responsible products is evaluating

products' carbon signature based on their Renewable Carbon Index (RCI). RCI is a tool currently used in cleaning and consumer goods, but there is value in applying the tool more broadly in mining.

RCI classifies the origin of carbon in a molecule and determines if it is from biobased sources or petroleum-based derivatives. Specifically, it is a percentage calculated by dividing the number of carbons derived from renewable sources by the total number of carbons in the product – the higher the percentage, the more renewable carbon is present. A typical "green" product will have an RCI higher than 75 per cent, with 100 per cent possible for products with fully bio-based ingredients. Bio-based ingredients are derived from naturally occurring sources such as plants and other renewable materials. By using products with renewable carbon, one can begin to contribute to "decarbonization" as this carbon is being reused, according to the Renewable Carbon Initiative.

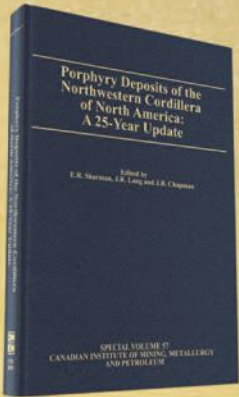
Aside from large-scale initiatives to reach net zero, it benefits the mining industry to pay attention to the smaller steps that, added up, can make big contributions to broader ESG goals. For instance, common reagents used in mining are made from commodity sources and synthetic materials – ingredients that have an RCI of zero percent. Switching to bio-based reagents or adding bio-based intermediates with high RCIs into their processes is one small but significant way that mining companies can take control of the carbon sources present in their operations. In comparison to synthetic ingredients, bio-based ingredients are derived from naturally occurring sources such as plants and other renewable agricultural, marine or forestry materials.

One way to quantify the improvement that mines can make is by looking at a standard flotation mill operation. U.S. mines use approximately 50,000 to 400,000 gallons of reagents (frothers and collectors alone) per year depending on the size of the mine. If these products were switched from synthetic ingredients to renewable carbon, the "decarbonization" effort would dramatically increase.

It may be impossible to switch to 100 per cent bio-based reagents in our lifetime, but by taking small steps to improve the RCI of the products used on mine sites, we can lead to big changes in decarbonization efforts. By simply switching common synthetic ingredients to bio-based ingredients, the RCI value of the end products goes up. Mining companies and chemical companies should work together to bridge the gap between sustainable innovation and current specifications and requirements, by reformulating products when possible. **CIM**

Laura Benavides is director of sustainability at Integrity BioChem and vice-president of technology at Integrity Mining and Industrial.

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Inspired by a photo he saw of a Japanese castle moat (similar to this one at Kumamoto Castle), Stefano Utili began researching slope design, leading to the creation of OptimalSlope.

Old pictures and new approaches

Ancient Japanese moats may lead to better open-pit mine designs

By Alexandra Lopez-Pacheco

The idea for OptimalSlope, a recently commercialized software solution that its inventor Stefano Utili believes could potentially revolutionize how open-pit slopes are designed, can be traced back to a puzzling vacation photograph he saw some 20 years ago when he was working on his PhD in Italy.

“My professor had just returned from a trip to Japan and had seen a Japanese castle built in the 1700s, with a very strangely shaped moat,” said Utili, now a professor of geotechnical engineering at Newcastle University in the U.K. The moat’s walls were not shaped in a straight diagonal line as is the norm. Instead, they were concave.

“I wonder why they did that,” Utili’s professor said to him. Neither of them could figure out the answer. But the puzzle stuck with Utili. Over the years, as he became a professor himself and researched ways to improve pit-wall designs and slope stability, he continued to wonder about the peculiar moat. When he finally decided to solve the puzzle, he realized he might very well have also solved a modern challenge that could help open-pit mines reduce their environmental footprints and increase their revenues.

A deepening problem

Over the last 100 years, open-pit mining companies have had to progressively dig deeper and deeper in order to access ore.

“Today,” said Utili, “the deepest open-pit mine in the world is more than 1,000 metres deep.”

This has increased the risk of slope failure such as the one that occurred in the 2013 slide at the Bingham Canyon mine in Utah, reportedly the world’s largest and deepest open-pit mine. Its pit at the time was close to 1,000 metres deep and 4,000 metres wide when, after slope monitoring identified movement and work was stopped, an estimated 52 million cubic metres of rock slid into the pit. To avoid such failures, slopes are designed by prioritizing stability and safety. The optimal slope is the steepest possible (to reduce the amount of rock waste) while still preserving the lowest factor of safety risk.

“We analyze many different potential failure models and the lowest factor of safety,” said Scott Cylwik, geotechnical project manager at Call & Nicholas, a Tucson, Arizona-based international mining consulting firm whose specialties include geological and geotechnical engineering.

Modern modelling and analysis take into account complex data specific to each site, but they always look to select one optimal surface angle for the entire slope – its planar shape. As a rule of thumb, the deeper the mine, the less inclined the pit walls need to be in order to prevent slope failures, which means today’s large open pit mines have also become wider and wider and have to haul more waste rock out of the way to reach the valuable ore.

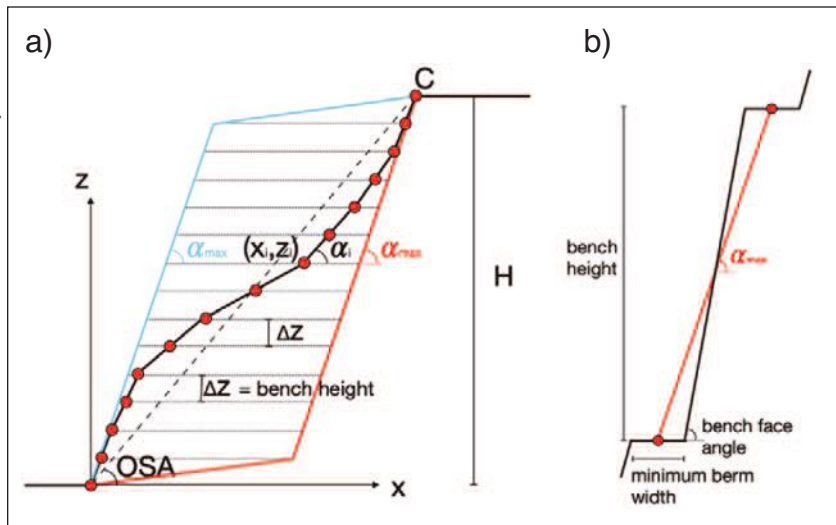


Figure A: A generic candidate slope profile. A uniform discretization along the z -direction is adopted. The red and blue lines enclose the region where the profiles are sought. In the context of open-pit mines, a good choice of Δz is to assume Δz equal to the bench height; figure B: Determination of α_{max} based on bench geometry (input to OptimalSlope).

“That means a bigger and bigger footprint for the operation,” said Utili. “Mining is very energy intensive. We need to innovate to find ways to reduce the amount of waste rock.”

Utili’s research to solve the puzzle of the Japanese castle moat led him to develop an efficient analytical method based on the theory of limit analysis to calculate the stability of any slope shape. “Then I started to think ‘what if actually there’s a better shape than the planar one, and can I find this optimal shape for slope stability?’”

And what if, he thought, this shape not only offered more stability but also reduced the amount of waste rock? Instead of prescribing a linear surface shape to an open-pit mine slope as has been done for generations, Utili set out to identify the optimal shape of a slope based on the thickness of the rock layers present and their mechanical properties. This can be done for each sector of a mine, with the entire pit wall shape from crest to toe determined as a result of a mathematical optimization.

By 2021, his years of research had culminated in the development of the OptimalSlope software.

OptimalSlope

OptimalSlope uses geotechnical data typically present in the mine-block model for its analysis. It generates thousands of potential slope profiles to identify the optimal one with the highest stability number and overall steepest angle. But, as Utili set out to do, instead of following a one-size-fits all straight line with one single angle for the entire slope wall in a given lithological unit, OptimalSlope finds the specific shape that allows maximal overall steepness for each slope sector of the mine. This more precise shape makes for an overall increase of pit-wall steepness by an average of one to four degrees inclination for the same factor of safety as the conventional slope profile.

In 2021, Utili set out to demonstrate his new software through a case study using a Kinross Gold mine already in development. Because of a non-disclosure agreement, he cannot reveal the name and location of the mine, but Kinross provided the OptimalSlope team with the data and collaborated with the case study, the findings of which were subsequently

published in the *CIM Journal*, Volume 12, 2021. The study conducted both a traditional slope design and an OptimalSlope one and then compared the two. The modelling for the Optimal-Slope design had 3.5 per cent less rock excavation than the conventional design and a net present value that was US\$14 million higher as well as an estimated reduction of 61,300 tonnes of CO₂ equivalent.

“To put the carbon-footprint reduction in context, taking the average carbon-footprint reduction calculated for the open-pit-mine case studies we have considered so far, imagine if every open-pit mine was to adopt OptimalSlope, this would lead to a global reduction of annual worldwide emissions by 0.1 per cent,” said Utili. “That would be a significant reduction on a global scale.”

Next steps

As a software solution, OptimalSlope can be upgraded to incorporate advancements in geotechnical knowledge as it becomes available. Late last year, Utili came across a published research paper by Cylwik on a new method of estimating anisotropic rock-mass strength. Utili reached out to Cylwik, hoping to incorporate this new method into OptimalSlope. That is now in the works.

Cylwik was impressed with OptimalSlope’s novel approach. “The idea is a really good idea. We’ve never really tried that before. Intuitively, to me, the idea makes sense,” he said. “And [Utili] has developed the software to do it.”

The next step will need to be taken by mining companies and the geotechnical engineers they hire because they are the ones who identify the optimal slope angle for open-pit projects.

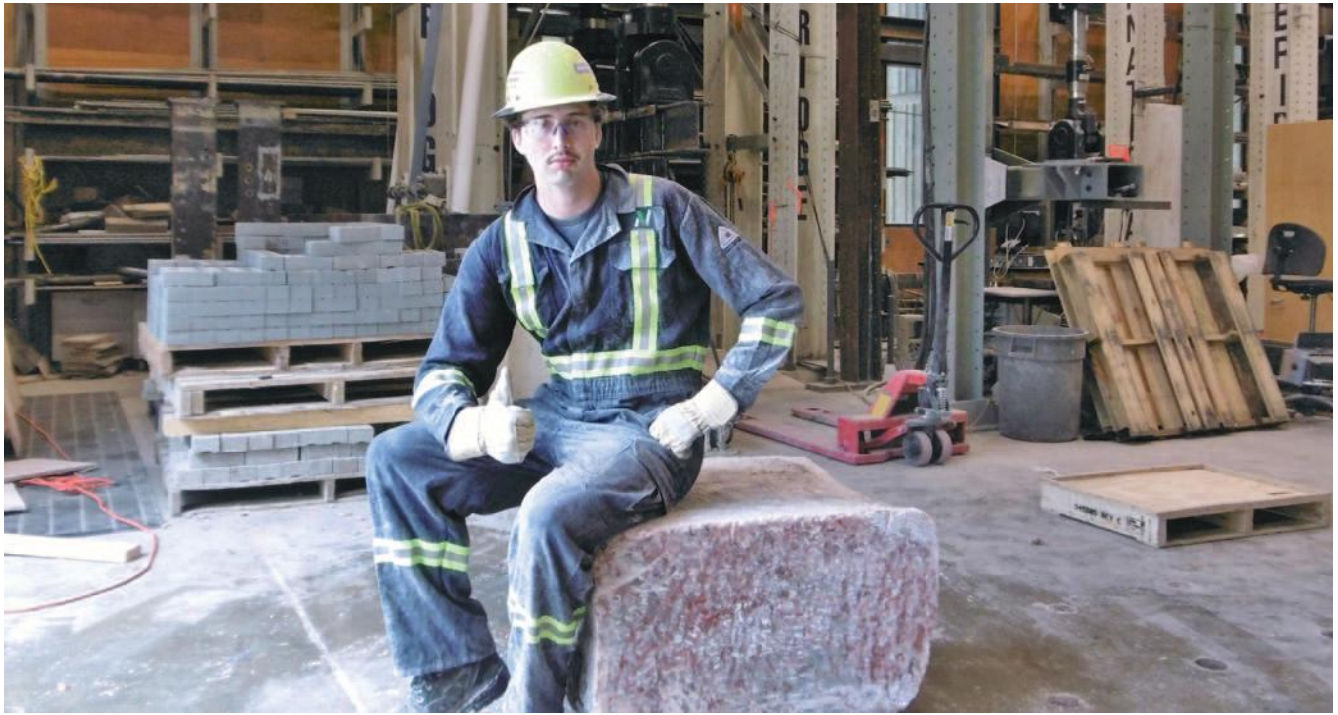
The prospect of a new advancement in slope optimization that reduces waste rock is an exciting one for Ernesto Vivas, principal mine plan advisor with digital global giant Hexagon. He too was impressed with OptimalSlope. “It’s revolutionary,” he said. “When I saw the approach, it really caught my attention and I saw its value right away. The consequences of OptimalSlope in the industry could be huge. Since the 1970s, when the industry started doing slope optimization, every now and then, there have been [breakthroughs] that have improved how we do it.”

Those breakthroughs have taken slope optimization from the simple calculations of the 1970s to the more specialized and complex analyses of today. Its developers and supporters hope that OptimalSlope will be the breakthrough innovation that will take slope optimization to the next level, even if the approach may date (at least in part) to the 1700s.

“We don’t know if the people who built the moat in Japan understood the mechanics behind it or if it was just intuition,” said Utili. “Often, intuition is at play. There are no written records so we don’t know. All I can say is, when I did the calculations for the material and dry-stacking technique they used, the resulting optimal shape was exactly the one they used.” **CIM**

Further recommended reading

Stefano Utili’s research paper was published in *CIM Journal*, Vol. 12, No. 4. Visit cim.org.



The made-up stress of potash

University of Saskatchewan graduate student, Latham Hamlin investigates the mineral's elastic and time-dependent properties in order to make mining operations safer

By Sarah Treleaven

One of the largest potash deposits in the world lies beneath the Saskatchewan prairie. It has been mined for decades and will be for many more to come, which is why it is so important to understand how this material changes over time and what that may mean for mine planning. At the recent CIM Convention + Expo, Latham Hamlin, a Master's student at the University of Saskatchewan, detailed some of his research on this topic. In his presentation, "Mining Induced Stress Measurement in an Underground Potash Mine," he described a study designed to solve a very specific problem: "As mining continues," he noted, "ore will be extracted from increasing depths and the need for an in-depth assessment of the effect of overburden stress on mine design performance was identified." Speaking with *CIM Magazine*, Hamlin described how he designed and executed a study at the Nutrien Rocanville potash mine in southeastern Saskatchewan to address these concerns – and the excitement he felt when the data started to roll in.

CIM: What can you say about this project and how it ties into your broader research?

Hamlin: At Rocanville, we're looking at the problem of stress-change measurement in rib pillars between production rooms; that's the overarching metric we use for assessing design performance at deeper and deeper depths. Nutrien has a big historical database of how the mine design performed in the last 50 years of mining, but over the next 50 years of mining, conditions may be different and reliable production must be maintained. We want to make sure that [Nutrien's] mine design continues to prioritize the safety of employees first, as well as maintain geo-technical and long-term stability of the mine.

CIM: And what are you able to tell me about potash mining in Canada more generally?

Hamlin: In Saskatchewan, we have the largest reserves of potash in the world – the Prairie Evaporite formation. About 300-odd million years ago, an inland sea evaporated and deposited a bunch of salt. Potassium crystallizes in specific seams and that's what we mine. Generally, there's mostly conventional underground mines here, but there are also solution-mining operations around Saskatchewan. But as far as conventional mining goes, Rocanville is the largest producer in that realm.

CIM: What issues in particular were you hoping to address with your study?

Hamlin: Stress, in general, is kind of a made-up quantity. There's no real way to measure it directly. We're always measuring it indirectly and then calculating it – whether that be by a strain measurement and an elastic relationship, or some other method. The issue we run into specifically in potash, on top of the normal made-up quantity type of stuff, is that potash has an extremely small linear elastic region of behaviour followed by a seemingly infinite amount of time-dependent behaviour. Underground, the stress states are high enough to prevent any measurable elasticity to occur. That makes it difficult when you try to put a number to how this material is performing elastically and plastically. You get a lot of errors. If you were to just take a Young's modulus and apply it directly to some measurements in the field, you're probably not going to have an accurate result because the stress-strain behaviour is changing based on the time interval you're looking at. If there's actual stress change, like mining happening close by, the response of the rock is different than when it's just

sitting in a steady-state resting phase. That's the issue that we set out to investigate: How can we reduce the error from the assumptions in our material properties?

CIM: What are the nuts and bolts of this specific project?

Hamlin: At the Nutrien Rocanville potash mine, a long-room and pillar mining method was used to extract ore from a seam about 1,000 metres below the surface. A program using three types of borehole instrumentation, in conjunction with room closure monitoring, was implemented to assess the stress change and design performance in active mining areas. The goal of this work was to form a foundational dataset for an empirical design method for future mining in deeper ore at Rocanville. To assess the performance of the design, mining stress change in the rib pillars was chosen as the primary indicator, and room closure of the development drifts was chosen as a secondary indicator. To monitor the stress change, three borehole instruments were used – two soft inclusions and one stiff inclusion. A total of 14 instruments were installed underground at three active mining locations. The locations for the study were chosen based on observed geology and in-situ stress estimates, and are located such that the continuous mining machine will mine several rooms around the instruments. At each location, an array of instruments was installed to monitor pillar performance. Multiple of instruments were used to provide redundancy and verification of data quality.

CIM: You've pointed to some novel methods that were employed in this study.

Hamlin: In the analysis, we applied the novel two-cell convergence method, which was specifically developed for application in soft-rock mining to account for the time-dependent behaviour of potash. This approach treats the modulus of the host material as an unknown – as well as the stress change – and solves for both by exploiting the difference in response from stiff- and soft-inclusion instruments. The successful implementation of the novel methodology, and the increased consistency of the results it provides, allows for correlation between stress change and mining activity. This forms the basis for optimizing the current mine design to new mining conditions and reduces ground-related risk for future mine plans and production targets.

CIM: Would you explain the results you got and how they rolled in. When did you start to get excited by the findings?

Hamlin: It started to get really exciting once we started seeing our data when the miner was mining in the area around our instruments. We took every precaution we could to make sure there was enough resolution, and our data-logging equipment was good enough, and all the instruments we installed were the right choice. But it's hard to tell before, and the rubber really meets the road at that point when you're putting everything out in the wild. It's like, 'Okay, we've done all we can theoretically, but this is in the field now.' We went with some really good data loggers and we put some lab-grade instruments in the field, which helped us out a lot with getting the resolution we wanted.

A lot of the problem you run into with potash is you get a lot of movement in short time intervals when the mining is hap-

pening. So that means you need to be able to read instruments rapidly because things are happening quickly. But then, in between, there's large lag phases where not much mining is happening for an extended period of time. Usually then, your instrumentation starts to get a little bit noisy, because the analog to digital conversion done by the computer has to pick a number. Assuming your instruments are providing stable readings, this conversion is the next limiting factor on the resolution of the readings. In more typical rocks, this noise is okay, but with potash that movement at steady state is an important characteristic of the mine design. With the setup we chose, it ended up working out really well and the data was clean in both cases.

CIM: What are the implications of the study results for potash mining?

Hamlin: We're looking to gather more results around the current mining locations at Rocanville, and using the baseline data set, continue installing these instruments as mining continues into areas farther below ground surface. We're then able to apply the knowledge that we have to those future cases, and empirically assess the performance of the mine design at Rocanville. This research provides the methodology and baseline data set for an empirical design method specific to Rocanville.


CIM: Do you think these study results have implications in the industry beyond potash mining?

Hamlin: Definitely. Especially the methodology because what we researched here is a way of analyzing the instrumentation data, so it would be relatively applicable in other soft-rock mining industries or in any place where we're dealing with a lot of time-dependent behaviour. The main issue other users would encounter is the instrumentation; they might have to use different instruments in a different rock mass or host material. Rock-mechanics instrumentation is one of those things that has to be catered to the rock mass on site. But other than that, the two-cell convergence method of analysis would be applicable to other time-dependent materials, like shales or coal or anything like that. I should also add that the method is only for calculating stress change measurement, not in-situ stress as a whole.

CIM: Who were your industry and other supporting partners on the project?

Hamlin: We completed this research under grants from the International Minerals Innovation Institute and Mitacs. We were also funded by our industry partners, Nutrien and Mosaic.

CIM: I know you're never supposed to ask a graduate student when they're going to finish their research, but can you tell me where you are in your studies?

Hamlin: It's going really well. This whole project is kind of like a snapshot of what my thesis is overall, and the instrumentation stuff is really the meat and potatoes of my work. I'm just going through the process of writing it. I haven't thought too much about what's going to happen after school, but our industry partner, Nutrien, hired me on as a mine engineer during this research. I'm doing school and working full-time right now because they were really interested in continuing the work I did in the field there. I haven't put too much thought into what happens next, but I'm definitely interested in soft rock, and I like this technical style of work. 



Courtesy of Labrador Uranium

Labrador Uranium's Moran Lake and Central Mineral Belt projects in central Labrador have undergone extensive exploration, but its Notakwanon uranium project in northern Labrador is largely unexplored.

The new Atlantic Canada exploration boom

Gold, clean-energy metals and even salt offer the promise of a bright future

By Alexandra Lopez-Pacheco

Canada's Atlantic region is experiencing a mining exploration rush the likes of which has not been seen in the area since the 1990s boom that followed the discovery of the nickel-bearing deposit at Newfoundland's Voisey's Bay. Once again, Newfoundland and Labrador is leading the way with more than 100,000 mineral claims staked in 2021 – the second largest annual claims total in the province's history after 1995. This time, the majority of exploration companies descending on the provinces of Newfoundland and Labrador, Nova Scotia and New

Brunswick are looking for gold instead of nickel. A handful of others, however, are not setting their sights on the precious metal but on critical minerals and metals that are vital for decarbonization of modern technologies.

Underexplored potential

Despite having produced some 30 commodities over more than 150 years, including gold, silver, iron ore, tin, nickel and copper as well as aggregates and potash, the region has



attracted only a trickle of exploration for years, compared to Ontario, Quebec and British Columbia – much to the vexation of the region's mining sector, which has argued its provinces are underexplored, especially when it comes to gold.

As part of the Appalachian Mountain range, the Atlantic provinces are geologically fortunate with tremendous mineral resource potential. In terms of gold, Newfoundland and Labrador is especially blessed, according to Derek Wilton, honorary research professor at Memorial University's department of earth sciences. "We have the Appalachian rocks, but also we have a big piece of the Canadian Shield, which is Labrador," he said. "Northern Ontario and northern Quebec, also part of the shield, are well known as mineral baskets, with all kinds of golds and sulfides. Well, we have similar types of rocks here."

Over his more than 30-year career in mining, Timothy Froude, who was born, raised and educated in Newfoundland and who is currently president and CEO of Sokoman Minerals, has been among those who tried to encourage more gold exploration in his home province. "We've always said Newfoundland is vastly underexplored when it comes to its gold potential," he said. "But few seemed to care much."

A few companies did care. One of them was Anaconda Gold, whose Point Rouse gold mine in north-central Newfoundland's Baie Verte Peninsula began operating in 2010. Anaconda has continued exploring in Newfoundland and Labrador at its Tilt Cove gold project, as well as its Goldboro project in Nova Scotia. Then there is Maritime Resources, which has spent more than a decade exploring its 98-square-kilometre Green Bay property, also in the Baie Verte peninsula – a property that includes the historical Hammerdown gold mine. Maritime is working to reopen the mine and, given its success to date moving through the regulatory process, the company recently said its decision to start building the mine could be announced this year. Additionally, there is Marathon Gold, which began exploring the Valentine Lake deposit in central Newfoundland in 2010. This spring, the province's government completed the environmental assessment review for Marathon's Valentine Lake project, which consists of a series of five mineralized deposits along a 20-kilometre system, and gave Marathon the go-ahead. The company plans to begin building what is expected to be Atlantic Canada's largest gold mine as early as this summer.

None of these companies, however, have been credited with sparking the gold rush. "They have been plugging away at it for the last ten years, increasing their size," said Wilton. "Suddenly, some new kids on the block come in and find this tremendous intersection in another part of the island."

The new kids on the block

Since few from outside Newfoundland and Labrador seemed interested in exploring for gold in the province, "we decided to do it ourselves," said Froude. In 2017, Sokoman Minerals acquired what is now its flagship Moosehead gold project in north-central Newfoundland. Four months later, the company announced it had intersected 11.9 metres of just under 45 grams of gold per tonne. "The phone started to ring," said Froude. "The next thing you know, Eric Sprott was our largest shareholder and we had millions of dollars in the bank, whereas before that we just had tens or hundreds of thousands of dollars. Suddenly people took notice."

As exciting as Sokoman's find was, it was not the company that sparked the current exploration boom. The main new kid on the block Wilton referred to is New Found Gold, which, in 2019, intercepted 19 metres of 92.9 grams of gold per tonne in the first hole of its first drill program at the company's Queensway project. With that news, Newfoundland's gold rush exploded.

Eric Sprott, founder of asset manager Sprott Inc. just made a move that is likely to add fuel the province's gold rush. The company purchased 15 million shares of New Found Gold from Novo Resources Corp. in mid April, for a total of \$125.9 million – a significant premium of 9.3 per cent over the \$7.68 closing price of New Found Gold shares on April 11.

Speaking about the investment, Sprott is quoted in *The Financial Post* as saying, "I do believe it is special." He added that, "it's going to prove to be maybe the greatest gold discovery in the history of Canada, if not in the world... so that's what makes it so easy for me to put that additional money in it."

According to Robert Bruggeman, president and CEO of Canstar Resources, "New Found Gold's world-class gold discovery got people really interested in finding something similar." And that includes Bruggeman. Canstar has staked a 62,175-hectare

claim for its flagship Golden Baie project in south Newfoundland, an area that is highly prospective for high-grade orogenic gold mineralization. While Canstar's exploration is still in its early days, Bruggeman's excitement over the Newfoundland project is palpable even when he compares it to another, more advanced project he is involved with in Argentina that has reserves of more than two million ounces of gold and silver. That project's gold is disseminated and not visible.

"We've always said Newfoundland is vastly underexplored when it comes to its gold potential. But few seemed to care much."

— T. Froude,
president and CEO, Sokoman Minerals

"The [Argentina] project has been drilling over 100 kilometres, but it's the most boring core ever. At our Golden Baie project in Newfoundland, prospecting can be rewarded with rock samples containing visible gold. There are few things more exciting than finding visible gold!"

There is another reason he is excited. He believes his company and others are pioneering what will become recognized as a new gold belt. "Usually, you're looking for gold in tricky, hard to reach places in the world so the discovery of a new gold belt in a place like Newfoundland in North America is a very interesting thing," he said.

Both Sokoman and Canstar belong to Newfoundland.Gold, an alliance of 15 companies focused on the advancing of gold exploration and mining projects in Newfoundland and Labrador.

"There's so much activity here right now that the assay labs are taking about five months to turn around results," said Bruggeman. "That is a really long time if you're waiting for your assays to come back so you can plan your next phase of exploration. But at least we have these visual clues. If you're drilling

and you see some physical gold, there's a good chance the assays are going to come back pretty well."

Excitement for the precious metal is not just limited to Newfoundland. The gold rush has spread to New Brunswick, where numerous gold exploration companies have arrived in the last few years and staked their claims. The province also has its long-timers that have been patiently exploring New Brunswick's gold potential for more than a decade. Puma Exploration focused its work on one of Canada's oldest mining districts, the Bathurst Mining Camp area in northern New Brunswick's Miramichi Highlands. For most of that time, the company was exploring for base metals but in recent years, it has turned its attention to gold. Puma has had encouraging finds at its flagship Williams Brook project near Bathurst, including up to 371 grams per tonne in surface samples and currently has a new, 10,000-metre program to identify high-grade gold targets.

Information provided by Natural Resources and Energy Development New Brunswick indicates the mining activities are strong, that there have been "steady increases over the past 10 years and sharp recent growth," and that the province has seen an "all-time high in area [measured in hectares] of actively staked claims." In 2021, the highest year on record, 911,858 hectares had been claimed for exploration. As of April 2022, that figure is 1,014,651.

In the first quarter of 2022 alone, 145,548 hectares of new claims were recorded. In comparison, 2020 – the record-setting year – saw a total of 286,201 hectares of new claims. If the current pace continues, 2022 should surpass 2020's total by the end of Q2.

Over in Nova Scotia, the province is experiencing its fourth gold rush. For perspective, the first three gold rushes took place between the 1800s and the 1960s. It has been a while. But exploration began to increase in 2017 around the same time Atlantic Gold opened its Touquoy open-pit gold mine in Moose River. Nova Scotia's eastern shore quickly attracted others, including Anaconda and Canadian junior exploration company Meguma-Gold, which announced in March of this year it had intersected 3.46 grams per tonne of gold over 23.28 metres at its Elmtree gold project.

"There's a huge amount of exploration for gold in the province," said Sean Kirby, executive director of the Mining Association of Nova Scotia (TMANS). "It has just been a very exciting period."

As of press time, TMANS was compiling data for an upcoming economic impact study of the province's mining industry, but Kirby expects 2022 to be a strong year for exploration, especially in comparison to last year.

Courtesy of Canstar Resources



Canstar Resources drills in the Kendell Zone of its Golden Baie project.



Courtesy of Atlas Salt

Atlas Salt is developing the Great Atlantic Salt project, located near Turf Point Port in western Newfoundland.

According to the Nova Scotia Department of Natural Resources and Renewables, “due to COVID-19, mineral claim-staking activity in Nova Scotia was down a bit in 2021, relative to 2020, with the total number of claims under licence decreasing to 35,886 from 41,798 in the previous year. However, we are seeing significant new staking so far in 2022 and anticipate we will surpass the 2020 figure.

“Field expenditures by the mineral exploration industry in 2021 are estimated at \$50.3 million, likely partly due to make-up of reduced work in 2020 attributed to the pandemic. The 2021 figure is a big increase in expenditures from 2020 (\$26.3 million) and 2019 (\$37.9 million).”

Critical metals and minerals

Increasing gold prices have played a role in driving the gold rush in Atlantic Canada, including during the pandemic. The precious metal is, after all, a financial anchor in troubled times. But others in the Atlantic provinces are searching for critical minerals such as lithium and tin.

Based on its geology, Atlantic Canada very likely has a profusion of critical minerals and rare earths, according to Wilton.

“Critical minerals,” said Kirby, “are on everybody’s radar screens these days and we are seeing more exploration for them in Nova Scotia. We also have a couple of past producing mines that we hope will be able to get back into production again in the not-too-distant future.”

Wilton pointed out that critical minerals tend to be by-products of other minerals. “People are saying, ‘Hey, we have all these tailings in Atlantic Canada,’” he said. “Maybe we should start looking at some of these tailings. Because we’ve already taken this stuff out of the ground and maybe in the tailings material, there are some critical minerals we can recover.”

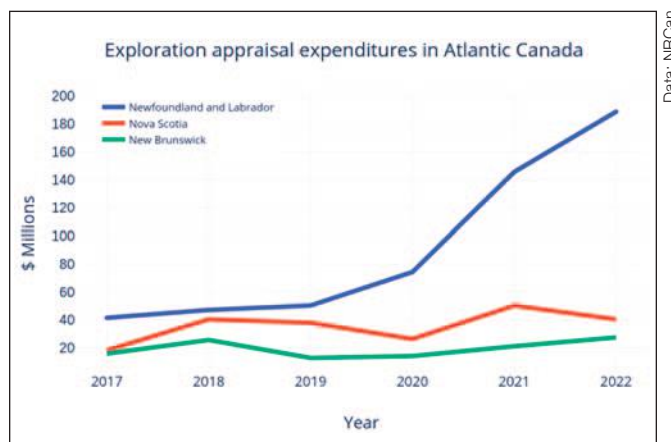
“Northern Ontario and northern Quebec, also part of the shield, are well known as mineral baskets, with all kinds of golds and sulfides. Well, we have similar types of rocks here.”

— D. Wilton, honorary research professor, Memorial University’s department of earth sciences

One example of this is the East Kemptonville project located approximately 45 kilometres northeast of Yarmouth in Nova Scotia. In the 1980s, it was one of the world’s largest tin mines but it was closed down in 1992 due to collapsed prices. The project is now being redeveloped by its new owner, Avalon Advanced Materials, which specializes in critical metals and minerals and is looking into recovering not just tin from old stockpiles and tailings at the mine but also indium, a rare earth critical for such technologies as touchscreens.

Another old Nova Scotia mine being revived is the Scotia zinc mine near Gays River. The mine, owned by EDM Resources, was put under care and maintenance in 2009 due to a decline in metal prices and high operating costs. Today, the company is in the process of refinancing the project with plans to restart commercial production at the mine by the end of 2023.

Over in Newfoundland in 2021, Sokoman came across high-grade lithium mineralization in one of its properties called Golden Hope. “Funny things happen when you send prospectors into the woods,” said Froude. “Sometimes they come back with



2021 figures represent preliminary estimates. 2022 figures represent spending intentions, collected between November 2021 and January 2022.

things you don’t expect. We were looking for gold, but we’re an exploration company so as such we should never turn a blind eye to any potential benefits that we may come across when prospecting for gold or whatever metal we’re looking for,” said Froude. “It’s our duty and our mandate to see just how significant this lithium prospect could be.”

Sokoman formed a joint exploration alliance with Benton Resources to continue exploring for lithium.

Clean energy exploration – and salt

There are two exploration projects in the Atlantic region that could help Newfoundland and Labrador become an important player in Canada’s transition to clean energy. The first is Atlas Salt’s Great Atlantic Salt Project near western Newfoundland’s Turf Point Port. The Great Atlantic Salt project got its start with exploration for oil and gas. Instead, a significant shallow salt deposit was discovered. Atlas Salt’s president Rowland Howe helped develop Compass Minerals’ Goderich mine in southern Ontario into the world’s largest underground salt mine, first as its manager for 16 years and then as a strategic engineer for the company. He believes Great Atlantic has the potential to become the world’s next great salt mine. “Goderich is the gold standard for salt mines,” he said. “The Great Atlantic Salt asset has the same bones and DNA as Goderich.”

While that part of the project is intended to provide de-icing salt for eastern Canadian and U.S. markets, the company is also looking to develop another one of its assets, Fischell’s Brook salt dome some 15 kilometres south of the Great Atlantic Salt deposit, into a renewable energy business. The project could help advance cutting-edge energy storage technology in Canada. Thanks to recent progress in storage technology, Fischell’s Brook salt dome could be transformed into a wind farm whose energy is turned into hydrogen, which would be stored in the salt dome and released as needed.

The second exploration project is actually three projects owned by Labrador Uranium that would supply the nuclear-energy sector, which has been identified in Canada as a key component of the country’s decarbonization strategy. The company’s Notakwanon uranium project in northern Labrador is largely unexplored. Its Moran Lake and Central Mineral Belt projects in central Labrador have undergone extensive exploration in the past and the latter is adjacent to Paladin Energy’s



Exploring in Newfoundland and Labrador offers Labrador Uranium a stable and predictable regulatory environment.

Michelin uranium deposit, which contains almost one million tonnes of mineral resources.

“We do have a historical resource, but we have to grow and make discoveries so the fundamental driver for us is exploration,” said Stephen Keith, Labrador Uranium’s president and CEO. “With the way the geopolitical environment in the world is today, I’m exceedingly happy to be in Labrador. Sometimes people say Canada is too difficult because of the regulatory regime. But I love that regulatory regime. It’s what offers security. You know what the rules are, what you need to do.”

Russia’s invasion of Ukraine that has put all of Europe and NATO countries on alert has led to both an increase in the price of uranium and other commodities as well as the realization of how important the stability and security of a jurisdiction is for companies investing in mineral exploration and development.

“It’s a bit of a mental reset for a lot of us,” said Keith. “As someone in the resource space, the world is changing in good ways. We’re moving away from carbon and becoming more energy efficient and we’re finding materials to help us do all those great things, but when you combine that with difficult geopolitical issues, it does mean as a miner, you start to ask yourself where are the safe places?”

In his opinion, the resource boom in Canada’s Atlantic region (one of the world’s safe places for mining investment), could very well last for a long time, given the current global demand for metals, and especially for critical minerals.

Investors

“Mining used to be a big part of [the Atlantic provinces],” said Peter Nicholson, CEO of Wealth Creation Preservation &

Donation Inc. (WCPD), who was born and raised in Nova Scotia. “I wear a 110-year-old ring that belonged to my great-grandfather who was a coal miner in Cape Breton and Sydney.”

The Atlantic provinces have been struggling for too long, he said, and that has forced many of its skilled and experienced miners to go west in search of jobs. The possibility of creating opportunities for them to return home for good mining jobs is one that brings a lot of hope to the region.

As with so many others who grew up in the Atlantic provinces, Nicholson has long believed the area’s mineral resources were underexplored and he is happy to see that is changing. In the last few years, WCPD has been able to work with some of the exploration companies behind the boom, including New Found Gold, to raise funds for their projects with flow-through shares.

WCPD has high-net worth clients who, like Nicholson, are originally from Atlantic Canada.

“They are now living and making their fortune in Montreal, Toronto and Vancouver,” he said. “And when I tell them we have an Atlantic Canada flow-through opportunity and the money would go back to their home provinces, that’s an extra positive incentive for them.”

Another incentive for many of WCPD’s investor clients, he said, is critical minerals exploration. As with many professionals from the Atlantic region, he echoes an emerging theme about the region’s underexplored potential.

“Canada has the opportunity to be a world leader in this,” said Nicholson. “We are blessed with the geology. And yes, there is a lot of critical mineral exploration potential sitting in the Atlantic provinces. Now let’s go out and find it.” **CIM**



Novamera says its SMD technology can be used to gain a better understanding of complex narrow deposits.

A new way to drill

Innovations in limiting waste, navigating drill holes and reducing noise pollution are improving the ways companies mine

By Olivia Johnson

Artificial intelligence and geological modelling can only tell us so much about what lies beneath our feet, which makes drilling a key component of mining.

It is how mining companies identify rock types, establish mineral content and discover any faults or weaknesses. The best way to know what sits below surface level is to take a look. Unfortunately, old methods of drilling can only do so much. When modern methods fail or prove to be too expensive, mining companies must turn to new technology to move forward with mineral exploration.

Unlocking resources sustainably

When Anaconda Mining began looking at mining a steeply dipping, narrow deposit in 2017, it realized it could not be mined using conventional methods.

In order to access the Romeo and Juliet deposit, located at the Point Rouse project in Newfoundland and Labrador, Anaconda was making too big of a pit and moving too much waste to access the ore body. The company couldn't justify the cost of mining.

With the help of researchers from the Memorial University of Newfoundland in St. John's, Anaconda president and CEO Dustin Angelo and Point Rouse general manager Allan Cramm began work on a new technology that could be used to economically mine the deposit. The result was the sustainable mining by drilling (SMD) project, and in 2020, Angelo and Cramm spun out of Anaconda and co-founded Novamera.



SMD uses three navigational tools: a downhole sensor, an entry sleeve and course-correction technology.

“When you’re trying to mine narrow deposits, you don’t have much margin for error,” said Angelo. “You need something that tells you more precisely where to drill and where to extract. We knew there had to be a better, more efficient way to mine steeply dipping, narrow vein deposits, so, as miners, we created one.”

He explained that the issue with ore-body delineation is that mining companies typically drill holes that are spaced 25 metres apart. Angelo explained that this requires a lot of interpolation and miners can’t be 100 per cent confident in the geometry and positioning of the ore body between those widely spaced holes.

SMD uses three navigation tools that enable surgical mining: a downhole sensor, an entry sleeve that attaches to a large diameter drill allowing it to optimize the collaring of the hole and course-correction technology. This allows SMD to see up to a three-metre radius around where it is drilling.

“We have created proprietary navigation tools, principally a downhole sensor that works in conjunction with large diameter drills, to be able to surgically extract ore from the ground and leave the excess waste behind,” Angelo explained.

“It’s capturing more information at a higher resolution in a narrow area in order to understand exactly where the ore body is,” he said. “And it’s that high-resolution information that enables us to be able to create a trajectory that the large diameter drill can follow.”

The first step is to drill a pilot hole using a traditional diamond core rig that does not require modification. A sensor is sent down the hole at various intervals and takes a reading to map out the trajectory for the large diameter extraction.

“The second step is the large diameter extraction,” Angelo said. “We bring in a large diameter drill that reams out the material and brings it to the surface using low-energy

reverse circulation air-lift assist. Then the third step is, once that hole is open and the ore has been processed, we take the tailings combined with cement and we make a paste and backfill that hole.”

He explained that the hole is then used as a tailings facility, reducing waste and the need for constructing a traditional tailings facility.

“We expect to get about 60 per cent of the material we take out of the ground back in the ground,” he said. “So, if you had to build a tailings facility, it could be 60 per cent smaller, essentially. That’s a big thing in the industry because dealing with tailings facilities is a huge cost and risk to mining companies.”

Reducing noise pollution

Ravenswood, a mining town located in Queensland, Australia, has strict laws concerning noise and environmental impact. Mining has been a part of the town’s history since 1868, and the once-thriving gold mining town is currently home to just over 250 people and a number of mining-related heritage sites.

Buck Reef West, a 500-metre-long open-pit mine, sits just 200 metres from the township. Since the mine operates 24 hours a day, it required noise-reduction solutions.

To combat the noise of drilling, Roc-Drill, who holds the drilling contract for Buck Reef West, implemented Epiroc’s SmartROC T40 Noise Reduction Kit and fitted it onto the larger SmartROC T45 carrier, something the company had never done before.

“There are often legal demands and noise restrictions when it comes to drilling within urban areas. With the Noise Reduction Kit, you are allowed to drill more hours a day,” said Ulf Gyllander, global product manager of the surface division at Epiroc.

“The noise while we’re drilling is actually the rock drill and the drill string itself. By enclosing that rock drill and the drill string, we reduce the noise around the machine by approximately 10 decibels,” said Gyllander.

He explained that the Noise Reduction Kit works like a box that goes around the feeder. The mast assembly is surrounded by a series of vertical hatches, controlled using hydraulics.

“Normally when you’re drilling, you start to drill and you press a button and you drill down to the desired depth that you would like to drill to without opening the boxes and the hatches,” said Gyllander. “When you are down to the correct depth, you rattle loose the drill string, open up the hatches and go up.”

He explained that as the operator returns to the surface, the drill rods disconnect and no longer rattle. The Noise Reduction Kit reduces the noise level to the sound of the engine and the compressor. Only the hydraulic pressure from the engine makes noise.

“The noise comes when you’re drilling down and we encapsulate that with the hatches and the box around the rock drill,” he said. According to Epiroc, the aluminum hatches can also limit the environmental impact if there is a consumables spill and are relatively easy to maintain. The rig operator simply flips the boom assembly horizontal to access the equipment.

Navigating drill holes

Carlson Software, a company that specializes in software and hardware for land surveying, civil engineering, construction and mining industries, noted while working with industry professionals, that mining companies needed to access drill holes faster and with a better understanding of how to react to anomalies while drilling.

“Being a smaller company, we’re trying to react to what the customer is looking for,” said Tim Jones, director of machine control at Carlson. “We’re not just saying here’s your product and that’s it. We’re always trying to better ourselves and our understanding of what they need from the feature and justify the dollars they spend on these types of systems.”

In order to fulfill the needs of its customers, Carlson began working on a hardware and a software guidance system called the Carlson Grade for Drills global navigation satellite system (GNSS) that, according to the company, allows drill operators to navigate and drill holes more precisely.

“The big thing around [the system] is having more digital representation of what’s happening in the field, compared to not having anything at all, and then being able to react to differ-



The Noise Reduction Kit is able to reduce the volume of drilling and rod changes by approximately 10 decibels.

ent things that they didn’t expect to see,” Jones said. “Did they hit a void that they didn’t expect to? Or are they seeing water in the hole?”

Whether it is a boom drill or a larger deck drill, the system assists the operator in finding the right approach for the drill so the operator can line up to the drill hole more efficiently, explained Jones.

By using the information from the blast-pattern layout and the projected final elevation, the system positions the bit to the proper collar position for the end-user. Jones explained that the system utilizes different sensors to measure hole depth and provide information to the operator to ensure that it is hitting the desired elevation within tolerance.

“As they’re drilling, we are taking into consideration the measurements from an encoder to get our depths,” said Jones. “If they hit any anomalies along the way, we allow the operators to be able to put in canned messages and any notes at the depths in which they see things to provide more information to the blaster. So, if they hit a crack or see a void, they can have [a message] there.”

This information is uploaded into the Carlson Command software, where operators can look at each individual drill hole and make decisions accordingly. The software also records the rate of penetration, said Jones, which tells the operator how fast they are drilling through the material. With this information, the operator is able to track their position and drill more consistently.

“We like to say that it should aid you in increasing or improving your productivity, and it does it in a way where we’re guiding the operator,” said Jones. **CIM**



Trigon Metals not only restarted the Kombat copper mine in October 2021, it spent \$10 million refurbishing the existing processing plant.

Kombat mine is back in town

A formerly flooded and shuttered mine in the Namibian desert has come back to life and is supplying life-giving water for farming operations

By Alexandra Lopez-Pacheco

The Kombat mining complex in Namibia's Otavi mountain range shares its name with the small town that was built in 1900 beside the mine to house its workers. At the time, the mine's original owners wanted to take advantage of the area's rich copper deposits – and the abundance of underground water. Both the mine and the town survived for generations, until one fateful day in December 2007 when a catastrophe hit.

Weatherly International, the mine's owner at the time, had built an 800-metre exploration and production shaft to access the mine's high-grade copper in an area to the west of the main mine. Two one-hour power outages interrupted the water pumps that needed to run 24/7 to control the underground water. The shaft flooded and subsequently so did the main mine. A year later, overextended by the cost of building the new shaft and a decline in copper prices, Weatherly gave up on both the expansion project and the main Kombat mine, which includes two other shafts, and put Kombat on care and maintenance. The livelihoods of the people of the town of Kombat dried up and the community plunged into poverty.

A Canadian company now hopes to breathe some new life into both the mine and the town. In October 2021, Toronto-based Trigon Metals restarted the mine with a phased approach

that the company hopes will grow the project into a significant copper producer that employs up to 1,000 people, many of them Kombat locals.

Trigon's Kombat project consists of five mining and prospecting licence areas covering more than 7,500 hectares and more than US\$100 million worth of usable infrastructure put in by its previous owners, including a processing plant, extensive underground workings, a tailings facility, ramp systems and multiple mine buildings. Three of those licences are for the Kombat project located in a 40-kilometre-wide valley in the Otavi Mountain range between the towns of Otavi to the west and Grootfontein to the east – an area that has seven known distinct mineralization zones, including Kombat West, Kombat Central, Kombat East and E900. Combined, they cover 1,219 hectares and contain indicated resources of 12.22 million tonnes of ore grading at 1.94 per cent copper, 0.7 per cent lead and 13.67 grams per tonne of silver as well as inferred resources of 1.91 million tonnes of ore grading at 2.19 per cent copper, 1.79 per cent lead and 6.13 grams per tonne silver.

The other two licences are for mineralized areas consisting of more than 6,000 hectares within close proximity to Kombat, which represent a potential strike extension. "Kombat lies in the middle," said Fanie Müller, Trigon's vice-president of oper-

ations, “so there are definitely more than 40 kilometres of unexplored strike potential adjacent to the Kombat mine.”

Additionally, Trigon holds an interest in two exclusive prospecting licences for an area about 200 kilometres from Kombat in northwestern Namibia.

Restarting the Kombat mine – Phase one

“We tried to figure out the easiest and most responsible way to get the mine into production,” said Müller. To that end, the company conducted several concept-level studies as well as a feasibility study. Based on those, Trigon decided that the path forward was to restart by mining in areas in Kombat East and Kombat Central as they lend themselves to shallow open-pit mining with a maximum depth of 60 metres.

“This is easier and quicker and lower capital than starting underground and allows us to use some of the revenue from the open pit to reopen the underground,” said Müller.

With open-pit mining and stockpiling of Kombat’s surface ore (which grades at between one and 1.2 per cent copper) launched in October 2021, Trigon turned its attention to refurbishing the mine’s processing operations. Idle for more than a decade, the plant required some retrofitting. The old flotation cells had rusted so there was no question they needed to be replaced. The old German-made primary crusher, on the other hand, was still working but spare parts were no longer available, so Trigon opted to replace the crusher.

All of the plant’s new equipment was manufactured by Chinese company Yantai Xinhai Industry. The total price tag for the refurbishment came to \$10 million, with most of the total going towards labour. “In terms of the cost, it’s probably less than 40 per cent of the price that we would have paid for the same type of equipment from South Africa, which is right next to Namibia,” said Müller. “The quality of the equipment is amazing.”

By December 2021, Trigon had completed the refurbishment of the Kombat plant and produced Kombat’s first copper concentrate in 14 years. Two months later, the company announced it had shipped its first truckload, consisting of 31 dry metric tonnes of concentrate, grading 20.41 per cent copper and 265 grams per tonne of silver.

Phase two

The second phase of the project involves dewatering Kombat’s main underground mine, which Trigon hopes to complete in 2023, and expanding its mining into the E900 mineralization area just east of the open-pit operation.

“The guys who mined Kombat in the 1960s and 1970s saw three per cent copper as waste whereas for us, it is high grade,” said Müller. “Lots of copper was left behind.”

As for the risk of another flood, Jed Richardson, Trigon’s president and CEO, believes the 2007 flood was caused by preventable errors. “The way I look at it is that it really was managed incorrectly,” he said. “They had very old pumps that were put in in the 1960s, where the pumps worked in stages. From the lower part of the mine, it was pumped up to an intermediate level and then another [unit] pumped it up to the surface. Now, we would put in one unit at surface that will pump up from the bottom of the mine to surface. We would have backup pumping capacity and we have backup power generation. So, it’s really just managing it better.”

When phase two is completed, Kombat will increase its expected 2022 production of approximately eight million pounds of copper concentrate to more than 30 million pounds per year in 2024.



Currently, Trigon is working shallow open pits in Kombat East and Kombat Central, but the intention is to restart underground activities.



On February 28, 2022, Trigon shipped its first load of copper concentrate from Kombat. The truckload (pictured above) consisted of 31 dry metric tonnes of concentrate, grading 20.41 per cent copper and 265 g/t silver.

Courtesy of Trigon Metals

Courtesy of Trigon Metals



Top: New Yantai Xinhai washer cells were installed in Kombat's copper flotation circuit. Bottom: Trigon holds five mining and prospecting licences in the area, covering 7,500 hectares.



Courtesy of Trigon Metals

Water pumped from the mine is being used to irrigate farm fields and grow crops, resulting in both farming jobs and high-quality produce that is sold to restaurants.

Future potential

Trigon will then turn its attention to picking up where Weatherly left off by dewatering the ill-fated shaft and resuming the exploration of the deep mineralization, which occurs at 500 to 800 metres below the surface.

“All the infrastructure is there. Everything works. But we have to dewater it,” said Richardson. He estimates that will cost about \$1 million and take about a month and a half.

“The shaft is in an area not in our NI 43-101 resources yet,” said Richardson. “When [Weatherly] sank the shaft, its plan was to drill from underground to build the resource. We will get back underground there, drill out the resource and then incorporate that into our mine plan.”

The company will also explore the 6,000 hectares of strike potential adjacent to the Kombat mine whose western portion is near the shaft.

“Where the main mine averages 2.6 per cent copper, this area is over three per cent copper so it could represent us going from 30 to 76 million tonnes annually,” said Richardson. “We will be systematically going through those targets and looking to develop more resources. Even beyond what we have in our sights, there is a real opportunity to turn this into something even more substantial where we have perhaps multiple open pits and multiple open frames all feeding a central mill for something worthy of a major copper company.”

Watering the future

While the mine’s biggest challenge has been water, in Namibia which is a desert country, it is also a highly valued resource. Trigon has an agreement with the Namibian govern-

ment’s water utility to pump water from one of its shafts in the main mine into settling ponds at Kombat and then to the utility’s reservoir for distribution. And as the project expands underground, there will be more water.

Trigon saw this as an opportunity to help the townspeople in both the short and long terms. It has built a four-hectare fruit and vegetable garden that employs women from the community. Some of the harvest is distributed to the people in the town. The rest is sold to restaurants serving the many eco-tourists who travel to Namibia’s game reserves and national parks every year to see the wildlife, and thereby paying for the salaries of the women employed.

“The longer-term thinking for this garden was about promoting sustainability in the valley for the future,” said Richardson. “As much as I have very long-term plans, as with any mine, the mine will close again at some point.”

Over the next four years, the company plans to collaborate with the town to expand the garden. “We are working with a regional councillor and they are bringing in agriculture groups to see what they can grow in the valley and our garden is proof that it can work,” said Richardson. “So that when the mine closes, Kombat town doesn’t go back to being a ghost town.”

As employment at the mine and new business opportunities grow, Kombat is also building a reputation not just for its copper but its fruits and vegetables, especially its winter crop of onions.

“Apparently, we have very good soil for onions,” said Richardson. “So, if you’re in Namibia and you have some particularly good onions, they probably came from Kombat.” **CIM**

Supporting the next generation of miners

The CIM Foundation stands behind its mission to promote mining education

By Michele Beacom

Celebrating its 50th anniversary this year, the CIM Foundation (CIMF) continues its mission to create and support a strong program of educational and charitable activities directed towards improving the contribution of the Canadian mineral industry to the progress and well-being of Canada. The non-profit charitable organization is dedicated to fundraising to promote and support education as well as best practices in the many facets of the mining world. This year, CIMF awarded scholarships to eight deserving students.

Etienne Paquette, a mining engineering student from Laval University in Quebec City is the recipient of the Stantec Mining Engineering Scholarship awarded to second year students. Paquette has long been interested in geology and mining and is passionate about his studies. “The immensity of the mining projects, the constant teamwork between the different departments and the commitment of the industry to always renew itself, both technologically and socially, are the main reasons that drove me to pursue my studies in this field,” he said in his application for the scholarship.

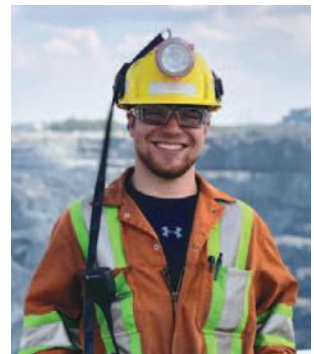
You might not think that a radiology student would apply for and get a mining-related scholarship, but Pierre Rochon, a first-year student in radiation technology at Collège Boréal, took home one of the three Taking Flight Scholarships. Rochon, who had considered a career in mining like others in his family, changed paths to X-ray technology to serve his northern Ontario community. This direction will help him to identify and prevent mine-related diseases such as miners’ pneumoconiosis (or nickel lung), silicosis, sarcoidosis, mesothelioma, asbestosis and anthrax.

With the support of the COSMO Mining Industry Consortium and McGill University Laboratory, the Taking Flight Scholarships are awarded to Indigenous or Métis students in high school, college or university studying in any area related to mining. The other two recipients this year are Alicia Gilles, a fourth-year mining engineering student at Laurentian University; and Martin Rousseau, a second-year student in the millwright program at Collège Boréal.

The CIMF Stantec/McIntosh Engineering Scholarship Fund was established in 2010 thanks to the generosity of Stantec/McIntosh Engineering Inc. During its 10-year run, it offered several multi-year scholarships to technical and degree students from across Canada beginning in their second year. The multi-year support afforded by the scholarship allowed each recipient to pursue their studies and to work in a mining-related co-op job during their undergraduate years. The opportunities to work hands-on in the industry while still at the undergraduate level were vast.

The final recipients of the Stantec/McIntosh Scholarship Fund final installment coincidentally are all mining engineering students at Queen’s University, but over its years, the fund awarded scholarships to students in mining engineering or a technical degree in mining programs, with a special emphasis on underground mining. The last to receive the award are: Jacob Yarrow of Kingston, Ontario; Jacob Bilous of Dryden, Ontario; Chas Meadows of Winnipeg, Manitoba; and Isabella Semadeni of Timmins, Ontario.

Congratulations to all the recipients! **CIM**



This year’s roundup of CIMF scholarships includes mining engineering students (from left) Jacob Yarrow, Queen’s University; Alicia Gilles, Laurentian University; Chas Meadows, Queen’s University; and Jacob Bilous, Queen’s University.



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Coup de chance

Chaque été, lorsque nous préparons notre calendrier rédactionnel pour l'année suivante, nous nous efforçons de tenir compte de l'esprit qui anime le secteur minier à ce moment-là et d'y répondre par un projet qui, dans l'idéal, sera encore pertinent 18 mois plus tard lors de la publication du dernier numéro de notre calendrier rédactionnel.

Notre section Objectif neutralité carbone, par exemple, est née de l'annonce par une multitude de sociétés minières de leurs objectifs à court et long termes de réduction des émissions de CO₂, de l'intérêt prononcé de nos lecteurs pour un débat sur ce thème, ainsi que des innombrables obstacles, certains facilement décelables et d'autres se dissimulant juste au-delà de l'horizon, pour atteindre cet objectif. Ceci nous donne carte blanche pour aborder dans nos articles une multitude de thèmes.

Je tiens à remercier chaleureusement les sociétés d'exploration qui se sont entretenues avec nous pour notre dernier article de la série dédiée à la neutralité carbone, « Prélude », par Kelsey Rolfe (p. 49). Par rapport aux exploitations minières gigantesques, les activités de ces sociétés ont une portée et des moyens modestes, mais l'élan dont elles font preuve pour réduire leur empreinte environnementale est tout aussi fort. Le marché le demande et les sociétés d'exploration doivent se tenir informées pour bien comprendre l'ampleur de leurs émissions, déterminer ce qui est réalisable en matière de réduction, et décider de ce qu'elles peuvent faire pour atténuer les émissions qui sont inévitables, même si la réglementation ne les oblige pas à les divulguer. Du point de vue d'une exploitation minière, la neutralité carbone à l'horizon 2050 ne paraît pas si lointaine. Ainsi, c'est en examinant scrupuleusement les projets au travers du prisme de l'intensité des émissions de carbone, peu importe l'étape à laquelle cet examen a lieu, que l'industrie se placera sur la bonne voie, et non en remettant son examen à plus tard sous prétexte que cette question ne constitue pas encore une préoccupation « matérielle ».

Le destin a aussi joué en notre faveur à d'autres niveaux de notre calendrier rédactionnel. Par exemple, notre article de fond dans ce numéro porte sur l'exploration et le développement minier dans le Canada atlantique. Par un heureux hasard, alors que nous préparions l'article pour cette édition, le fonds d'investissement dans les métaux précieux Eric Sprott annonçait une prise de participation supérieure à 125 millions de dollars dans la société New Found Gold. Lors de la planification éditoriale initiale, l'inspiration pour l'article de fond m'était en partie venue de l'identification d'une tendance non-scientifique il y a quelques années pendant des vacances d'été en Nouvelle-Écosse, durant lesquelles j'étais tombé sur un article consacré à deux projets aurifères distincts de la province, figurant à la une de deux journaux locaux.

Si la pandémie a mis un frein à beaucoup de travaux d'exploration dans les provinces de l'Atlantique, l'activité a repris l'année dernière de plus belle et les premières indications de 2022 montrent qu'il s'agira d'une année record pour la région.

Ce qui est remarquable avec le projet de Queensway, au-delà des hautes teneurs observées après le forage, c'est que la propriété est située à proximité d'une agglomération urbaine et bénéficie d'un accès relativement direct au réseau électrique.

« Nous avons toujours dit que le potentiel aurifère de Terre-Neuve-et-Labrador était largement sous-exploré », déclarait Timothy Froude, directeur général de Sokoman Minerals et originaire de la province, à la journaliste Alexandra Lopez-Pacheco du *CIM Magazine*. « Mais peu de gens semblaient s'en soucier. »

Ce temps-là est probablement révolu, et nous sommes impatients de partager avec vous les récits entourant ces projets à mesure qu'ils se développent.



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Prospérer dans un monde imprévisible

Après deux années passées clouée à mon poste de travail créé à la hâte et totalement non-ergonomique, je suis prête à retourner dans le monde, à recréer des liens en personne avec mes amis et mes collègues, à faire de nouvelles connaissances et à élargir mes perspectives. Le congrès et l'Expo de l'ICM (CIMBC22), qui a eu lieu cette année en présentiel à Vancouver, en était l'occasion idéale.

Si vous avez pu vous joindre à nous lors du CIMBC22, vous avez été chanceux! Le discours liminaire a soulevé d'importantes questions et a certainement invité les participants à se remettre en question. La session d'ouverture animée par des dirigeants de l'industrie était par ailleurs une véritable source d'inspiration. J'ai appris que les deux aspects de l'innovation (l'efficacité et la créativité) sont essentiels pour répondre aux enjeux complexes et aux possibilités auxquels nous sommes collectivement confrontés en tant qu'industrie et société. Parmi ces enjeux figurent le changement climatique, l'extraction et le

recyclage des ressources nécessaires pour atteindre la neutralité carbone, la pénurie de main-d'œuvre qualifiée et la collaboration avec les communautés locales en faveur d'une prospérité durable.

Le concept de prospérité dans un monde toujours plus imprévisible est tout aussi valable pour un institut national tel que l'ICM. Pour moi, l'ICM est tout autant dévoué à la communauté et la célébration de l'excellence qu'à l'échange des connaissances, la promotion des meilleures pratiques et la mobilisation de la société. Ces cinq principes existent depuis longtemps et sont encore d'actualité de nos jours. Ce qui change, c'est la façon dont nos sections, nos sociétés et nos comités y adhèrent à mesure qu'ils évoluent. Laissez-moi vous donner un exemple. Il y a 40 ans, les membres de l'ICM attendaient avec impatience la toute dernière publication de l'ICM, qui leur était envoyée par la poste et dont les articles à comité de lecture les tenaient informés des dernières innovations techniques. Aujourd'hui, cet échange de connaissances techniques reste essentiel, mais peut se faire sur Internet, à la demande. Le principe de l'échange des connaissances persiste. C'est le mécanisme par lequel ces connaissances sont échangées qui évolue. L'ICM doit s'assurer que nos plateformes, nos pratiques et nos procédures de gouvernance continuent d'évoluer pour faciliter les besoins de l'industrie, de la société, de nos partenaires et de nos membres.

Dans un contexte de transition vers un avenir à faibles émissions de carbone et de croissance rapide de la population mondiale, les métaux et les minéraux sont plus importants que jamais. Il est essentiel que toutes celles et tous ceux qui souhaitent concrétiser ces opportunités pour s'assurer que le monde dispose de ressources suffisantes se sentent les bienvenus, intégrés et représentés par l'ICM. Les frontières des disciplines traditionnelles s'estompent toujours plus, tout comme les rôles en amont et en aval dans les chaînes logistiques (j'ai récemment entendu l'expression *supply webs*, des réseaux de distribution interconnectés). L'effacement progressif de ces rôles traditionnels dans le secteur minier peut être envisagé comme une occasion de mobiliser un réservoir de talents bien plus important. Au-delà de nos frontières traditionnelles, nous collaborons et développons des solutions pour améliorer la sécurité, la productivité et la performance environnementale.

Alors que l'ICM s'apprête à célébrer son 125^e anniversaire en 2023, Angela Hamlyn et les membres du conseil de l'ICM participeront (croisons nos doigts!) à divers événements organisés par les sections et les sociétés et collaboreront en personne avec des fournisseurs et des partenaires de l'industrie. Le succès de l'institut et de notre industrie repose sur le travail d'équipe.

Bienvenue chez vous, c'est un plaisir de vous retrouver en personne. Je suis impatiente d'assumer ma fonction de présidente de l'ICM à votre service pour l'année à venir.

Anne Marie Toutant
Présidente de l'ICM



Les sociétés d'exploration telles que Fireweed Zinc, qui doivent envoyer par avion les foreuses démontées et les pièces (sans parler du personnel), trouvent difficile de réduire leurs émissions de gaz à effet de serre.

Prélude

Limitées par leur situation géographique et leurs ressources, les sociétés menant des activités d'exploration se tournent vers des projets dédiés à l'efficacité du site et à la compensation de leurs émissions de carbone afin de réduire leur empreinte de GES

Par Kelsey Rolfe

Fireweed Zinc a de grands projets pour la prochaine saison de forage cet été. Cette petite société minière se prépare à mener une évaluation économique préliminaire (ÉÉP) pour son projet Macmillan Pass de zinc, plomb et argent dans le sud-est du Yukon, en se fondant sur les résultats de forage de ses propriétés de Tom, Jason et Nidd.

Ce faisant, déclarait Pamela O'Hara, vice-présidente de la durabilité à Fireweed, la société génère, contre son gré, des émissions de gaz à effet de serre (GES) qu'elle n'a aucun moyen de réduire.

Le projet Macmillan Pass regroupe 13 propriétés sur 945 kilomètres carrés (km²). Le site, situé à environ 200 kilomètres au nord-est de la rivière Ross, est accessible par la route et par sa bande d'atterrissage sur le site. Le camp de 50 personnes de la société, alimenté par un groupe électrogène diesel, est installé sur sa propriété de Tom. Nidd se trouve à 20 minutes en hélicoptère. Le programme de forage qui aura lieu cet été consistera à démonter les foreuses et à envoyer les pièces par avion vers le site en plusieurs voyages, avec les tiges de forage, le personnel, le carburant et tout autre bien de consommation. La société

fonctionne 24 heures sur 24. Les hélicoptères font donc des allers et retours dans la journée pendant les quarts de travail.

Étant donné l'isolement géographique du projet, sa grande ampleur et la saison d'à peine quatre mois (entre juin et octobre) durant laquelle a lieu l'exploration, aucune option écoénergétique viable n'existe, indiquait M^{me} O'Hara.

« En tant que petite société d'exploration, il ne nous est pas possible, tant du point de vue économique que technique, de nous éloigner des combustibles fossiles dès maintenant », expliquait-elle. « Ceci étant dit, nous prévoyons de commencer la production d'ici 10 ans, et nous assisterons sans doute à des avancées considérables dans le secteur. »

L'histoire de Fireweed est loin d'être singulière pour les sociétés d'exploration minière. Dans un contexte où le secteur minier fait face à une pression toujours plus forte concernant la décarbonation, les sociétés d'exploration sont prises entre deux feux. Confrontées à des obstacles de nature géographique, financière et technique pour réduire leurs émissions, beaucoup se tournent vers des projets d'optimisation et des programmes de compensation de leurs émissions pour avoir un impact.

Veiller au grain

Si de nombreuses sociétés d'exploration envisagent de réduire leurs émissions, elles ne sont pas tenues de les communiquer ni de payer pour ces émissions. Le seuil de communication des émissions de GES établi par le gouvernement fédéral est de 10 000 tonnes d'équivalent dioxyde de carbone (équivalent CO₂ ou éq. CO₂) par an. Depuis 2019, les exploitations industrielles qui émettent plus de 50 000 tonnes par an sont soumises à un système de tarification fondé sur le rendement (STFR) pour le carbone. Dans son document d'orientation en ligne sur les émissions de GES, la *Prospectors and Developers Association of Canada* (PDAC, l'association canadienne des prospecteurs et développeurs) indiquait que, s'il est « peu probable » que les activités d'exploration atteignent un seuil de tarification fondé sur le rendement, un programme de forage d'exploration à grande échelle d'environ 200 000 mètres par an ou des activités impliquant au moins 10 foreuses pourraient se voir soumises à des exigences de surveillance et de communication.

« Les membres de la PDAC opérant au Canada sont encouragés à envisager dès à présent de mesurer les émissions directes totales d'éq. CO₂ de leurs activités », lisait-on dans le document d'orientation.

C'est ce qu'Andy Randell, directeur général et géoscientifique principal à la société de conseils en géologie SGDS Hive basée en Colombie-Britannique (C.-B.), a commencé à faire après qu'un client lui en ait fait la demande. Sans modèle existant pour les sociétés à l'étape d'exploration, M. Randell et l'équipe de Hive ont développé leur propre formulaire de comptabilité carbone. Il répartit les émissions en trois catégories : le carbone opérationnel émanant des transports et de l'équipement du site, des moteurs portables, de la production d'électricité pour le camp et autre ; le carbone humain émanant de l'électricité, des déchets et de l'usage de papiers au camp ; et le carbone environnemental provenant du défrichement qui réduit la séquestration du carbone.

Aujourd'hui, Hive propose gratuitement la comptabilité carbone à ses clients. M. Randell mesure également l'empreinte carbone d'Aeonian Resources, la société d'exploration minière qu'il a créée, qui gère trois projets en Colombie-Britannique. Le projet cuprifère de Koocanusa d'Aeonian près de Cranbrook a émis 1 621,35 kilogrammes (kg) de carbone en 2021 dans le

cadre des activités de l'équipe de M. Randell, qui consistaient à établir une grille de levés magnétiques sur une section de la propriété, à élargir la propriété par jalonnement et également à prospecter, à cartographier et à échantillonner cette nouvelle zone. Maintenant que la société a une meilleure idée de ses émissions, indiquait-il, elle peut commencer à faire le nécessaire pour les réduire.

Travailler dans les limites

Toutefois, des limites importantes persistent concernant ce que les sociétés d'exploration peuvent faire pour réduire leur empreinte carbone.

« Les sociétés d'exploration font face à des difficultés certaines », déclarait Gabrielle Beauchamp, directrice de projet du secteur minier à Tugliq Énergie, un producteur d'électricité indépendant du Québec offrant des alternatives privilégiant les énergies renouvelables pour des applications dans des lieux isolés et non reliés au réseau électrique. La nature provisoire des installations du camp dans des lieux non reliés au réseau électrique fait qu'il est difficile de s'engager envers une infrastructure permanente reposant sur les énergies renouvelables, indiquait-elle. Les sociétés d'exploration du Nord auront par ailleurs beaucoup plus d'émissions associées au chauffage, notamment en raison de l'utilisation de matériel pour lutter contre le gel et de radiateurs électriques (alimentés par des groupes électrogènes au diesel).

Kristina Hamernik, responsable du développement commercial à Tugliq, ajoutait que sans infrastructure dédiée à l'énergie propre, il est difficile d'adopter un équipement électrique mobile, sans parler des options limitées sur le marché en matière d'équipement lourd électrique, confronté à un compromis entre le poids de la batterie et sa durée de fonctionnement. « Les véhicules les plus lourds et les plus volumineux auront besoin de batteries plus grandes. À un moment, les deux ne sont plus compatibles. »

Comme l'indiquait le document d'orientation de la PDAC, les variables spécifiques à l'exploration peuvent aussi affecter la quantité d'émissions de gaz à effet de serre sur le site. Les carottes à plus gros diamètres et les trous de forage plus profonds consomment davantage de diesel pendant un programme de forage. La qualité du sol a en outre « l'un des impacts les plus importants » sur l'usage du diesel dans les foreuses. L'association indiquait par ailleurs que l'ancienneté et l'état de la foreuse ainsi que le niveau de qualification de l'équipe avaient une incidence sur les émissions.

M^{me} Hamernik indiquait que les offres du marché pour trouver des solutions à plus petite échelle privilégiant l'énergie renouvelable ne cessent de croître. La société travaille sur un projet pour le ministère fédéral de la défense nationale afin de démontrer le bien-fondé de solutions à petite échelle privilégiant l'énergie renouvelable en association avec un traitement des déchets et de l'eau pour les petits camps provisoires, qui pourraient s'avérer utiles pour les sociétés d'exploration. L'utilisation de turbines éoliennes inclinables et ayant une structure moins permanente peut aussi être intéressante en cas d'entretien ou de météo peu clémente, tout comme des installations solaires mobiles conteneurisées.

« Il existe sans aucun doute des possibilités pour l'intégration de l'[énergie] renouvelable à plus petite échelle, même pour des [solutions] mobiles... Mais en raison de certains facteurs de fiabilité, les sociétés hésitent », ajoutait-elle. « Les engagements



devenant plus omniprésents dans l'industrie, le désir de transition sera plus visible. À l'étape d'exploration, on observe au moins une légère part d'intégration. »

Petits changements

Pour de nombreuses petites sociétés, le coût est un facteur réel, indiquait M. Randell. « On s'approvisionne plus facilement au grand magasin Canadian Tire que chez un grand fournisseur industriel pour trouver de l'équipement qui fonctionne sans émissions. »

Il expliquait qu'Aeonian avait remplacé ses réserves de carburant par un mélange de qualité supérieure plus propre et plus onéreux qui émet moins de CO₂. La société utilise également des foreuses autopropulsées sur chenilles afin de ne pas avoir à utiliser un bulldozer pour les déplacer dans le site. Elle s'intéresse à de petits chargeurs pour les téléphones, aux radios et à d'autre matériel électronique qui permettraient de réduire l'utilisation du groupe électrogène diesel. Elle a aussi envisagé les implications en termes d'émissions du transport des matériaux à recycler en ville, par rapport à une destruction par combustion sur place. « Malheureusement, tout ceci n'est qu'un prélude », déplorait M. Randell. « Les petites choses sont les plus faciles à changer. »

Fireweed a introduit des stratégies d'atténuation simples, indiquait M^{me} O'Hara. Sa politique contre la marche au ralenti de ses véhicules permet de garantir une utilisation efficace du carburant, un point important pour la petite société minière des points de vue des émissions et des coûts. La société opère également des vols à double usage : le même avion transporte personnel et approvisionnement vers le site, et ramène le personnel ainsi que les carottes de forage et les échantillons d'eau vers le sud à son retour.

Compenser les émissions

Troilus Gold, une petite société minière qui développe le projet Troilus sur une mine héritée d'or et de cuivre active de 1996 à 2010, adopte une approche différente à la question des émissions. Fin février, la société annonçait qu'elle avait embauché Tugliq pour mener un inventaire de son empreinte de GES actuelle et passée et pour aider Troilus à élaborer une feuille de route afin de développer une mine neutre en carbone. Troilus prévoit de mettre à jour ses estimations des ressources minérales et de mener une étude de préféabilité au deuxième semestre 2022 sur son programme d'exploration de 100 000 mètres de 2021. La société indiquait qu'elle continuera ses activités d'exploration régionale pendant toute l'année.

La société a été fondée en 2018 lorsqu'elle a acheté les concessions de Troilus. Catherine Stretch, vice-présidente des affaires de l'entreprise, est chargée de surveiller les initiatives environnementales, sociales et de gouvernance (ESG) de la société. Le site est relié au réseau d'Hydro-Québec, qui fournit 83 % de l'énergie actuellement utilisée sur le site, indiquait-elle. Toutefois, les foreuses, les autres véhicules du site et le groupe électrogène diesel de secours génèrent encore des émissions.

La société prévoit d'acheter des crédits d'émission de carbone afin de compenser ses émissions de GES depuis 2018. Aux côtés de Tugliq, elle travaille sur un projet de réduction des émissions pour l'avenir.

Aeonian compense son empreinte carbone au travers de programmes de plantation d'arbres. D'après M. Randell, la société se fonde sur le prix du carbone fixé par la Colombie-Britannique à 50 dollars la tonne pour calculer son coût approximatif lié aux

émissions de CO₂, puis fait don d'une somme équivalente à un organisme caritatif qui plantera des arbres avec la somme recueillie. D'après l'organisme caritatif de plantation d'arbres One Tree Planted, chaque arbre peut stocker environ 10 kg de carbone par an pour les 20 premières années de sa vie. Chaque arbre coûte environ 6 dollars, indiquait M. Randell. Pour compenser les émissions de CO₂ de Koocanusa en 2021, le coût se serait élevé à 80 dollars en taxe carbone. La société a fait don de 97 dollars à un programme de plantation d'arbres.

« Il est plutôt dangereux d'attribuer une somme en dollars aux compensations, car ces sommes sont si insignifiantes que beaucoup pourraient être tentés d'en faire le moins possible. Toutefois, je pense que la plupart des sociétés se rendront compte que ces sommes sont vraiment infimes et qu'elles pourraient facilement les tripler. »

M. Randell s'est également entretenu avec les clients de Hive concernant l'allocation de fonds pour l'achat de graines à distribuer aux Premières Nations, à des écoles ou à des programmes disposant de pépinières de plantes indigènes s'ils se trouvent dans des régions d'activités forestières où des arbres seraient, de toute manière, plantés.

D'après un guide de 2019 sur l'achat de crédits d'émission de carbone par la fondation David Suzuki et l'institut Pembina, les entreprises et les organisations peuvent optimiser leurs investissements dans des crédits carbone en mettant l'accent sur des projets qualifiés de « complémentaires » (en d'autres termes, ils n'existeraient pas sans ce marché de crédits d'émission qui les finance et les fait avancer). Elles peuvent aussi investir dans des projets « de haute qualité » tels que ceux consacrés à l'énergie renouvelable et au rendement énergétique, qui créent un avantage permanent en matière de climat.

À l'horizon

S'il est difficile de réduire les émissions sur le court terme, les sociétés d'exploration sont en position forte pour développer des mines du futur qui afficheront l'empreinte carbone la plus faible possible, indiquait M^{me} Beauchamp.

« Une mine existante qui essaie de réduire ses émissions de GES et s'efforce de moderniser ses activités sera confrontée à des dépenses plus importantes que lorsqu'elle envisage de construire une infrastructure complète dès la phase d'exploration », ajoutait-elle. « Les sociétés minières en phase d'exploration ont tout intérêt à étudier des stratégies qui leur permettront de disposer d'une infrastructure reposant fortement sur l'énergie verte. »

D'après M^{me} Stretch, certains dans le monde minier ont été étonnés du partenariat de Troilus avec Tugliq étant donné que la société se trouve encore à l'étape d'exploration et de développement. Toutefois, indiquait-elle, « c'est le moment idéal pour le faire et pour contribuer de manière positive à l'avenir de notre secteur. Les décisions que nous prenons aujourd'hui pourraient avoir des répercussions qui dureront des décennies. » **ICM**

La série **Objectif neutralité carbone** se poursuivra tout au long de l'année 2022. Elle examinera les difficultés liées à la réduction des gaz à effet de serre et à l'élimination des empreintes carbone, et étudiera également les possibilités qu'offrent ces actions. Si vous souhaitez apporter votre contribution, veuillez nous contacter à l'adresse : editor@cim.org.

Commandité par





Trigon Metals ne s'est pas contentée de remettre la mine de Kombat en service en 2021. Elle a investi 10 millions de dollars dans la modernisation de l'usine de traitement existante.

La mine de Kombat est de retour

Une mine autrefois inondée et définitivement fermée dans le désert de Namibie reprend vie et sauve des exploitations agricoles en les approvisionnant en eau

Par Alexandra Lopez-Pacheco

Le complexe minier de Kombat dans la chaîne de montagnes d'Otavi, en Namibie, a le même nom que la petite ville construite en 1900 à proximité de la mine pour loger ses employés. À l'époque, les premiers propriétaires de la mine souhaitaient tirer profit des gisements riches en cuivre de la région et de l'abondance de l'eau souterraine. La mine et la ville ont survécu pendant des générations, jusqu'à une journée fatidique de décembre 2007 quand une catastrophe a frappé.

Weatherly International, propriétaire de la mine à l'époque, avait construit un puits d'exploration et de production de 800 mètres pour accéder au cuivre à haute teneur de la mine dans une zone située à l'ouest de la mine principale. Deux pannes d'électricité d'une heure ont interrompu les pompes à eau, censées fonctionner 24 heures sur 24 et 7 jours sur 7 pour contrôler l'eau souterraine. Le puits a été inondé, suivi de la mine principale. Une année plus tard, dépassée par les coûts de reconstruction du puits et le déclin des prix du cuivre, Weatherly a abandonné le projet de développement et la mine principale de

Kombat qui inclut deux autres puits, puis a placé la mine en mode de soins et maintenance. Les revenus des habitants de la ville de Kombat ayant disparu, la communauté a sombré dans la pauvreté.

Une société canadienne espère aujourd'hui donner un nouveau souffle à la mine et la ville. En octobre 2021, Trigon Metals, une société basée à Toronto, a remis la mine en service en adoptant une approche progressive qui, elle l'espère, transformera le projet en un producteur important de cuivre employant jusqu'à 1 000 employés, dont de nombreux habitants de la région de Kombat.

Le projet de Kombat de Trigon comprend cinq zones de permis d'exploitation minière et de prospection couvrant plus de 7 500 hectares et une infrastructure utilisable de plus de 100 millions de dollars américains installée par les précédents propriétaires, notamment une usine de traitement, des chantiers souterrains considérables, un parc à résidus miniers, des systèmes de descenderie et plusieurs bâtiments miniers. Trois



Avec l'aimable autorisation de Trigon Metals

L'eau aspirée de la mine sert à irriguer les terres agricoles et à les cultiver. Cela crée des emplois agricoles et des cultures de grande qualité vendues aux restaurants.

de ces permis concernent le projet de Kombat situé dans une vallée de 40 kilomètres de large dans la chaîne de montagnes d'Otavi, entre les villes d'Otavi à l'ouest et de Grootfontein à l'est. Cette région possède sept zones de minéralisation distinctes connues, notamment Kombat Ouest, Kombat Centre, Kombat Est et E900. Ensemble, ces zones couvrent 1 219 hectares qui affichent des ressources minérales indiquées de 12,22 millions de tonnes à une teneur de 1,94% de cuivre, 0,7% de plomb et 13,67 grammes par tonne d'argent ainsi que des ressources présumées de 1,91 million de tonnes à teneur de 2,19% de cuivre, 1,79% de plomb et 6,13 grammes par tonne d'argent.

Les deux autres permis concernent des zones minéralisées couvrant plus de 6 000 hectares à proximité de Kombat, qui représentent un prolongement possible de la longueur du gisement. « Kombat se trouve au milieu », déclarait Fannie Müller, vice-présidente des opérations de Trigon. « Il existe donc plus de 40 kilomètres de longueur potentielle du gisement non explorée adjacente à la mine de Kombat. »

En outre, Trigon détient une participation dans deux permis de prospection exclusifs pour une zone située à environ 200 kilomètres de Kombat, dans le nord-ouest de la Namibie.

Nouveau départ pour la mine de Kombat - Première étape

« Nous avons tenté de trouver la manière la plus responsable et la plus simple d'amener la mine jusqu'à la phase de production », indiquait M^{me} Müller. Pour ce faire, la société a mené plusieurs études conceptuelles ainsi qu'une étude de faisabilité. Sur la base de ces études, Trigon a décidé que la voie à suivre consistait à redémarrer les activités à la mine en procédant à l'extraction des zones de Kombat Est et Kombat Centre, car elles se prêtent bien à une exploitation à ciel ouvert peu profonde, avec une profondeur maximale de 60 mètres.

« C'est une approche plus simple, plus rapide et moins coûteuse que de commencer en souterrain. Elle nous permet par ailleurs d'utiliser une partie des revenus de l'exploitation à ciel ouvert pour rouvrir la mine souterraine », ajoutait M^{me} Müller.

Trigon a commencé l'exploitation à ciel ouvert et la constitution de piles de stockage avec le minerai de surface de Kombat (dont la teneur en cuivre varie entre 1 et 1,2 %) en octobre 2021, ce qui lui a permis de se concentrer sur la remise à neuf des opérations de traitement de la mine. Inexploitée pendant plus d'une décennie, l'usine avait besoin d'une réfection. Les anciennes cellules de flottation étaient rouillées, il n'était donc pas question de les laisser telles quelles. Quant à l'ancien concasseur primaire de fabrication allemande, il fonctionnait toujours, mais les pièces de rechange n'existaient plus. Ainsi, Trigon a dû opter pour le remplacement du concasseur.

Tous les nouveaux équipements de l'usine ont été fabriqués par la société chinoise Yantau Xinhai Industry. Le coût total de cette réfection s'élevait à 10 millions de dollars, dont la majeure partie couvrait les coûts de main-d'œuvre. « En termes de coût, cela représente sans doute moins de 40 % du prix que l'on aurait payé pour le même genre d'équipement en provenance d'Afrique du Sud, à la frontière de la Namibie », déclarait M^{me} Müller. « La qualité de l'équipement est exceptionnelle. »

En décembre 2021, Trigon avait terminé la remise à neuf de l'usine de Kombat et a produit le premier concentré de cuivre de la mine en 14 ans. Deux mois plus tard, la société annonçait l'expédition de sa première cargaison, qui comprenait 31 tonnes métriques sèches de concentré, affichant une teneur de 20,41 % de cuivre et 265 grammes par tonne d'argent.

Deuxième étape

La deuxième étape du projet consiste à dénoyer la mine souterraine principale de Kombat, que Trigon espère finaliser



Le 28 février 2022, Trigon a expédié sa première cargaison de concentré de cuivre de Kombat. Cette cargaison (en photo ci-dessus) comprenait 31 tonnes métriques sèches de concentré, affichant une teneur de 20,41 % de cuivre et 265 g/t d'argent.

en 2023. Elle impliquera également le développement de l'exploitation minière dans sa zone de minéralisation E900.

« Les mineurs qui ont extrait le minerai de Kombat dans les années 1960 et 1970 considéraient le cuivre d'une teneur de 3 % comme un déchet. Pour nous, ce pourcentage constitue une haute teneur », indiquait M^{me} Müller. « Beaucoup de cuivre n'a pas été récupéré. »

Concernant le risque d'une autre inondation, Jed Richardson, président et directeur général de Trigon, est d'avis que l'inondation de 2007 était le fruit d'erreurs et aurait pu être évitée. « Personnellement, je pense que l'incident a été mal géré », indiquait-il. « Les pompes étaient obsolètes, elles avaient été installées dans les années 1960 et fonctionnaient à l'époque par étapes. Dans la partie inférieure de la mine, l'eau était aspirée vers un niveau intermédiaire puis une autre [unité] l'aspirait jusqu'à la surface. Aujourd'hui, on placerait une unité à la surface qui aspirerait l'eau depuis le fond de la mine jusqu'à la surface. On disposerait d'une capacité de pompage supplémentaire et d'une unité de production d'électricité de secours. En d'autres termes, la gestion serait meilleure. »

Une fois la deuxième étape achevée, Kombat augmentera sa production prévue pour 2022 d'environ 8 millions de livres (l'équivalent de 3 629 tonnes) de concentré de cuivre à plus de 30 millions de livres (environ 13 608 tonnes) par an en 2024.

Potentiel futur

Trigon mettra ensuite l'accent sur la reprise des activités là où Weatherly a abandonné, en dénoyant le puits au destin tragique et en reprenant l'exploration de la minéralisation profonde, qui se situe entre 500 et 800 mètres en dessous de la surface.

« Toute l'infrastructure existe. Tout fonctionne. Il ne nous reste qu'à dénoyer », expliquait M. Richardson. Selon lui, le

dénoyage coûtera environ un million de dollars et prendra un mois et demi.

« Ce puits se trouve dans une zone qui ne fait pas partie des ressources annoncées dans notre NI 43-101 », indiquait M. Richardson. « Lorsque [Weatherly] a noyé le puits, elle prévoyait de forer sous terre pour compléter les ressources. Nous retournerons sous terre, extrairons les ressources puis les intégrerons dans notre plan de mine. »

La société explorera également les 6 000 hectares de long-ueur potentielle du gisement adjacente à la mine de Kombat, dont la partie ouest est proche du puits.

« La mine principale affiche une moyenne de 2,6 % de cuivre, mais cette zone dépasse largement les 3 % de cuivre. Ceci pourrait nous permettre de passer de 30 millions à 76 millions de tonnes par an », expliquait M. Richardson. « Nous examinerons systématiquement ces cibles et chercherons à développer davantage de ressources. Même au-delà de ce que nous envisageons, nous devons saisir l'occasion de faire de cette mine une exploitation encore plus grande, où plusieurs mines à ciel ouvert et plusieurs chevalements alimenteront un concentrateur central pour obtenir un produit de grande valeur, digne d'une grande société d'exploitation cuprifère. »

Irriguer l'avenir

Si l'eau a indéniablement posé le plus grand problème pour la mine, il s'agit également d'une ressource précieuse dans un pays désertique comme la Namibie. Trigon a conclu une entente avec le service public d'eau du gouvernement namibien pour aspirer l'eau de l'un de ses puits dans la mine principale et la déverser dans des bassins de décantation de Kombat, puis dans le réservoir du service public d'eau à des fins de distribution. À mesure que le projet se développe sous terre, l'eau sera plus abondante.

Trigon y a vu une occasion d'aider les habitants de la ville sur les court et long termes. Elle a créé un jardin potager de quatre hectares qui emploie des femmes de la communauté. Une partie des récoltes est distribuée aux habitants de la ville. Le reste est vendu aux restaurants servant les nombreux adeptes du tourisme écologique visitant chaque année la Namibie pour ses réserves de chasse et ses parcs nationaux en quête de faune sauvage, dont les dépenses permettent de payer les salaires des femmes employées.

« L'idée à plus long terme derrière ce potager était de promouvoir la durabilité dans la vallée pour l'avenir », expliquait M. Richardson. « Même si j'ai des projets sur le très long terme, cette mine devra de nouveau, comme toutes les autres mines, fermer ses portes un jour. »

Au cours des quatre années à venir, la société prévoit de collaborer avec la ville pour développer ce jardin potager. « Nous collaborons avec un conseiller régional qui fait venir des groupes agricoles afin qu'ils déterminent ce qui peut être cultivé dans la vallée. Notre potager est une preuve tangible que l'on peut cultiver », ajoutait-il. « Ainsi, lorsque la mine de Kombat fermera ses portes, la ville ne deviendra pas une ville fantôme. »

L'emploi à la mine et les possibilités professionnelles ne cessent de croître. Ainsi, Kombat se forge une réputation non seulement pour ses ressources en cuivre, mais également pour ses fruits et légumes, notamment sa récolte hivernale d'oignons.

« Apparemment, le sol se prête très bien à la culture d'oignons », indiquait M. Richardson. « Si vous êtes en Namibie et que vous goûtez de bons oignons, il est fort probable qu'ils viennent de Kombat. » **ICM**



CIM Journal

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The Sudbury Basin stress tensor – a critical review

F. T. Suorineni, Nazarbayev University, Nur-Sultan, Kazakhstan

Sudbury is an internationally recognized mining camp, and mines in the basin have served as living laboratories. Of significance are lessons learned from rockbursts. Rockbursts are stress driven mechanisms and mining systems selection requires satisfactory knowledge of the in-situ stresses and rockmass properties. Unfortunately, the accuracy of in-situ stress tensors remains unacceptable. The Sudbury Basin stress tensor is the seed around which most of the basin mine stress tensors evolved. This paper tracks down the source of the Sudbury Basin stress tensor to ascertain its reliability through a critical review of stress measurements campaigns in the basin. It is concluded that the source and database of the Sudbury Basin stress tensor remains a myth, and its reliability cannot be determined. A new stress tensor based on a certified in-situ stress measurement database is suggested. The review also provides a comprehensive chronology of in-situ stress measurement campaigns in the Canadian Shield.

Ventilation design, construction, and commissioning to meet production expansion requirements in a potash mine

E. De Souza, Queen's University, Kingston, Ontario, Canada; and K. Penner, Nutrien Potash–Rocanville, Rocanville, Saskatchewan, Canada

The Rocanville mine has recently increased its site production nameplate capacity from 3.0 to 6.51 million tonnes of potassium oxide per annum. The production expansion consisted of doubling its processing capacity by building a second mill facility, increasing the ore hoisting capacity by converting the existing service shaft into a production shaft, and increasing mine production capacity by nearly tripling the production mining machine fleet and opening new ore reserves. A new remote shaft was also constructed to act as a service shaft. This article presents the design of the mine ventilation system that meets the post-expansion production requirements, the construction of the ventilation facilities, and the commissioning that was implemented in phases to permit a controlled ramp-up to full ventilation capacity with minimal disruption to mine operations.

An undergraduate hydrometallurgy laboratory emphasizing engineering design

E. Guerra and J. Schmidt, Laurentian University, Sudbury, Ontario, Canada

The development of a set of laboratory experiments, intended to help undergraduate students meet Canadian Engineering Accreditation Board requirements for Engineering Design outcomes, is described. The laboratory, which is part of a third-year-level course in hydrometallurgy, is aimed at advancing the ability of students to generate and use experimental results to design an industrial copper leach/solvent extraction/electrowinning plant. Emphasis is placed on the students demonstrating the ability to use their engineering knowledge in weighing the pros and cons of the various process options that they test in converging to a final flowsheet.



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“Discovery Ridge”

This photo was taken while I was working for Tripoint Geological Services Ltd. on Wedgemount Resources Corp.’s Cookie Project in the South Toodoggone region of British Columbia. Project geologist, Michael Brinton, was prospecting a ridge within a Cu-Au porphyry deposit.



Lauren Piccott, an Earth and Ocean Sciences student at the University of Victoria.

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