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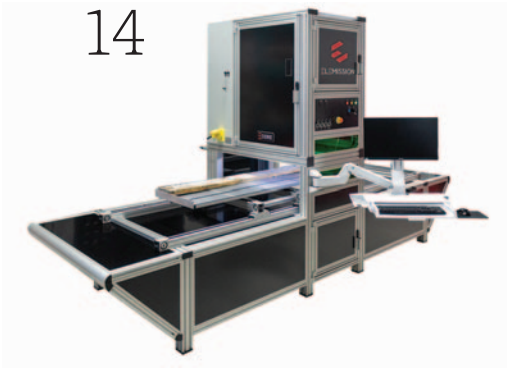

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76%

consider vehicle electrification as having the greatest potential to increase efficiency and sustainability of mining operations

42%

plan to invest in the decarbonization of their haulage fleet by 2026

68%

plan to electrify at least 25% of their fleets by 2030

More than 400 executives from mining companies globally were surveyed and agree that the time to act is now. To achieve safe and sustainable mining operations while developing a proficient and productive workforce, the shared sentiment is that automation, electrification, and digitalization are essential to future operations. Read their perspectives and how they plan to evolve their operations in our latest ESG report.

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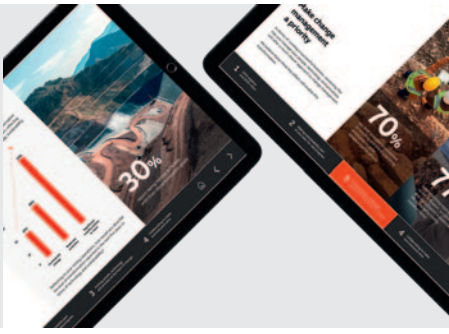

ABB

“In the oil sands, bigger is better”

The global debut of the PC9000

SUNCOR

Fort Hills has reached a major milestone, becoming the first site in the world to operate the largest mining hydraulic shovel on the market today – the PC9000.

The sheer size and capabilities of this new shovel are expected to significantly boost productivity and performance.

"We are always exploring ways to enhance our operations by adopting the latest technologies and innovations," says Peter Zebedee, Executive Vice President – Oil Sands. "In the mining business, efficiency drives everything – and in the oil sands, bigger is better."

Initial discussions with equipment manufacturer Komatsu Germany Mining Division and dealer SMS Equipment Inc. about the potential of the PC9000 quickly revealed the new shovel could bring tangible value to Suncor's mining operations.

"Our collaboration with Komatsu and SMS is built on years of trust, transparency and a shared vision," says Peter. "What started as early conversations quickly turned into something much bigger – proof of what's possible when industry leaders come together. We had a unique opportunity to be a first mover in the sector with a product that is new to the ultra-class market and designed to further enhance our operations."

"We're incredibly proud to work with Komatsu and Suncor to bring the first PC9000 to Canada," says Dennis Chmielewski, Executive Vice President – Mining at SMS Equipment. "Helping customers increase productivity and safety while reducing emissions intensity is central to what we do."

Suncor has the world's largest fleet of 980E-class mining trucks, and the PC9000 has been purpose-built to match. With a larger bucket designed to load five perfectly measured passes into each 980E truck, the result is faster cycle times, less spillage, and lower cost per tonne.

The shovel is more powerful, with a higher digging force and an extended arm reach. It also moves on a pivot to load trucks from either side, reducing repositioning time and increasing overall loading efficiency.

"Fort Hills has a complex geology that requires an innovative approach," says Alisdair Gibbons, Vice President – Fort Hills. "Unlike traditional rope shovels, this diesel-powered unit has more flexibility and breakout force making it an ideal machine to customize a solution that really takes our operations at the mine to the next level."

Shipped in components from Germany and assembled on site, the PC9000 will officially begin operations in early May. A Komatsu trainer from Germany is currently on-site, supporting operator training and ensuring a smooth start-up.

The PC9000 shovel during assembly and testing at Suncor's Fort Hills mine.

"Our investment in a world-class matched truck and shovel fleet shows just how committed we are to the future of our mines," says Alisdair. "We strive to provide our crews with the best equipment available and the PC9000 is a prime example of this."

Feedback from Suncor and its employees will inform future versions of the PC9000, giving the company direct influence on the machine's evolution and performance.

"I am extremely excited about the PC9000," adds Peter. "I really believe that my role as a leader isn't to repeat what was delivered yesterday, but to deliver results that go beyond the status quo. Launching the PC9000 at our site and working it into our operations to drive scale and efficiency is really something special."

The new Komatsu shovel is another example of Suncor driving innovation in the oil sands. From the implementation of autonomous haulage to additional safety systems to the PC9000, Suncor's desire for continuous improvement as a best-in-class operator ensures it remains on the leading edge.

"Innovation makes a meaningful difference in the lives of the people we deliver our products to each and every day," says Peter. "We are really powering the country. When we improve how we develop the resources and execute, in particular in our mining operations, everyone benefits – Suncor, our shareholders and all of Canada."

Suncor is set to receive its second PC9000 shovel in July, with two more expected to arrive next year. As Suncor continues to lead the way, other companies are watching closely. There is already a line up for the next available shovels to come off the assembly line.

Policy questions

A few years ago, at a mining conference and trade show in the United States, I met a man who had once been a miner in the eastern U.S. He was both friendly and gruff. He shared stories with me about working in underground coal mines and the near misses he had survived. When he retold how he had nearly been buried alive under coal and had to dig himself out, it was not with relief that those days were behind him, but with pride that he had the mettle to work with that risk and shrug it off.

He scorned the Mine Safety and Health Administration (MSHA), whose responsibility is to ensure safety regulations are followed. From his perspective, all the agency did was get in the way of people doing their jobs. For its part, MSHA had a pronounced impact on safety in U.S. mines. In the five years after MSHA was created in 1977, fatalities per number of coal miners fell by over 30 per cent as compared to the five years prior. Over time, the number of coal miners has declined, but not nearly as steeply as fatalities.

This former coal miner, however, was at the event to promote the National Institute of Occupational Safety and Health (NIOSH). Like MSHA, it was created in the 1970s, though its task was not to enforce regulations, but to research the cause of workplace-related injuries, illnesses, disabilities and deaths and to provide guidance for their prevention. If MSHA is a sharp stick, NIOSH helps to guide where it pokes.

NIOSH, for example, contributed to recent research that identified why cases of black lung had taken a sharp turn upward in miners working in the Appalachian coal mines, despite tighter controls on coal dust exposure. Modern coal mining machines, it turned out, are generating much more silica dust because they can cut into the rock above and below the coal seams. All this extra silica dust is ruining miners' lungs at an alarming rate.

New regulations to address this problem were enacted last year with compliance required by this April.

Of course, things have taken a new direction this year: the Trump administration is pushing for more coal mining; MSHA's resources for enforcement have been cut dramatically; the enforcement of the new silica dust limits in coal mining has been temporarily paused; and NIOSH's division focused on mining has been largely dismantled.

Sure, I have my opinions about this, but I would rather learn what has become of that coal miner turned civil servant and what he would make of this moment in time.

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

The Newtrax Cap Lamp enables tracking, proximity detection and can send emergency distress signals.

Courtesy of Sandvik

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Courtesy of Candace MacGibbon

Connecting for a strong future

As the new president of CIM, it is a privilege to welcome what is shaping up to be a transformative year for our industry. We are witnessing unprecedented political and market uncertainty, and our members will play an important role in sustaining the growth of Canada's resource industry to support our economy over the next few decades.

In the spirit of collaboration, innovation and continuous improvement, I'm proud to share a few topical themes that were shared at our recent CIM CONNECT 2025 conference and in this issue of the magazine.

CIM CONNECT: Minerals, innovation and the energy transition

CIM CONNECT is more than just a conference—it's the heartbeat of our professional community. This year's event took place in Montreal from May 4 to 7 and offered an opportunity for leaders, professionals, students and community members to gather to share ideas, tackle challenges and imagine the future of mining and materials to support the energy transition.

CIM CONNECT also provided a platform for us to celebrate excellence in our industry. The CIM Awards Gala recognized individuals and organizations whose contributions have advanced our industry and strengthened our community. (See p. 50 for a rundown of this year's winners.)

Women in mining: Driving change and leadership

Diversity is a driver of performance, innovation and safety. We are proud to support initiatives that advance diversity within the resource sector, and we're committed to ensuring our industry is one where stakeholders feel valued and empowered. At CIM, we proudly support women who are changing the face of mining—from the boardroom to the rock face. (See p. 38 to read our feature "Questions of representation.")

Safety and mine rescue: At the core of what we do

Safety remains the foundation of our work—nothing is more important than ensuring every worker goes home safely. CIM is a staunch advocate for the advancement of safety culture, technology and training. Our members are actively sharing best practices in emergency response, mental health, automation and hazard mitigation with the goal of zero harm. (See p. 46 to read "Smarter safety.")

Metallurgy and materials: Innovation in every atom

Innovation in metallurgy and materials science is critical to the efficient transformation of our resources into materials that support global infrastructure and energy systems. Whether it's improving recovery in complex ores, reducing environmental impacts or developing new materials and emerging technologies, our metallurgists and materials engineers are leading innovation (see p. 34 and p. 36).

Looking ahead

CIM is a home for ideas, leadership and lifelong learning. Whether you are a student discovering your passion, a professional refining your craft, or a leader shaping policy and direction, CIM is here to support your journey. Let's continue building a future that reflects our values—safety, inclusion, excellence and sustainability.

I enjoyed meeting many of you at CIM CONNECT and look forward to meeting more in the year to come. Let's connect, collaborate and continue shaping the future of mining together.

Candace MacGibbon
President, CIM

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SME Society for Mining, Metallurgy & Exploration

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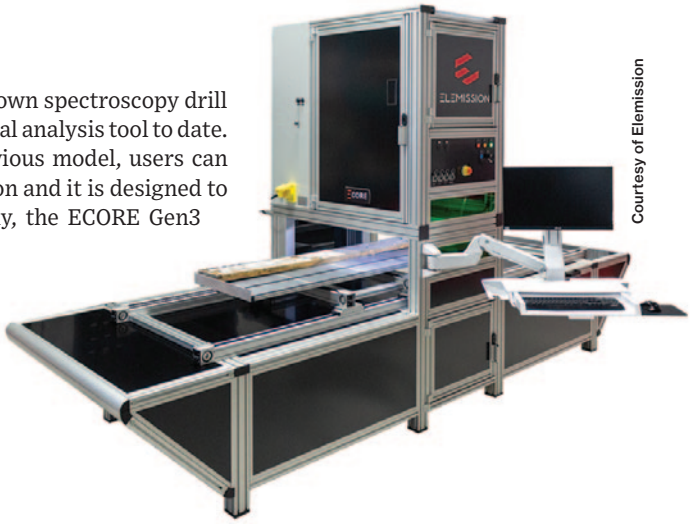
Courtesy of Caterpillar

Waterbot

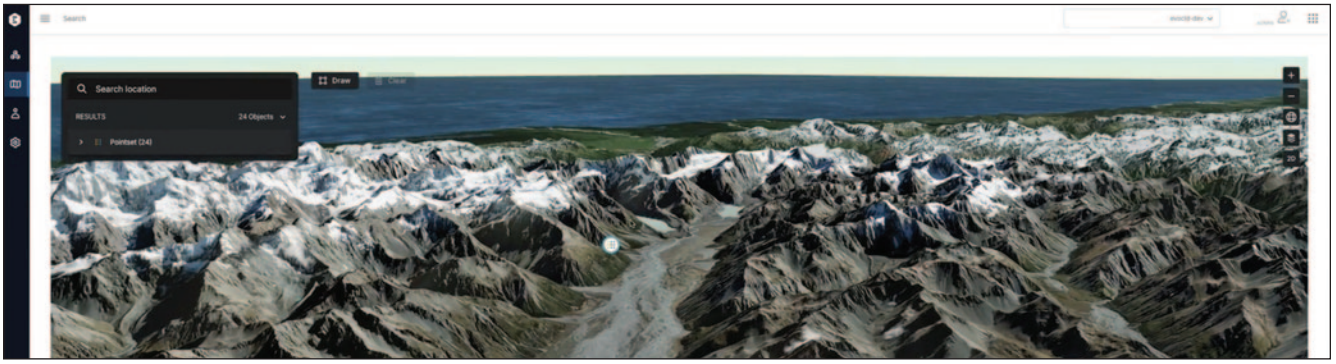
Caterpillar has introduced the Cat 789D Autonomous Water Truck (AWT) to optimize dust control and water usage on mining haul roads. The 789D AWT is fully integrated with the company's Cat MineStar Command system, which allows it to monitor traffic, weather and road conditions to prioritize where and when to water, and how many passes are needed for optimal coverage. As the largest water truck in the company's lineup, the 789D AWT can hold up to 165,000 litres, can distribute up to 2,839 litres of water a minute and has a spray distance of up to 60 metres. It is able to sense low water levels in the tank and can automate refilling, including an auto shutoff feature to prevent overfilling. The system adjusts water flow based on truck speed, halts watering at low speeds to avoid road damage, and it includes safeguards that protect the truck's water pump from running dry, reducing the need for servicing.

Rapid mineralogical analysis

Elemission recently introduced its ECORE Gen3 laser-induced breakdown spectroscopy drill core scanner, which it stated is its fastest and most precise mineralogical analysis tool to date. With a 50 per cent faster processing speed than the company's previous model, users can receive results within minutes. The tool requires no sample preparation and it is designed to be easy to operate with minimal staffing. According to the company, the ECORE Gen3 tackles common challenges in mineral exploration, including delays in geochemical results—which it said can typically take weeks or months—limited access to high-resolution mineralogical data, and the difficulty of scaling traditional lab analyses across large drill programs. By delivering lab-grade analyses directly at the drill site, the company stated that the tool accelerates decision making, reduces reliance on off-site labs and scales microanalysis to the macro level for a better understanding of the ore body.



Courtesy of Elemission



Courtesy of Seequent

Streamlined data integration

Seequent recently launched Evo, a cloud-based geoscience data and computing platform designed to improve data management, collaboration and decision making in the mining and geoscience sectors. By consolidating data from Seequent and third-party applications into a central hub, Evo ensures teams can access, share and analyze information through a unified platform instead of having to search for data in vast, scattered datasets. Evo can connect and consolidate data from any source, allowing for cross-functional teams to make better-informed decisions and reduce inefficiencies.

Compiled by Ashley Fish-Robertson

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Developments

Courtesy of Rio Tinto

Uncut gem

Compiled by Silvia Pikal

On April 1, Rio Tinto announced that it had unearthed a massive yellow diamond from its Diavik mine in the Northwest Territories. Roughly 99 per cent of the diamonds mined there are white gems,

(continued on page 17)

A massive yellow diamond is a rare discovery at Rio Tinto's Diavik mine, as they make up less than one per cent of production at the mine.

making this diamond an extraordinary find. It is only the fifth yellow diamond with a weight of more than 100 carats that Rio Tinto has found at Diavik since the mine began operations in 2003. The egg-shaped rough diamond is one of the largest gem-quality yellow diamonds ever brought to the surface in Canada, at a whopping 158.20 carats. "This two-billion-year-old, natural Canadian diamond is a miracle of nature and testament to the skill and fortitude of all the men and women who work in Diavik's challenging sub-Arctic environment," said Matt Breen, chief operating officer of the Diavik diamond mine. Diavik will operate until 2026, when it is scheduled to enter closure. CIM

Nature forward

New ICMM guidance sets out how mining companies can contribute to building a nature-positive future at their sites

By Kelsey Rolfe

A new guidance document from ICMM aims to help mining companies restore and preserve biodiversity at their operations, with the ultimate goal of achieving biodiversity net gain, which means that the overall biodiversity at a mining site exceeds biodiversity losses.

The document, released on March 20, lays out a seven-step process for companies to determine the baseline of biodiversity at their operations, minimize the impact of their operations on nature, monitor key biodiversity indicators and report overall progress.

"Nature loss is really staring us in the face, and there's been so many really horrifying statistics about the decline of key species, the degradation of ecosystems. We just need to do this faster than [we have been]," said Hayley Zipp, director of ICMM's environment program, in an interview with *CIM Magazine*.

The guidance is meant to help ICMM's member companies achieve the commitments set out in the organization's position statement on nature, which was released in January 2024. The statement committed member companies to achieve no net biodiversity loss, or achieve net biodiversity gain, at their operations by 2030, relative to either a pre-operation baseline for new operations or a pre-expansion baseline for significant expansions of operations, or to a 2020 or earlier baseline for existing operations.

The statement also commits companies to work with suppliers and customers to protect nature across their value chains; work with stakeholders to restore, conserve and regenerate shared landscapes; and advocate for broader systems change, such as by supporting research and development, biodiversity data sharing or sustainable finance.

Courtesy of Teck Resources

A worker monitoring wildlife at Teck's Highland Valley Copper operations in B.C.

"Meaningful action really comes when you look at what can be done at the landscape level, and how you ratchet up that action through partnerships. We need innovation, we need each and every actor to be accountable, and we need collaboration amongst a number of different players within the landscapes that are critically in need of rehabilitation, restoration and protection," Zipp said. "That's why our members have made these commitments to nature that we see across the board."

Zipp said she hoped that the broader mining industry would use the guidance document and added that she sees it having applicability to other industries, such as oil and gas.

Mining operations often interact with areas of high biodiversity. An analysis by the Worldwide Fund for Nature–Norway, in collaboration with the Rainforest Foundation Norway—which used 2023 S&P Global data—found that 4.6 per cent of active mining projects globally have a "direct spatial relationship" with intact forest landscapes, 7.5 per cent have a direct spatial interaction with protected areas and around 6.2 per cent are associated with areas of global significance for biodiversity conservation. The ICMM guidance noted that those figures would be much higher if the analysis was expanded to include active mining concessions, as many of these do not advance to the development stage.

Sara Carlsén, the biodiversity coordinator for Swedish miner Boliden, told *CIM Magazine* that she saw ICMM's nature commitments as ambitious but achievable. Carlsén, who was involved in the development of the ICMM nature

position statement, said Boliden updated its own biodiversity and nature policy to align with the statement. Previously, the company had committed to having a net positive impact on biodiversity by 2030 at its direct operations; it has since set goals addressing the statement's value chain, landscape and systems change commitments.

"It's definitely going to be some work to get there, but it's not at all impossible," she said.

In an interview with *CIM Magazine*, Justina Ray, president and senior scientist at the Wildlife Conservation Society Canada, said both the guidance and nature position statement were positive, and in particular praised the guidance's acknowledgement that the industry has dependencies on biodiversity, such as access to clean water, and that protecting it is a business imperative.

However, she noted that achieving no net loss or net gain at the project level is dependent on many factors and players outside the company, especially the decisions of governments and other nearby landscape users.

"This kind of approach will have benefits for sure, but it's limited in its ability to manage cumulative impacts of a lot of development in the area that may come from actors that are not them, and not even (other) mining companies," she said, adding later that "those are not necessarily the responsibilities of individual companies. But in order to do the thing that this guidance wants to do, they're going to need other elements [such as government regulations] that incentivize various actors to row in the same direction."

The guidance document provides details on how to select an area of analysis to assess biodiversity risks and impacts, which it said can expand or change over the life of the operation. The geographic area should encompass the physical footprint of the mine operations and any areas that could be directly or indirectly affected by operations; nearby protected areas or internationally designated sites; and habitat ranges for species that intersect with the operation.

It also covers how to establish a biodiversity baseline. Zipp said that while there was plenty of existing guidance about establishing baselines for greenfield projects and expansions, ICMM needed to fill in the gap in knowledge around setting retrospective baselines for existing operations or acquired projects that lacked historical data. It suggests a combination of any existing project data, satellite and aerial imagery, consultations with experts and stakeholders, field surveys of adjacent or similar vegetation and habitat types, and scientific modelling.

"We need innovation, we need each and every actor to be accountable, and we need collaboration amongst a number of different players within the landscapes that are critically in need of rehabilitation, restoration and protection."

– Hayley Zipp, ICMM

Carlsén said Boliden has been relying on historical satellite imagery, drone photography and land and habitat quality surveys where available to establish its 2020 site baselines.

The guidance also digs into quantifying biodiversity losses and gains, something that Zipp said is a particular challenge for companies. "Nature is so local. When you've got a company with a number of mines in different jurisdictions, across different commodities, it's hard to set metrics that are easy to be rolled up to give a picture at the corporate level," she said.

It explains how to select site-specific biodiversity indicators, which act as proxies for broader ecosystem health and quality. These could include the condition, extent or fragmentation of an ecosystem that supports threatened species; ecological processes important to ecosystems, such as groundwater recharge; or the population size or number of breeding pairs to monitor nearby, migratory or congregatory species.

Lotus Raphael via Unsplash.com

#ICYMI

In case you missed it, here's some notable news since the last issue of *CIM Magazine*, which is just a sample of the news you'll find in our weekly recap emailed to our newsletter subscribers.

Increased political attention on Arctic sovereignty (pictured is Yellowknife, Northwest Territories), particularly following annexation threats from U.S. President Donald Trump, could present Agnico Eagle Mines with the chance to unlock new mining prospects in the region. The company has spent almost 20 years advocating for greater investment in Arctic infrastructure, which could drive significant growth for the miner, especially at its Hope Bay gold mine in Nunavut, where production was suspended in 2022 to prioritize exploration activities.

Trump has invoked emergency powers to increase U.S. production of critical minerals, in an effort to reduce reliance on foreign imports. An executive order signed on

It instructs companies to apply the mitigation hierarchy, which prioritizes avoidance measures to anticipate and prevent negative impacts on biodiversity, followed by mitigating the impacts that cannot be avoided, restoring degraded ecosystems, and finally, offsetting adverse impacts.

Ray said that the avoidance and mitigation steps have often been weakly implemented or skipped in the past, because they are "challenging to do, and you have to do them in a broader context." However, she noted that the more restoration and offsetting work a company has to pursue, "the more you're constrained in terms of your ability to have the outcomes you desire."

Zipp said avoidance actions are often hard to measure, because sensitive areas are usually identified during the environmental assessment process and ruled out immediately. "The area is avoided, but it's not documented," she said. ICMM wanted to make avoidance actions the "standard," she said, and was encouraging companies to explain how and why they were avoiding biodiversity impacts. CIM

Wesdome Gold Mines to acquire Angus Gold

Wesdome Gold Mines shared on April 7 that it plans to acquire junior exploration company Angus Gold in a cash-and-share transaction valued at around $40 million. The deal would expand Wesdome's land position at its Eagle River operation, located 50 kilometres west of Wawa, Ontario, by consolidating two adjacent properties, including Angus Gold's Golden Sky exploration project, into a roughly 400-square-kilometre land package within the Mishibishu Lake greenstone belt.

The Eagle River operation consists of the Eagle River underground gold mine and mill, which has been producing since 1995, and the Mishi open-pit gold mine, in production since 2002.

The deal must first be approved by a minimum of two-thirds of Angus Gold shareholders and also requires approval from the Ontario Superior Court of Justice. A meeting for shareholders to vote is expected to take place in June, with the transaction anticipated to close in the second quarter of this year. The value of Angus Gold shares rose 60 per cent upon the announcement.

The acquisition would enable Wesdome to capitalize on existing infrastructure at its Eagle River mine and mill to support exploration and potential development at the neighbouring Golden Sky project.

"On behalf of the board of directors of Angus Gold, we are excited to have reached an agreement with Wesdome," said Breanne Beh, president and chief executive officer (CEO) of Angus Gold, in an April 7 press release. "Since 2020, through a series of property acquisitions, we consolidated a district-scale land package, completed over 40,000 metres of drilling and made significant gold discoveries."

"Since 2020, Angus has invested over $20 million into exploration across the Golden Sky project, generating a pipeline of targets and confirming the geological continuity with Eagle River," said Anthea Bath, president and CEO of Wesdome, in

March 20 makes use of the country's Defense Production Act to provide financing and investing support for domestic mineral projects. The order aims to speed up permitting for projects, prioritize mineral production on federal land and address concerns over China's control of critical minerals, with the U.S. heavily reliant on imports. According to the U.S. Geological Survey in 2024, 12 minerals on the U.S.'s list of 50 critical minerals could be sourced only from other countries.

Canada's mining sector largely avoided new tariffs from Trump's latest executive order on April 2, which slapped 25 per cent tariffs on imports that do not comply with the Canada-U.S.-Mexico Agreement (CUSMA). Canadian companies must file paperwork to demonstrate CUSMA compliance. Energy products, potash and some critical minerals that are non-compliant will incur a 10 per cent tariff. However, steel and aluminum industries remain under pressure due to 25 per cent tariffs imposed on March 12. The copper sector also faces potential future tariffs.

On April 8, Trump signed several executive orders aimed at revitalizing the U.S. coal industry. The orders allow older coal-fired power plants to remain operational instead of being shut down. Additionally, Trump has instructed federal agencies to locate coal resources on federal lands, remove barriers to coal mining and also prioritize coal leasing on public lands. The president also signed a proclamation granting coal-fired power plants a two-year exemption from federal mandates that aim to reduce emissions.

A groundbreaking ceremony was held on March 25 to mark the start of construction on Alamos Gold's Lynn Lake gold project, which, once operational, would be Manitoba's first new mine to open in 15 years. The mine will span two sites and have a 27-year lifespan, creating over 600 jobs during construction and 450 during operation. Initial production at Lynn Lake is expected during the first half of 2028.

Defense Metals has filed a prefeasibility study, prepared by Hatch and SRK, for its wholly owned Wicheeda rare earth element deposit located around 80 kilometres northeast of Prince George, B.C. According to the company, the deposit contains high concentrations of neodymium and praseodymium—critical minerals used in wind turbines and electric vehicles that are in strong global demand.

British Columbia has introduced a new framework for mining claims consultation, which now requires companies to notify First Nations during the claim-staking phase. B.C. Assembly of First Nations regional chief Terry Teegee argued that the framework falls short of the collaborative approach detailed in the province's Indigenous rights law and warned that it could overwhelm First Nations offices and limit their influence over mineral permits.

Nova Scotia's Bill 6, which paves the way for lifting provincial bans on uranium mining and fracking, has passed its third and final reading at the legislature. Nova Scotia Premier Tim Houston's government sees this as a step towards financial self-sufficiency for the province amid trade tensions with the United States. However, the bill has faced considerable opposition, with concerns over insufficient consultation with Mi'kmaw chiefs and public pushback, especially regarding fracking.

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Stay up to date on the latest mining developments with our weekly news recap, where we catch you up on the most relevant and topical mining news from *CIM Magazine* and elsewhere you might have missed.

Courtesy of Wesdome Gold Mines

Last year, Wesdome's Eagle River operation in Ontario yielded 94,561 ounces of gold, surpassing its guidance range of 89,000 to 93,000 ounces.

the same press release. "Wesdome remains deeply confident in the prospectivity of the Eagle River camp and the broader potential of our ongoing fill-the-mill strategy. This transaction represents a strategic investment in that vision and underscores our long-term commitment to unlocking value at Eagle River."

Wesdome hopes to eventually bring the Golden Sky project into production, highlighting the project's proximity to its existing infrastructure at the Eagle River operation.

This transaction is also noteworthy in that it is a deal between two Canadian mining companies both led by women CEOs. **– Ashley Fish-Robertson**

From the wire

Compiled by Ashley Fish-Robertson

Rebecca Hudson has stepped down as chief financial officer (CFO) of **EV Minerals Corporation** on Feb. 28, after having served in the role since July 2023. She is also the CFO of Andean Drilling Services. **Alex Pekurarhas** has succeeded her at EV Minerals, bringing with him more than 13 years of leadership experience in both private and public companies.

Mason Resources has welcomed **Gregory Duras** to the company as CFO, succeeding **Carmelo Marelli**. Duras has amassed over 30 years of leadership experience in senior financial management roles and has worked for several publicly traded companies, such as Savary Gold Corp., Nordic Gold Corp. and Avion Gold Corp. He previously served as CFO for Emerita Resources and IsoEnergy.

The return of *Penelope the Miner*

Two decades after its original release, Burlington, Ontario-based author Lenna Rhodes is ready to inspire a new generation of young readers to explore the world of mining with her self-published children's book *Penelope the Miner*. Illustrated by Gayle Shkrabek and edited by Peter J. Cashin, the book—targeted at readers aged six to 10—seeks to inspire young minds to explore the world of mining in a fun and imaginative way, while also encouraging girls to pursue careers in mining.

"I wanted to not just represent women in mining, but I also wanted boys to like the book, too," Rhodes said in an interview with *CIM Magazine*. "I also wanted to teach [local readers] to have pride in their mining heritage—to have pride in what is going on in their immediate world."

The plot follows Penelope, a young girl growing up in The Land of The Biggest Nickel (inspired by Sudbury, Ontario), whose mother's dreams for her career are limited to a ballet dancer, a beauty queen or a model. Penelope, however, is drawn to hard hats, safety glasses and books about mining.

Influenced by her father, a geologist, Penelope is motivated to pursue her dreams of one day working in the mining industry. She reminds those around her, including her mother, that mining is crucial for producing the materials needed to make phones and computers—technology the world depends on daily, yet is often taken for granted without considering how it is made. The book also features an educational section titled *Digging Deeper*, offering insights into working in the mining industry and the importance of mining and minerals in daily life.

Rhodes was invited to this year's PDAC conference, held in Toronto from March 2 to 5, to relaunch her book. She reprinted 250 copies and donated a portion of all book sales to Mining Matters, an organization based in Toronto dedicated to educating young people about earth sciences, the minerals industry and the importance of minerals to our society.

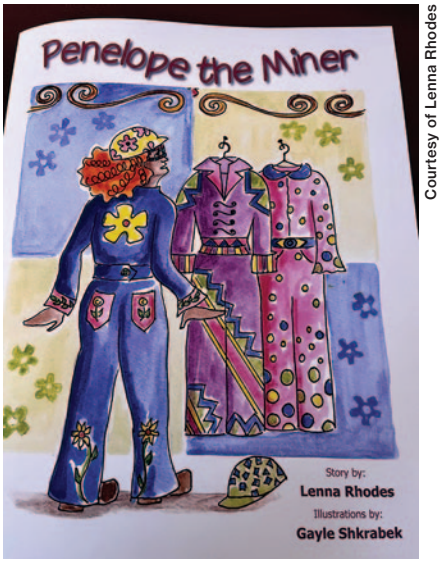
Sparking interest in mining

While working as a full-time kindergarten teacher in Sudbury, Rhodes wrote and published her first book made for kindergarten students, *Inside a Geologist's Bag*, in 2003. The book was inspired by both her husband, a geologist, and her observations over several years of teaching, where she noticed that despite having books about rocks and minerals available, her students were not engaging with the material. This led her to recognize a gap in children's literature on mining and geology, especially books that "mixed magic with the facts."

Shortly after releasing *Inside a Geologist's Bag*, Rhodes was approached by the Sudbury Mining Week committee (now known as Modern Mining & Technology Sudbury), which asked if she would be interested in taking on the role of mining and education teacher-representative for the Rainbow District School Board of Northern Ontario, where she would be tasked with promoting mining education in line with provincial curriculum guidelines.

The committee also asked Rhodes if she would be interested in writing a new book focused on mining, this time aimed at older children. Rhodes eagerly accepted the offer, particularly after discovering that, despite Sudbury's rich mining heritage and how many children had grandparents who worked in the industry, there was a surprising lack of knowledge and interest in mining among local kids.

When *Penelope the Miner* was released in 2004, Rhodes said that the



Courtesy of Lenna Rhodes

According to author Lenna Rhodes, her book *Penelope the Miner* not only introduces young readers to the daily tasks of mine workers but also promotes the idea that women can thrive in a mining-related career.

CIM Sudbury Branch and the Northern Ontario Heritage Fund Corporation collectively purchased 5,000 copies to hand out at schools associated with the Rainbow District School Board.

When Rhodes and her husband moved to Burlington in 2005, and she took a substitute teaching position with Notre Dame Catholic Secondary School, the book's influence spread. She read the book to various classes, where she noted that students were now asking questions about mining.

"[This book] opened up a conversation, and I realized that even though this is for young children, the older children were still interested, which blew me away," said Rhodes.

Determined to inspire the next generation of miners, she brought the book back into print this year. To promote it, Rhodes has been actively participating in community events, including live reading sessions held in libraries and other venues. She has also created various props to further engage young readers, including bejewelled hard hats, dolls dressed as mining professionals and more. Rhodes is now planning to write a third children's book, noting that it will be another "mining-based story."

Penelope the Miner can be ordered via email at lenna.mc.rhodes@gmail.com.

– Ashley Fish-Robertson

China introduces export restrictions on some rare earths

In response to U.S. President Donald Trump's recent tariffs, China imposed export restrictions on rare earth elements (REEs) on April 4, impacting all countries. This move has left U.S.-based manufacturers racing to secure fresh supplies of REEs, which are in high demand.

After multiple tariff escalations between the U.S. and China, the Trump administration shared on April 9 that it would impose 125 per cent tariffs on Chinese imports, hours after China imposed 84 per cent tariffs on U.S. imports, along with the restrictions on REEs. The Trump administration further increased the tariffs on Chinese goods on April 10, bringing the total to 145 per cent. The following day, China raised its tariffs on U.S. imports to 125 per cent.

China, which accounts for 70 per cent of the world's mined production of REEs and 87 per cent of global refined REE production, has placed controls on seven categories of rare earths, including samarium, gadolinium, terbium, dysprosium, lutetium, scandium and yttrium-related items. The restrictions include mined minerals, permanent magnets and other finished products.

The move comes several months after China introduced an export ban on antimony, gallium and germanium to the U.S. in December 2024. According to *Reuters*, while the U.S. government has access to stockpiles of several REEs, they are insufficient to meet the long-term needs of its defence contractors.

For several of the REEs impacted by these new restrictions, the U.S. has possible alternative sources available, with Canada standing out as a key supplier. According to Natural Resources Canada, while the country is not yet a commercial producer of REEs, it is home to several

Courtesy of Rio Tinto Fer et Titane

Scandium, one of the seven rare earth elements (REEs) affected by China's recent export restrictions, is among the REEs that Canada has the capacity to produce domestically. In 2022, Rio Tinto announced the successful production of its first batch of high-purity scandium oxide at its commercial scale demonstration plant in Sorel-Tracy, Quebec.

advanced exploration projects, some of which are targeting the production of samarium, scandium, terbium and dysprosium.

Canada holds some of the world's largest measured and indicated reserves and resources of REEs, estimated at over 15.2 million tonnes of rare earth oxide in 2023. Given these significant reserves and resources, Canada is well-positioned to potentially become a key supplier of these materials.

For example, Rio Tinto Fer et Titane produces some scandium at its titanium plant in Sorel-Tracy, Quebec. Although the site currently operates as a commercial demonstration plant and has yet to scale up production, the company estimated that, once operating at full capacity, it could produce up to three tonnes of scandium oxide annually, representing approximately 20 per cent of the global market.

Aside from Rio Tinto's demonstration plant, Canada hosts a handful of early-stage rare earths projects. Geomega Resources is in the process of developing a rare earth recycling demonstration plant, located in Saint-Bruno-de-Montarville, Quebec, which will produce several REEs from magnet waste, including dysprosium and terbium. Additionally, the Saskatchewan Research Council's (SRC) rare earth processing facility in Saskatoon has the ability to process samarium and neodymium. The SRC is currently the first and only facility in North America to produce REEs at a commercial scale.

Some junior mining companies are also working to advance several REE projects across Canada, though the majority face long development timelines—often spanning several years—due to the need to demonstrate economic viability, secure offtake agreements and raise capital.

One such company, Montreal-based Torngat Metals Ltd., is developing the Strange Lake project in the remote Nunavik region of northern Quebec. The site hosts deposits of dysprosium and terbium, with the company planning to complete prefeasibility and feasibility studies by year-end.

– Ashley Fish-Robertson

Federal approval waived for major infrastructure, mining projects

On March 21, shortly after his First Ministers' meeting with Canada's premiers in Ottawa, Prime Minister Mark Carney announced several initiatives aimed at bolstering Canada's economy and reducing interprovincial trade barriers. Among these measures is a policy to allow major mining and infrastructure projects to move forward with approval from provinces and territories alone, eliminating the need for duplicative federal approval.

"So, one project, one review, and we will work with the provinces and other stakeholders, Indigenous groups, to identify projects of national significance and accelerate the timeframe to build," Carney said during a news conference on March 21.

With Carney's call for an early federal election on April 28 (which at the time of print had not happened yet), Conservative leader Pierre Poilievre has been ramping up his campaign, including a March 19 visit to Sudbury, Ontario, to announce his plan to accelerate the development of the Ring of Fire region within six months if elected. However, the environmental assessment for the Northern Road Link, which would connect the Ring of Fire region to Ontario's highway network, is not expected to be completed until 2026, conflicting with Poilievre's promise of a six-month timeline.

On January 28, the Ontario government pledged over $90 million to upgrade vital infrastructure in northern Ontario, supporting mining in the Ring of Fire region and connecting First Nations communities to major highways.

The Prime Minister's announcement of a "one review" permitting system was accompanied by several other measures aimed at further unlocking domestic economic projects. The federal government has agreed to commit up to $200 million for the construction, commissioning and operation of the Cedar LNG project, a proposed Indigenous-led liquefied natural gas export facility that would be located near Kitimat, B.C. The project, a partnership between the Haisla Nation and Pembina Pipeline Corp., is estimated to cost around $5.8 billion to construct. The project has secured all necessary regulatory approvals, with early construction work already under way and operations expected to begin in late 2028.

Looking ahead, Carney highlighted several projects that could benefit from an expedited review process, such as the Grays Bay Road and Port project in western Nunavut—designed to link the Slave Geological Province of Nunavut and the Northwest Territories, which is rich in mineral deposits, to a deepwater port via an all-season road—and the development of the Ring of Fire region in northwestern Ontario.

The federal government will also invest $175 million in the Hudson Bay Railway and Port of Churchill to open new transportation corridors, drive economic growth and reconciliation in the

> **"One project, one review, and we will work with the provinces and other stakeholders, Indigenous groups, to identify projects of national significance and accelerate the timeframe to build."**
>
> - Prime Minister Mark Carney

Courtesy of Cedar LNG

Ahead of an early federal election, Prime Minister Mark Carney unveiled a series of measures to strengthen Canada's economy amid trade challenges. The Cedar LNG project (rendering pictured above), a proposed Indigenous-led liquefied natural gas export facility in B.C., will receive federal funding to move forward.

Arctic and Far North and enhance access to global markets for Canadian products. This funding follows the Manitoba government's February commitment of $36.4 million over two years to the Arctic Gateway Group for supporting infrastructure projects at the port.

On April 9, during an election campaign stop in Calgary, Carney announced further details of the one project, one review process, stating that he would establish a Major Federal Project Office, responsible for making decisions on major projects within two years. Carney also shared plans to expand the critical minerals exploration tax credit to include costs for technical studies and to modify the clean manufacturing tax credit to support brownfield site development.

– Ashley Fish-Robertson

Canadian company seeks U.S. approval for seabed mining

Vancouver-headquartered The Metals Company (TMC), which is focused on deep-sea minerals exploration, is seeking approval from the U.S. government to extract critical minerals from the ocean floor in international waters managed by the United Nations' (UN) International Seabed Authority (ISA). This move could enable TMC to bypass the ISA, which has yet to grant exploitation permits due to the absence of a deep-sea mining code. The UN-affiliated agency has been working to finalize a mining code for years.

TMC currently holds two ISA licences to prospect for cobalt, nickel and other metals found in polymetallic nodules scattered across the ocean floor in the Clarion-Clipperton Zone, a 4.5-million-square-kilometre area of the Pacific Ocean that is located between Hawaii and Mexico. For more than a decade, TMC has been exploring the Clarion-Clipperton Zone but will need a licence to begin mining in the area.

Under the Deep Seabed Hard Mineral Resources Act (DSHMRA) of 1980, U.S. entities can explore and recover deep-sea minerals in international waters, which could provide TMC with a regulatory path forward to begin mining. In a statement issued by TMC on March 27, the company shared that under its U.S. subsidiary, it had formally launched a process with the National Oceanic and Atmospheric Administration (NOAA) under the U.S.

Courtesy of the U.S. National Oceanic and Atmospheric Administration

There are vast deposits of polymetallic nodules, rich in manganese, nickel, copper and cobalt, in the deep abyssal plains of oceans that could serve as a potential resource for critical minerals extraction.

Department of Commerce to apply for exploration licences and commercial recovery permits for deep-sea mining under DSHMRA.

TMC stated that following extensive legal diligence on DSHMRA, NOAA's implementing regulations and other applicable environmental protection legislation, it "strongly believes that the U.S. seabed mining code offers the greatest probability of securing a permit for commercial recovery of deep-sea mineral resources in a timely manner."

Reuters reported on March 31 that, according to sources with knowledge of the matter, the Trump administration is considering an executive order to fast-track deep-sea mining in international waters, which would allow companies to bypass the UN-backed review process. The order would likely declare the United States' right to extract critical minerals from the ocean floor, allowing companies to apply for permits directly with the NOAA. This development comes shortly after U.S. President Donald Trump invoked emergency powers under the country's Defense Production Act on March 20 to increase domestic production of critical minerals.

TMC plans to extract polymetallic nodules, which contain cobalt, nickel, copper and manganese, from the ocean floor, which the company said could then be processed with minimal waste. The company, originally founded as DeepGreen Metals in 2011, seeks to use the minerals extracted from the nodules.

"We believe we have sufficient knowledge to get started and prove we can manage environmental risks," said Gerard Barron, chairman and chief executive officer of TMC, in the March 27 statement. "What we need is a regulator with a robust regulatory regime, and who is willing to give our application a fair hearing. After extensive legal review and constructive engagement with NOAA and other officials across the U.S. government, we believe the United States offers a stable, transparent and enforceable regulatory path." Barron added that the company anticipates it will submit applications to NOAA in the second quarter of 2025.

Although the ISA has already developed regulations for prospecting and exploring for three types of deep-sea minerals—polymetallic nodules, polymetallic sulfides and cobalt-rich ferromanganese crusts—it has spent several years working on a mining code specifically for the industrial extraction of polymetallic nodules.

In 2021, the island nation of Nauru, a member state sponsoring TMC, triggered a two-year rule in the UN Convention on the Law of the Sea (UNCLOS) by applying for the approval of a plan of work for exploitation of seabed minerals in the Clarion-Clipperton Zone. This provision meant that the ISA had to either expedite the development of the mining code or allow deep-sea mining to proceed without a formal mining code in place. Under the ISA framework, all mining contractors are required to be sponsored by an ISA member state to be granted an exploitation licence.

An ISA council and assembly meeting was held in Kingston, Jamaica, in July 2024 with the intent of finalizing global regulations for seabed mining by 2025. The ISA recently convened in Kingston on March 17 to 28 for a council meeting, under the leadership of Leticia Carvalho, its newly appointed secretary general. While progress was made during the first part of its 30th session on March 28, the code has not yet been finalized. The council completed a reading of the draft exploitation regulations.

A March 28 press release from the ISA noted that some key issues still require further discussion, such as the approval process and the pace of regulatory adoption. The release stated that Carvalho expressed deep concern at the council meeting about TMC's plan to bypass the ISA to commence mining, emphasizing that the ISA holds exclusive jurisdiction over all activities in the international seabed area, which the ISA calls the "common heritage of humankind." She stressed that any unilateral actions outside the ISA's framework violate international law and weaken multilateral governance.

According to the press release, Carvalho's comments received strong support from numerous delegations, many of whom harboured similar concerns about TMC's plans. Going forward, member states will continue to submit proposals to refine the remaining draft regulations, annexes and related documents. Discussions on standards and guidelines have begun, with further talks planned for the summer.

The ISA has 169 member countries and the European Union, but the U.S. is not a member and has not ratified the UNCLOS, the treaty that created the ISA. This treaty designated certain areas for mining, including specific reserved areas located within the Clarion-Clipperton Zone, for the U.S. in the event that it eventually joins the convention.

– Ashley Fish-Robertson

Taurus Gold shared that **Robert Sim** has stepped into the role of interim chief executive officer (CEO) following the departure of **Frank Lagiglia**, who has been with the company since September 2023. Sim brings with him experience in resource development, retail and real estate development.

Frederic Mercier-Langevin has joined **Patriot Battery Metals** as its chief development and operating officer, where he will lead the ongoing assessment and development opportunities for its flagship lithium project in the Eeyou Istchee James Bay region of Quebec. Mercier-Langevin is a mining engineer with more than 20 years' experience in open-pit and underground mining and has held senior and executive positions respectively with Agnico Eagle Mines and Wesdome Gold Mines. His experience in commissioning, operations and development will help support the next stages of the lithium project, which includes finalizing both a feasibility study and an environmental and social impact assessment.

Daryn Gordon is the new CFO of **Hi-View Resources**, replacing **Steve Mathiesen**, who will stay on as a consultant for the company. Gordon is a chartered professional accountant and has previously held CFO roles with various publicly traded mining companies.

Centerra Gold has appointed **David Hendriks** as its new executive vice-president (VP) and chief operating officer. Hendriks has over 30 years of experience in the mining industry, which includes previous leadership roles with Calibre Mining and Kinross Gold. Hendriks succeeded **Paul Chawrun**, who has been with Centerra Gold since 2022. The company acknowledged Chawrun's contributions during his time with the company, highlighting his leadership in implementing a site optimization program at the Mount Milligan open-pit copper and gold mine in central B.C.

David Brett has stepped down as CEO of **EnGold Mines** after more than a decade with the company but will remain on the board of directors. **John Brown**, chairman of the board and director of the company, will take over the CEO role on an interim basis.

Courtesy of Chris Robert via Unsplash

Canada and the U.S. have long shared a robust trade partnership—but tariffs introduced by the U.S. in recent months have tested that bond, with direct consequences for Canadian exporters.

Bracing for impact

Canadian mining exporters are exploring strategies to minimize the strain of U.S. tariffs

By Ashley Fish-Robertson

Following U.S. President Donald Trump's imposition of 25 per cent tariffs on steel and aluminum imports from Canada and other trading partners, which came into effect on March 12, the Canadian mining industry has been grappling with supply chain disruptions and rising costs for certain materials. In response to the tariffs, Canada unveiled a list of U.S. goods on March 4 worth $30 billion that would be subject to 25 per cent retaliatory tariffs, which affect mining machinery and parts.

While Canada has not been subject to the Trump administration's recent 10 per cent universal tariffs, effective April 9, the original 25 per cent tariffs on steel and aluminum remain in place, along with a 25 per cent tariff on goods that do not comply with the Canada-U.S.-Mexico (CUSMA) Agreement.

B.C. suppliers seek tariff relief

Members of the Mine Suppliers Association of British Columbia (MSABC) have been feeling the effects of both U.S. tariffs and Canadian countermeasures, which include rising product costs and delayed purchasing decisions driven by ongoing uncertainty. Alec Morrison, MSABC president and chief executive officer, explained that members are pursuing relief through federal tariff remission processes and exploring alternatives to U.S. sources of inputs and products whenever possible. They are also highlighting the challenges of finding non-U.S. alternatives to products that meet North American safety standards.

With mining machinery and parts included on the list of Canadian countermeasures, Morrison noted that products such as specialized bulldozers, trucks, attachments and parts being used in the B.C. mining industry either do not have equivalent non-U.S. alternatives, or if they do, incorporating those alternatives cannot be done in a way that is economically feasible. To avoid steep cost increases if new tariffs are applied, suppliers and mine operators would need to seek exemptions or tariff remissions for these products.

Morrison highlighted that giant mining tires are one of the products most significantly impacted. "For these specialized and costly tires, U.S. manufacturers' factories are equipped with unique machinery designed specifically for the needs of B.C. and Canadian mines," he wrote in an email to *CIM Magazine*. "Retooling non-U.S. factories to meet Canada's demand would require substantial investment and could take years to complete. If remissions are not granted for these specialized products, B.C. suppliers and mines will face a steep rise in tire costs." He added that tires are among the top operating expenses for mining operations.

MSABC is working closely with the Mining Association of BC and other partners to ensure that the concerns of B.C. mining suppliers, contractors and

service providers are heard by provincial and federal governments.

Morrison noted that while the Canadian government must respond to U.S. tariffs imposed on Canadian exports to the U.S., that response should be targeted in a way that also supports Canadian businesses.

"We support ongoing efforts to mitigate tariff impacts through important programs such as the Government of Canada's remission process, duties relief program and duty drawback program," Morrison wrote. "These programs must be resourced properly to provide timely responses to time-sensitive requests for tariff remission and other support. While these programs are essential, in some circumstances the better approach may be to remove items with limited or no regionally available non-U.S. alternatives from the Canadian tariff countermeasure list altogether."

Morrison added that MSABC members would also like governments to consider all options to support and promote B.C. and Canadian businesses, such as reducing interprovincial trade barriers, and targeted measures to promote B.C. companies. Morrison cited Australia's METS Ignited program, which was designed to enhance awareness of, and commercialization within, the Australian mining equipment, technology and services sector, as a potential model to consider.

Impacts on mining equipment supply

In an email to *CIM Magazine*, Cheryl Gray, vice-president (VP) of mining for Finning Canada, which specializes in Caterpillar products, parts and services, explained that Caterpillar products can only be sourced from the U.S. from highly specialized production facilities. Despite this, the company is confident in its ability to navigate tariff-related challenges and continue supporting its customers.

"Right now, Finning is focused on continuing to understand the impact of these tariffs on our operations and our customers," Gray wrote. The company was actively involved in the government's consultation process regarding the proposed countermeasures in response to U.S. tariffs on Canadian goods.

Finning is strongly urging the federal government to exclude heavy equipment and parts essential to the mining industry from the tariff countermeasures and is encouraging its industry partners to take similar action.

Support for Canadian exporters affected by tariffs

Todd Winterhalt, senior VP of international markets at Export Development Canada (EDC), a crown corporation that supports Canadian companies, including mineral exploration and junior and major miners in the global marketplace, said in an interview with *CIM Magazine* that EDC launched the Trade Impact Program on March 7 to support Canadian exporters and their suppliers currently impacted by market uncertainty.

The program offers a total of $5 billion in financing and insurance solutions, including loans, guarantees, and working capital, over a period of two years. The program seeks to help Canadian businesses manage challenges like supply chain disruptions and currency risks, while also enabling global expansion. The amount of support provided to each company will depend on the specific case, including factors such as product type and individual needs.

Key concerns EDC has been hearing from its clients include payment uncertainty for cross-border shipments and supply chain disruptions. Winterhalt explained that, out of clients in its exporter base, raw material producers with existing contracts in the U.S. have faced issues where their exports were recently repudiated at the U.S.-Canada border and not received by customers.

Winterhalt noted that the size of a company greatly influences how it responds to tariffs. "Some of our larger customers are saying, I can probably tough this out for four or six, maybe even eight months, absorb some of the impact, and hope that things get a little bit more stable," said Winterhalt. "Obviously, on the smaller end, it's a lot harder. That's measured sometimes in weeks, sometimes even in days, in terms of how much runway some of those smaller companies have with the uncertainty." CIM

Northisle Copper and Gold has announced the appointment of **Pablo Mejia Herrera** as its new VP of exploration. He succeeded **Robin Tolbert**, who has transitioned into a newly created position as chief geoscientist, and will work with Mejia Herrera and the rest of the exploration team to support the company's ongoing exploration activities at its North Island copper-gold project, located near Port Hardy, B.C. Mejia Herrera is a geoscientist with a focus on copper, gold and nickel, and brings more than 20 years of experience in mineral exploration to the role. He previously held the role of VP of exploration at Ero Copper Corp., where he oversaw both greenfield and brownfield programs in Brazil that led to several significant discoveries.

Geoffrey Chinn has joined **NorthWest Copper** as VP of business development and exploration. Chinn has amassed nearly 35 years of mining industry experience. Prior to this new role, he worked as director of corporate development for Iamgold, where he played a key role in identifying and initiating the early evaluation of the Côté Gold project in northeastern Ontario, overseeing the project's preliminary economic assessment and prefeasibility study.

Ehsan Salmabadi has resigned from the role of VP of exploration for **Stuhini**, with **Dave Nuttal** assuming Salmabadi's responsibilities as senior geologist. Nuttal is currently the president of Geo Exploration and has previously served as VP of exploration at Serac Exploration and was also chief geologist at Scottie Resources.

Courtesy of Matthew Hallett

Modular construction in the mining industry

By Matthew Hallett

Modular construction might not be new for the mining industry, but there is an uptick in the number of projects considering some form of modular construction with the hopes of shaving precious months, weeks or even days off the schedule.

So why the sudden increase in popularity in modular construction and is it the right approach for every project? Most would agree that some form of modularization could benefit a project, but before jumping onto the modular construction bandwagon, it's a good idea to look closer at the extra costs to see if saving some time is worth the financial risk.

So, what is modular construction? The Construction Industry Institute, which has plenty of resources to help facilitate modular construction to improve project performance, defines it as a major section of a plant resulting from a series of remote assembly operations and may include portions of many systems; usually the largest transportable unit or component of a facility.

Modular construction offers plenty of benefits, including better quality, safer construction with less work being completed on a congested construction site and, most importantly, an opportunity to compress an already demanding schedule. But modular construction is not a one-size-fits-all solution. Applications of modular construction vary depending on the industry, the system and project-specific constraints.

One application of modular construction gaining popularity in the mining industry lately is the installation of loading pockets at the bottom of mine shafts, where typically all work in the shaft is determined to be on the critical path. In this application, the loading pocket structure is divided into several large, preassembled steel modules that are then lowered down, sometimes a thousand-plus metres, to shaft bottom and assembled into a complete structural system. The total weight of loading pocket structures may range from 300 tonnes to 1,000 tonnes. Average-sized modules typically weigh between five and 15 tonnes, but some modules could weigh 50 tonnes or more. The benefit is clearly to save time by completing as much work as possible on the surface rather than the time-consuming process of sending bundles of loose steel underground to erect or "stick-build" at the shaft bottom, where space is limited and where the underground work environment presents a unique set of hazards.

Some of the additional costs associated with modularizing a loading pocket include the following:

Increased planning and coordination. Large-scale mining projects involve many key stakeholders who are responsible for delivering their work on time to ensure there are no delays that could jeopardize the start of installation. The installation sequence of the modules is carefully studied to prevent any possible interferences. Special long lead items are identified and procured from vendors.

Module design and engineering. Starting with defining the modules early in the design phase, each module is structurally evaluated and designed to meet minimum safety factor requirements for handling and suspending modules in the mine shaft. Module connections are evaluated to ensure ease of fit-up with previously installed modules, requiring early contractor engagement.

Specialized equipment design and engineering. Lowering large modules down a mine shaft often requires customized shaft conveyances and cranes for handling and positioning modules designed by a specialized engineering team familiar with shaft work. Other equipment designed and fabricated to meet the installation requirements include custom spreader frames, special rigging components, access platforms and ladders and temporary support structures. By contrast, stick-build steel is typically planned and installed by tradespeople requiring minimal engineering support and standard rigging.

Understanding the cost savings potential when attempting to shorten the construction schedule and the additional costs associated with modular construction is key to making informed decisions that will benefit the overall project.

Engineered lift plans. The handling of each module is evaluated in each critical position, considering the mass, location of the centre of gravity and location of module lift points, until the module reaches its final position near the bottom of the shaft. Often several lift plans are required for each module to safely load and transport to site, unload at site and store, then lift and lower the module into final position.

Trial lifts and preassembly. Trial lifts are completed on critical modules to verify the location of the centre of gravity and to check plumbness. Preassembling on surface may be required prior to installation to avoid fit-up issues in an effort to de-risk the project.

Shipping oversized loads. Modules assembled at the fabricator's shop are sometimes shipped long distances to a remote site often requiring a logistics study, escorts, special permits and insurance, and longer travel distances due to route restrictions.

Fast-tracking fabrication. More fabrication resources may be required to meet the project requirements of trial lifts, preassembly and a demanding schedule for rapid installation. This sometimes requires engaging more fabrication shops to ensure the modules arrive on the scheduled installation date or risk a costly delay that could quickly evaporate any potential cost savings.

Now that we have looked at some of the additional costs associated with modularizing a loading pocket, let's consider the benefits. In the mining industry, the biggest benefit is typically saving time. Modular construction is considered on most projects

because it provides the opportunity to complete work concurrently, off the schedule's critical path. However, to properly evaluate if modular construction offers an overall benefit to the project, it is important to accurately estimate the benefits of compressing the schedule in terms of potential overall project cost savings.

This can be done by evaluating the net present value (NPV) of the project based on two different scenarios. The first scenario, to stick-build the loading pocket as originally scheduled and then start production mining. The second scenario, to incur the additional modularization costs and complete construction earlier, saving on indirect construction costs, and start production mining sooner, possibly improving the NPV of the project with earlier positive cash flows.

Understanding the cost savings potential when attempting to shorten the construction schedule and the additional costs associated with modular construction is key to making informed decisions that will benefit the overall project. Because most of the cost savings benefits are directly tied to the schedule, delays pose the biggest financial risk with modular construction, making it a balancing act between risk and reward. CIM

Matthew Hallett, P.Eng., is a specialist engineer civil/structural at Cementation Canada Inc.

Courtesy of Davide Elmo

Beyond blaming red tape

By Davide Elmo

While our industry often points to bureaucratic processes as the primary obstacle to mine development, we must acknowledge a more fundamental truth: our approach from mineral discovery to operational mine requires transformation if we hope to streamline the permitting process. Permitting processes, environmental assessments and regulatory requirements are not impediments to progress. They could be—and should be—opportunities to improve the exploration-to-operation timeline and for the mining industry to look inward. The "red tape" narrative conveniently obscures an uncomfortable reality: many of our design methodologies remain anchored in an era when environmental considerations were secondary and societal expectations were vastly different from today's.

Reimagining mining education

Addressing this problem requires the combined efforts of universities, professional bodies and regulatory authorities. For example, it serves little purpose for university programs to introduce innovative design concepts when both industry practices and regulatory permitting frameworks remain fixated on using empirical methodologies that were developed in the 1960s and 1970s, such as the rock mass rating system. Conversely, modernized practice and permit guidelines require university programs to adopt more rational and innovative content. Every mine is a complex interdisciplinary system. The mining industry needs to pay more attention to identifying the cause-and-effect relationships that govern each mine independently, rather than relying on established beliefs and applying those to new projects.

Engineering practices due for modernization

Contemporary mining demands more than technical proficiency—it requires a holistic approach integrating cutting-edge technologies, environmental stewardship and community engagement. Yet our professional practices often resist meaningful transformation.

Consider geotechnical engineering, where we employ sophisticated numerical models while relying on input methodologies that remain largely empirical and qualitative. Our field is shaped by cognitive biases that often dismiss outliers rather than question whether our established beliefs fully apply to specific scenarios. This creates a self-reinforcing cycle where preferential attachment to traditional methods prevents innovation and adaptation.

When regulatory questions arise, this rigid adherence to conventional approaches does not merely slow the process, but it can halt progress entirely. Permitting delays frequently stem not from bureaucratic roadblocks but from our reluctance to reconsider established practices. We should view regulatory inquiries not as obstacles but as opportunities to improve communication and refine our approaches.

To address the challenge of regulatory delays in mining projects, it is essential to implement a collaborative technical review framework that involves rightsholders, such as Indigenous communities, from the outset. Mining projects must begin with early-stage collaboration that includes technical experts from mining companies and technical experts appointed by rightsholders. The objective is to capture diverse perspectives before design plans become finalized and difficult to modify. This collaboration must continue throughout the entire mine life cycle, including closure and reclamation. Early-stage collaboration offers the opportunity to reduce—if not eliminate—lengthy legal challenges. Taking extreme positions on either side of the spectrum (pro-mining or anti-mining) impacts constructive dialogue between differing viewpoints. It removes space for compromise and practical implementation strategies that might otherwise be dismissed by those holding more rigid positions.

From a technical perspective, I suggest companies utilize advanced modelling and scenario analysis to demonstrate how alternative designs might perform better environmentally over the mine's life cycle. Similarly, they could develop comparative risk assessments that quantify the benefits of new approaches against conventional methods.

The technology we have available today—advanced geospatial imaging, machine learning and sophisticated numerical modelling—offers unprecedented potential to minimize environmental impacts while enhancing operational efficiency. These tools allow us to simulate long-term outcomes, anticipate environmental changes and design operations with multi-decade integrity. However, their effective implementation requires more than adopting new hardware; it demands transforming the core philosophy of mining engineering.

Most methods in rock engineering design were developed when minimizing a mine's footprint was not a priority. Traditional geotechnical approaches treat mine closure as the final phase rather than an integral consideration of stability design. This perspective fails to recognize that mining represents a temporary land use alteration that must ultimately return to its rightful owner. By integrating reclamation planning from the exploration phase, we could prioritize extraction methods that minimize waste and protect water resources and ecosystems.

Transparency as a competitive advantage

Critical innovation cannot thrive in an environment lacking transparency. Similarly, developing approaches that balance resource extraction with environmental and social responsibilities will fail if our industry does not embrace information sharing. When we cite confidential or inaccessible reports in permitting documents, we ask regulators and communities to trust rather than to verify our claims. This position of unverified trust inevitably prolongs scrutiny.

Trust develops through transparency and reproducibility, not through assertions based on hidden evidence. The practice of basing engineering standards on claims without proper

scrutiny creates precarious foundations for mining projects. Our industry must accept that confidentiality agreements should not extend to technical documents crucial to mine applications and rightsholders' interests.

Indeed, the principle of informed consent requires complete transparency about every element of a proposed project or activity, with information presented in a manner that is accessible to those whose consent is being sought. Regulatory permitting frameworks should be amended to require mining companies to share all relevant technical information at the time of submitting a permit application rather than only upon request during the review stage. This should not be viewed as an additional burden but rather as an opportunity to avoid lengthy review processes, as technical reviewers may find that their questions are already addressed in documents that, in the current permit framework, would otherwise be listed as confidential reports.

The path forward

The most direct route to mine approval is not through regulatory shortcuts but through industry transformation that demonstrates clear societal benefits. By adopting more holistic design approaches, embracing transparency and modernizing our engineering practices, we can build the trust and efficiency needed to accelerate the permitting process. The mining industry stands at a crossroads. We can continue attributing delays to external factors or lead a transformation that addresses the legitimate concerns behind regulatory processes. The choice is clear: innovation offers not just a path to quicker approvals but also a more sustainable and respected mining sector for generations to come. CIM

Davide Elmo is a professor of rock engineering at the Norman B. Keevil Institute of Mining Engineering, University of British Columbia

Send comments to editor@cim.org

Courtesy of Tersa

Elesha Hoffarth, research and development manager at Tersa, built the synthetic biology program at the company.

Reconciliation through remediation

In B.C., a partnership between a technology start-up and the business arm of Wet'suwet'en First Nation is building trust while investigating a new way to treat mine tailings

By Sarah St-Pierre

The Equity Silver mine, in the backyard of the Wet'suwet'en First Nation in northwestern B.C., stopped producing in 1996. Since then, it has been under care and maintenance for acid rock drainage. The mine was formerly operated by Equity Silver Mines Limited and Goldcorp Inc., until Goldcorp was acquired by Newmont in 2019.

"This land can never be used by the Wet'suwet'en peoples again," said Reg Ogen, president and chief executive officer (CEO) for the Yinka Dene Economic Development Limited Partnership (YLP), in an email to *CIM Magazine*.

"If we can find the right remediation technology, we can reduce this harmful process," he wrote.

YLP is a corporation that acts as the business and economic development arm of the Wet'suwet'en First Nation. Last September, YLP entered into a strategic partnership with Tersa Earth Innovations, a clean technology start-up based in Vancouver.

Tersa's water remediation technology, TersaClean, was developed to extract metals from mining waste and to clean tailings water. Its potential benefits are both economic and environmental.

"Our common ground is a healthy and robust environment for existence, economics and ecosystems," Ogen wrote.

Tersa's technology is still at the pre-pilot stage, but the company wanted to develop a different model for engaging Indigenous partners. Rather than reaching out with a market-ready technology, Tersa started working on building a relationship with YLP before it began approaching mines on Wet'suwet'en territory. The two partners also have a revenue-sharing agreement in place to share the profit TersaClean may generate on Wet'suwet'en territory.

"How we come to the table is, we step back and allow [YLP] to lead," said Barinder Rasode, co-founder and CEO of Tersa.

In 2024, YLP approached Newmont to solicit its interest in demonstrating a proof of concept of Tersa's technology in an industrial setting. The three companies have since been developing a relationship over the past six months to

utilize Tersa's technology to address Equity Silver's acid rock drainage.

Though there is no formal agreement in place at this time, all three businesses worked together to put forward an application to the BC Fast Pilot program, a joint initiative between the National Research Council of Canada's Industrial Research Assistance Program and Innovate BC.

If things keep moving forward, Rasode said that YLP "will have the agreement with Newmont, and we hope to be the supplier of the service."

A new technology

TersaClean uses two microbial processes; one to extract metals from waste and the other to neutralize the water. They are designed to be used together for water treatment but can also be split up based on client needs.

The systems are contained in modules that can both fit within the size of a 40-foot shipping container for pilot-scale deployment. Water affected by acid rock drainage gets pumped into them.

For the first process, microbial fuel cells remove valuable metals, like copper, gold and silver, that are contained within water contaminated by the acid rock drainage and would otherwise be lost as waste. The microorganisms in the fuel cells generate electricity as they break down organic matter. Through bioelectrical reduction, the microbes separate the metals from the wastewater. The metals get deposited on electrodes, from which they are ultimately collected and sent to a refinery. The process is similar to electrowinning but uses a different energy source since the microbes generate electricity in the system.

In the second half of the process, microbes generate carbonates that combine with leftover toxic or undesirable metals in the waste. They precipitate into solid form and settle out of the water. Some of the carbonates get cycled back into the system to neutralize the acidic water's pH, which removes the need for lime as the neutralizing agent; Tersa's technology only needs an initial external neutralization agent, like magnesium carbonate or sodium hydroxide, to put the microbes to work and let them take over.

"By using the carbonate precipitation instead of lime neutralization, we can also reduce the amount of sludge that comes out at the end," said Elesha Hoffarth, research and development manager at Tersa.

Skipping the sludge is one of the main elements setting Tersa apart from most of its biological and electrochemical remediation competition. Another advantage is that by foregoing lime, less carbon dioxide gets released.

The Minerals Research Institute of Western Australia estimates that there is US$3.4 trillion's worth of lost critical minerals in mining waste globally. Using the remediation process to extract them is Tersa's economic proposition to mining companies.

"Mining companies grapple with who is going to pay for waste remediation," Rasode said. "So this is potentially a way for the company, the industry to pay for it."

Until a pilot can be conducted and proves conducive, the technology remains unproven, but Tersa is seeing encouraging lab results so far with samples from BHP and Newmont sites. Rasode said the company is currently able to remove nearly 100 per cent of contaminants, like arsenic, from acid rock drainage and recover 95 per cent of metals. Among those metals, Tersa's most promising extraction rates include critical minerals like copper, aluminum and cobalt.

Tersa's water remediation technology currently stands at a technology readiness level of five out of nine, as defined by the federal government, which means basic components of the technology are being tested together as an integrated process in a simulated environment. The pilot stage happens at level seven.

Tersa started working with BHP in 2023 and Newmont in 2024 to test its technology using water affected by acid rock drainage from their sites.

Ogden wrote that YLP has been building its own relationship with Newmont since 2013. YLP participates in regular meetings and has gained a proactive understanding of Newmont's remediation system at Equity Silver.

Until Tersa's technology is proven, there are no guarantees on the metal recuperation potential at mines in the Wet'suwet'en First Nation's territory.

"We're not going in with the promise of great prosperity," Rasode said. "We're going in with the promise of, we're going to be partners and work on this together and share whatever comes of it."

Together from the beginning

Tersa approached YLP early on in its road towards the commercialization of TersaClean. "Tersa's invitation to be at the table before the menu is set means a lot in the building of trust," Ogen wrote.

He added that YLP is used to receiving such invitations once planning, strategy and implementation are already completed. "We find that disrespectful," he wrote. "In this case, Tersa's vision of inclusivity and participation at the early stages is rare, but both parties recognized that there are tangible and non-tangible benefits."

Ogen believes that if Tersa approached YLP after the technology was already commercialized, it would have meant fewer opportunities for YLP, and its relationship with Tersa would not be as "robust and dynamic."

YLP does not yet have a financial stake in the technology but has assisted in grant and funding applications. It may choose to invest later down the line. "Our potential investment can also be placed on a stronger ground if we were involved at this stage; having intimate knowledge," Ogen wrote.

The partnership between YLP and Tersa strays from the more common template that is seen in the mining sector, of companies reaching out to Indigenous communities during early work on a new mine.

Its focus on mine maintenance and closure provides a rarer model. "I haven't actually heard of anything in that space yet, but I think it's quite interesting," said Cherie Brant, partner and national leader of Indigenous law at BLG in Toronto.

Brant is not involved in the partnership, but her law practice focuses on helping First Nations organizations to negotiate major natural resources agreements, including mining impact benefit agreements and renewable energy partnerships.

Brant advises her clients to do their due diligence when vetting partnerships and to consider proven technologies over pilot projects, especially if they are considering a financial stake.

She said she always urges caution because she has seen many examples of communities being taken advantage of or

investing in early-stage technologies that do not end up coming together. Brant said her primary concern is the protection of a First Nation's reputation and credibility.

"I'm always very cautious about new technology, but I'm also extremely supportive of economic development," she said. "I don't know this project, but I think with the right advisors and people at the table and a proper due diligence process, you can identify whether there's a viable opportunity."

A community mandate

Should Tersa's technology prove commercially successful, YLP will stand to benefit. It has a revenue sharing agreement in place.

All of YLP's profits are returned to the community to assist in its mandate of "increasing the well-being in the community for seven generations," Ogen wrote, referring to a principle prescribing that decisions made in the present should keep sustainability in mind for generations to come. YLP's mandate is achieved through five pillars: culture and language, health, training and employment, housing and governance.

The collaboration is also a means for YLP to foster training and employment opportunities to encourage more people to consider careers in the environment and natural resource fields, Ogen added.

The aim would be to have community members versed in western knowledge, Wet'suwet'en traditional ecological knowledge and holistic perspectives to "increase the well-being in our community through pride as contributors and co-managers of our unceded territory," Ogen wrote.

"The really good projects and deals are when the benefits are felt by the community members themselves," Brant said. Whereas companies in the mining industry find value in the social licence derived from collaborating with Indigenous partners, what makes such deals worthwhile for the latter are the social benefits.

"I can't see that reconciliation obligation ever ending in the mining space, because it's so complicated and complex," Brant said. "I think that there's still a lot of work to be done."

Assistance and understanding are key elements of economic reconciliation from Ogen's perspective. He stated that YLP is not interested in greenwashing projects. Though YLP supported TC Energy's Coastal GasLink pipeline infrastructure project, Ogen wrote that the business has learned a lot from the project and has passed along positive and negative critiques to its proponent.

"For those wishing to design, install and profit from projects in the Wet'suwet'en First Nation territory, the key is to know our hopes and aspirations and join with us to create a framework that guides the parties," he wrote. "One size does not fit all."

He believes YLP's partnership with Tersa fits within this vision of economic reconciliation because YLP is viewed as a contributing partner with valued input.

The respect of YLP's and Tersa's cultures, as well as a foundation of learning, sharing and transparency, have been the foundation for the partnership for Ogen.

Rasode said Tersa's intention is to create "collective prosperity, collective responsibility and then collective accountability."

Through the opportunity to recover critical minerals from waste while cleaning it up, land use for mining on Wet'suwet'en First Nation territory will become more efficient, and better for the environment, according to Ogen.

"If we have a healthy and resilient ecosystem, our culture and language will not be diluted," he wrote. CIM

Indigenous Participation in Mining will run throughout 2025 and explore the people, the ideas and the models that are moving mining projects and economic reconciliation forward.

Courtesy of Gideon Lambiv Dzemua

Large quantities of cement have to be stockpiled in Yellowknife, as the material can be transported to mine sites only when the ice roads are available for a couple of months each year.

Sustainable cement in the North

Researchers have found that producing cement in the Northwest Territories with local materials can reduce costs and lower carbon emissions

By Tijana Mitrovic

When Gideon Lambiv Dzemua moved to Yellowknife, Northwest Territories, eight years ago, he had a realization. "Driving from Edmonton to Yellowknife, you met so many vehicles transporting cement," he told *CIM Magazine* in an interview. "This is over 1,500 kilometres of transportation every day."

Currently, none of the cement that the Northwest Territories consumes is produced in the territory; instead, it is transported long distances by freight truck, mostly from Edmonton. As an industrial minerals geologist at the Northwest Territories Geological Survey (NTGS), Lambiv Dzemua wanted to see if it was possible to improve this practice.

"Based on my knowledge of the geology of the Northwest Territories, we have all the raw materials [needed for cement production]," he explained. "So why [don't I] try to look for these materials, collect samples of them and [evaluate them] to see if they are suitable for manufacturing the cement."

Producing cement locally in the Northwest Territories would have several economic and environmental benefits, according to Lambiv Dzemua, including reducing the shipping costs and emissions from the current long-distance transportation of cement. "[And] not only will the cost of construction be cheaper because the cement will be produced locally, but [it could] also provide local employment," he explained.

If possible, the move would also benefit the mining industry, said Wei Victor Liu, a mining engineer and associate professor at the University of Alberta's Faculty of Engineering. According to Liu, who specializes in developing sustainable cementitious materials for the mining industry and collaborated with Lambiv Dzemua on this research, over 10 per cent of the cement used in the Northwest Territories is consumed by the mining industry.

Cement-based materials used in mining include concrete—which is used in foundations, water retention dykes, shafts and infrastructure such as roads—as well as most types of backfill. It is also a key part of ground support methods in underground mines, such as shotcreting and grouting.

As mining is the largest contributor to the economy of the Northwest Territories, local cement production would have cost and environmental benefits for miners. The long-distance transportation currently increases the price of cement by over 50 per cent and increases the carbon footprint of this cement by about 0.2 tonnes of CO2 per tonne of cement, according to Liu and Lambiv Dzemua. It would also benefit the miners by allowing them to skip staging the cement in Yellowknife—the current process of stockpiling the cement destined for the mines, because it can be transported to mines only via an ice road that is briefly open in February and March each year—and instead directly transport cement to mines.

In the field

Lambiv Dzemua and Liu began their research in 2022, with the goal of producing cement in the Northwest Territories using

local raw materials and mine waste that would meet commercial standards and requirements and be comparable to the commercial ordinary portland cement (OPC) currently being used.

As part of the research process, Lambiv Dzemua, with the support of Scott Cairns and Philippe Normandeau at the NTGS, would search for and source the raw materials needed in the Northwest Territories—or as he called it, go "rock hunting." He would then ship the raw materials he found to Liu and his research team at the University of Alberta, which included postdoctoral fellow Guangping Huang and PhD student Jian Zhao. The research team would then analyze the raw materials to see if they were suitable for cement production and testing, and identify if any of them were deficient or unusable so that Lambiv Dzemua could search for alternative materials.

Commercial OPC is manufactured using limestone, clay, gypsum and iron ore. While the NTGS already knew there were deposits of limestone, clay and gypsum in the territory, the team still needed to identify them and verify if they could be used for cement production. And as it happened, there were still challenges in sourcing these materials; for example, procuring the clay was a challenge because there was not enough of it, and Lambiv Dzemua said that a possible clay source he found ended up being clay-sized particles rather than actual clay minerals.

While he eventually located clay from limestone clay, the Northwest Territories lacked one critical raw material for manufacturing cement—iron ore. Having read previous studies that used solid waste materials to successfully produce cement, Liu and Lambiv Dzemua looked at tailings from the proposed NICO cobalt mine located 160 kilometres northwest of Yellowknife to see if they could fulfil the requirement for iron, as they hypothesized that these tailings would have a high iron content.

Lambiv Dzemua reached out to Fortune Minerals, the mining company that owns the NICO project, to see if he could use some of the project's tailings for the cement production. Liu and Lambiv Dzemua said using tailings in the cement production in this way could not only sustainably dispose of the waste material, but also help reduce the space needed to safely store tailings and mitigate its environmental impact, as well as promote a circular economy.

In the lab

The first step in the process was manufacturing, or turning the raw materials into cement, and the second step was testing the lab-prepared cement against commercial OPC to compare performance.

Once Liu and his team had all the raw materials, they crushed them and dried them at 105 degrees Celsius, before pulverizing them into a fine powder with a ball mill. Then they analyzed the characterization of the materials using scanning electron microscopy with energy dispersive X-ray spectroscopy (SEM-EDS) to understand the oxide composition. The team mixed the correct proportions of the materials together before using calcination, rapid cooling and grinding to create the cement product, which they called NWT cement.

"It was labour intensive," Liu said of the manufacturing process. "There was no automation—it was our researcher doing all [these steps] to turn the raw materials into the final product. It eventually looks like this really successful cooking process [where] we were just following the recipe. Then, the next step [was to] look at the characteristics and see how this compared with the [OPC.]"

Once the research team was satisfied with the composition of the cement from raw materials, they moved on to testing and evaluating it. The tests evaluated the performance of the NWT cement on its setting time, workability, hydration reaction, volume stability and compressive strength. Liu explained that the strength test, in particular, was key, as uniaxial compressive strength (UCS) is one of the most important properties of concrete.

"If we look at the comparison [of the UCS], on the first day the lab-created cement is lower than the [OPC] but still meeting the American Concrete Institute (ACI) 506 standard. Then on the seventh day, it performed even better than the OPC," Liu said.

On the 28th day after being cured, which is the standard protocol for assessing UCS in cement production, the NWT cement had a UCS of 44.2 megapascals compared to 44.8 megapascals from the OPC. "They are very similar; I would say [the NWT cement] is of comparable strength in comparison with the commercial [OPC]," he explained, adding that the NWT cement met the ACI standard for use in the mining industry.

The first bag of cement

The two researchers confirmed it is feasible to produce cement locally in the Northwest Territories. "The key message is that we have the right materials," Lambiv Dzemua said. "So whoever is interested in [developing local cement production] will know that the materials are there and the technology has been proven."

The research team's preliminary life cycle analysis also found that producing cement locally has the potential to reduce CO2 emissions by around 25 per cent when compared with cement imported from other provinces, and they plan to publish a more detailed life cycle analysis soon.

The research results have been well received thus far. Liu presented the findings at SME's MINEXCHANGE annual conference and expo in Denver, Colorado, in February, and Lambiv Dzemua shared that the NTGS and territorial government have proposed a preliminary economic evaluation for developing local cement production.

Liu and Lambiv Dzemua have set their sights on two new research ideas for the future: using kimberlite tailings from diamond mines to capture carbon dioxide and using local materials to create limestone calcined clay cement, or LC3 cement, a lower-carbon cement alternative to OPC.

Lambiv Dzemua said that he would also like to see more research into using and recycling mine tailings waste. "There are so many old mines here that we can see how these tailings can be used to do other things for other engineering purposes," he said.

The researchers are hoping that recent geopolitical attention on the North will lead to more investment and research that promotes the local economy. "This is really a region that needs lots of attention, in particular for the mining industry," Liu said. "I really hope more investment and more research opportunities are coming in the future."

While the availability of funding is a constraint for their future research plans, Liu is proud of the work they have done so far.

"We [did] something really useful [that is] applicable to our local community, in particular the northern community, including our Indigenous communities," he said. "We feel that we are doing something really useful for society [that is] really making an impact." CIM

Courtesy of Xiaolei Wang

A seawater solution

Xiaolei Wang discusses how seawater could help make rechargeable aqueous batteries a safer, more affordable and scalable alternative to traditional lithium-ion batteries

By Ashley Fish-Robertson

Xiaolei Wang is a Canada research chair in batteries for sustainability and an associate professor in the department of chemical and materials engineering at the University of Alberta. He runs the Nano for Advanced Clean Energy Laboratory at the university, focusing on the design, development and application of novel nanostructured materials for clean energy technologies.

The large-scale transition to renewable energy depends heavily on the availability of safe, economical and scalable battery technology, and a new breakthrough from Wang and his research team at the University of Alberta could help address this challenge. The team is working with Canadian Light Source, a national research facility at the University of Saskatchewan, to develop an anode for rechargeable aqueous batteries—a potentially safer and more cost-effective alternative to lithium-ion batteries—designed specifically for large-scale grid energy storage, using seawater as an electrolyte. *CIM Magazine* spoke with Wang about advancing the design of this anode; the challenges of working with aqueous systems; and the potential of seawater-based batteries to support large-scale, sustainable energy storage in the future.

CIM: Could you discuss the development of this anode and explain how it works, particularly how the use of seawater as an electrolyte contributes to its functionality?

Wang: What we are doing now is focusing on the aqueous battery system, which is a little bit different from current commercialized lithium-ion batteries. We use seawater directly as the electrolyte system. Compared to lithium batteries, it's safer, more cost-effective and more environmentally benign. So, it hosts great promise for the future.

There are still challenges with this type of battery. First of all, the energy density is not comparable to current lithium batteries, which means that if we were to adopt this kind of battery technology in electric vehicles (EVs), they may just run for a very short distance. That's why it's not suitable [for EVs], but it's quite suitable for large-scale energy storage. The challenges are still the fundamental study of materials for these types of batteries, and then also the configuration of the anode.

For example, with aqueous-based systems, people [typically] use zinc foil as the anode, and this causes a lot of problems, including corrosion, byproduct formation and also dendrite growth. We're trying to replace the metal anode with polymers, because polymers are cheap, naturally abundant and it's easy for us to manipulate these kinds of materials.

The thing is, polymers [have] problems associated with low conductivity. The capacity that these materials can provide is very limited. If we would like to have capacity that is comparable to organic materials, then we have to increase the loading of these materials.

Polymers are similar to hairs. You stack them together, but it's very hard for us to utilize a lot of them because they occupy a lot of space. They are very light, so we try to compress them, but their structures make this compression very difficult. We still have a lot of pores instead and this porous structure actually leads to a high volume and low mass, so the capacity is still very limited. We've been trying to combine this polymer with a very tiny amount of carbon nanotubes, and then by a very specific compression process, we can make a very thick electrode.

What we have found, particularly with this project, is that polymer nanosheets and carbon nanotubes can actually accommodate multiple ions naturally. So, instead of just allowing one type of ion as the charge carrier to shuttle between the two electrodes, we can actually use multiple ions—which is the case for seawater, because seawater has a lot of ions. This makes the battery more universal [capable of storing various ions]. If we apply these materials as the anode for this type of rechargeable aqueous battery, we can use seawater as electrolytes, which reduces costs by allowing us to use seawater directly as the input instead of making electrolytes.

CIM: Why is energy storage so important in today's energy landscape?

Wang: Energy storage is very important to us. Before, we relied a lot on fossil fuels, but these are not very sustainable, and we know

the cost is high, along with a lot of environmental problems. Then there are clean energies, [such as] solar energy, tidal energy and wind energy, but they do not produce energy continuously over time. So, we collect the energy from these sources and store it. Then, when we want to use it, we have a large store continuously providing the energy to us no matter when and where.

Among all the energy storage technologies, electrochemical energy storage technology is believed to be the most efficient, because we know that the conversion between chemical energy and electrical energy is actually 100 per cent and no such conversion can be realized between mechanical energy or thermal energy to [supply] the electrical energy that we need.

That's why we would like to develop electrochemical energy storage technologies, particularly these batteries, because these batteries are designed to realize this conversion of energies. For us, the consideration is what type of batteries are more efficient for specific applications. We need lithium batteries at the moment for EVs, laptops or cellphones, but we also need to consider some of the better technologies suitable for some other applications, like large-scale energy storage. What we're focusing on right now is low-cost, sustainable battery technologies for large-scale storage.

CIM: Can you outline the next steps involved in bringing aqueous batteries closer to real-world applications?

Wang: We are very interested in making these materials [polymer nanosheets and carbon nanotubes] useful for future practical applications, and what we are doing now in the research group is trying to make a large amount of these materials.

First, we're trying to scale up the technology so that we can produce such materials in a very large amount. Secondly, we're also trying to see if the large-scale produced materials have the same properties as other controlled-reaction materials. Lastly, our research group is equipped with a benchtop pouch cell fabrication system. It has just arrived, so we have it ready to use for fundamental research to investigate whether the aqueous batteries could be designed as pouch cells [a type of battery with a flexible, flat pouch-shaped design].

Then we can validate these materials so that we can pass on information to the [battery manufacturing] industry, [informing them] if these materials still have advantages compared to other materials. We can also provide them with some key information about if this battery can be normally operated at such a large size. And then, if possible, see if we could utilize these cells for different applications.

CIM: Do you foresee any challenges or potential breakthroughs that could accelerate or delay the widespread adoption of aqueous batteries?

Wang: If we take a look at Canada, we don't really have our own battery industry. We have several companies in Ontario, and several start-ups or companies in Quebec, but the thing is that these [companies] are from other countries, not local. So that's a big challenge.

Secondly, depending on how large the market is, right now, different batteries are still dominating because of the booming markets of EVs and electronics. For large-scale energy storage, we still rely on some of the traditional ways to store energy, such as [hydroelectric] dams. We have a way to store the energy in thermal turbines, rather than in batteries, so this is an emerging technology that holds promise, but there's still a long way to go.

Then, we definitely need to validate them at different sizes. We also need to see if there are still some challenges at the fundamental research level. After solving these problems, we can [confirm] if these batteries are safe and cost effective [for energy storage], and then we would probably need to seek partners for commercialization.

CIM: Could aqueous batteries eventually find a place in EVs, or offer solutions for the mining industry?

Wang: Currently, lithium batteries are still dominating [EVs], and this is the best choice, at least at the moment. However, there are still a lot of challenges with lithium batteries, like the [possibility] of explosions and the [high] cost. Using aqueous batteries for EVs is not an option at the moment, but our research is aiming to try and develop more novel materials for batteries with higher capacity, so that the whole battery can provide more energy.

On the other hand, you ask about the mining industry. Right now, particularly in Canada, we are trying to build a sustainable and secure supply chain of critical minerals. If we take a look at the Canadian government's list of critical minerals, we have lithium, cobalt, nickel and graphite. These four minerals are the major components of current lithium batteries. If we reduce the reliance on these critical minerals, that's another contribution to the safety and security of [Canada's] critical minerals [supply chain], and also to national security. CIM

Courtesy of the Saskatchewan Mining Association

Questions of representation

Majors continue to invest in making mining more attractive to women, but need to dig deeper to boost interest in the production and trades side of the industry

By Dinah Zeldin

Karina Gistelinck, asset president, potash at BHP. In April, the company achieved 40 per cent female representation in its global workforce.

In February 2025, female participation in Canada's mining industry hit an all-time high of 19 per cent, as per Mining Industry Human Resources Council (MiHR) data.

According to Ryan Montpellier, executive director of MiHR, a decade of heavy investment from industry is finally paying off.

"We had not seen huge gains in female participation over the past decade, but now it's going up," he said. "We just wish the slope of the progress would be a little faster."

Hannah Ellix, associate partner in McKinsey and Company's mining and metals practice, said the pace of change is unlikely to pick up significantly in the near future.

"We're seeing very gradual improvements in recruiting numbers [and] in relative retention numbers," she said. "Diversity and inclusion is a challenging problem to solve, and if there were one silver bullet, everyone would have used it by now."

But some major miners operating in Canada are ahead of the curve and have even been named among Forbes' list of the World's Top Companies for Women in 2024. This list of 400 companies included: global giant Rio Tinto, which, according to a company spokesperson, had set a target of 25.8 per cent female representation for its global workforce in 2024, and achieved 25.2 per cent; and Vancouver-based Teck Resources, whose chief inclusion officer, Jackie Scales, told *CIM Magazine* in an email that women represented 29 per cent of new hires in 2024 and currently represent 26 per cent of the company's workforce.

In 2016, Australia-headquartered BHP publicly announced an ambitious target of achieving gender balance—which the company defined as a minimum of 40 per cent women and 40 per cent men—in its global workforce by the end of fiscal year 2025. According to a press release from July 2023, it reached gender balance on its potash team, which includes its Saskatchewan corporate office and the Jansen project that is under construction, with 43.8 per cent female representation.

In April of this year, the company announced that it had achieved 40 per cent female representation in its global employee workforce, which is a 23 percentage point increase since it set the target in 2016.

"When you look at BHP's full executive and C-suite team, it's quite remarkable what they have done on that, and with some of their sites," said Beth Borody, founder and CEO of the Femina Collective, a membership-based organization for female executives in mining that aims to radically transform the experience for women in the industry.

"BHP's CEO is the biggest advocate for this. It takes leaders, and particularly men in these organizations, to say: we're going to be intentional about recruiting and offering opportunities for advancement to women."

Barriers persist

Borody believes that the industry needs more women at the table to address its current challenges, but that it struggles to attract talent because working in the mining industry remains inhospitable to women.

"We have a reputational problem with [mining] being considered unsafe for women," she said. "And it is still not welcoming for women in a lot of areas. For young mothers to be

able to do a fly-in-fly-out rotation is nearly impossible. We are seeing remote camps where women are being bullied, harassed and assaulted. Those are still real things that are happening, that we cannot gloss over, and we cannot pretend we have moved on from."

According to Borody, even at the leadership level, women have to remain hyper aware of their self-presentation. "We have to play the game to be seen as one of the group," she said.

For Jocelyn Peltier-Huntley, owner of Prairie Catalyst Consulting and chair of Women in Mining and Women in Nuclear Saskatchewan, recruitment is not as much of a problem as retention.

"Sometimes women face overt forms of bias, like discrimination and harassment," she explained. "Sometimes it's more subtle forms of bias that might be embedded in systems, so it could be related to pay equity, promotion or hiring."

Peltier-Huntley, who now does diversity, equity and inclusion (DEI) assessments within organizations and makes recommendations on how to make company culture more inclusive, is a mining industry veteran. After over a decade working as a professional engineer and progressing to management, she learned she was being compensated 50 per cent less than male colleagues at the same level.

"There wasn't a resolution process that was easily accessible to address that," she reflected.

Peltier-Huntley left the industry, in part, due to her experiences with "toxic culture," and went on to pursue a PhD at the University of Saskatchewan, funded by the International Minerals Innovation Institute, Vanier Canada, Mitacs and Women in Mining Canada. Her research used a participatory approach with industry to examine how to effectively support inclusive and equitable workplace practices by activating allies.

"I wanted to try to solve some of the problems I experienced and witnessed happening to those around me," she said.

The outcome of her research is Active Allies, a digital course that aims to train individuals on how to be effective allies in practising DEI in the workplace. An article titled "Facilitating inclusion: workplace allyship interventions to foster a practice of inclusion" that she co-authored with fellow researcher Rosa Moazed was recently published in *CIM Journal*.

According to Peltier-Huntley, the key to boosting retention of women in mining lies in engaging staff at all levels in transforming company culture.

"It is about trying to get everyone involved with the solution, and not just focusing on trying to 'fix' women to fit into a workplace," she said. "If we're not directly impacted by discrimination or harassment, we may not notice when it's happening to someone else. Growing our awareness so we can recognize when it's happening makes us better able to intervene and help create more psychologically safe and inclusive spaces—and that ends up benefiting everyone."

The Trump effect

The hostility of U.S. President Donald Trump and his administration towards DEI initiatives has been unequivocal, but its impact among mining's leaders is unclear.

"Some organizations are moving forward, but some are wondering if they need to be stepping back," said Peltier-Huntley. "There are definitely discussions happening within organizations about where they stand on DEI, especially those operating in the U.S."

Courtesy of Rio Tinto

A loader operator at Rio Tinto IOC operations in Labrador City, Newfoundland and Labrador. The company achieved 25.2 per cent female representation for its global workforce in 2024.

According to Borody, an industry-wide backlash to DEI has been present for a few years, with some men in the industry worried about women receiving preferential treatment because new policies were challenging existing power dynamics; however, recent events have added fuel to the fire.

"Trump coming into the White House has just amplified what was already happening and given a much stronger foothold for companies to jump on board by removing DEI policies, because now you have one of the most powerful countries in the world saying it's not important," she said. "It puts women in danger of not being promoted, and of not being given the same opportunities as men."

However, neither Montpellier nor Ellix have observed any impact on Canadian mining companies' commitments so far, with both citing the industry's need for labour as a powerful motivator for companies to remain invested in DEI initiatives.

"Of the conversations I have had with my clients, both in Canada and in the U.S., there isn't any backing away from their commitment to creating inclusive environments at sites, wherever those may be," said Ellix. "Companies are thinking about DEI differently than they did a few years ago, but it is a trend that started before the more recent U.S. administration. Over the last three to four years, there has been a move to what I call neutral inclusion."

Ellix pointed to a steep decline in companies offering mentorship and career development programs specifically targeted at women and minorities.

"At face value, you could say [that] in 2025 there are fewer programs uniquely available to women," she said. "But [McKinsey's] research is showing there is actually just a greater willingness to include more people in the fold of what we would consider supportive HR [human resources] programs."

Montpellier, whose organization supports Canadian mining companies by providing training, a toolkit with case studies and workshops to help them on their DEI journeys, echoed Ellix: "We haven't seen companies shy away from DEI-related initiatives. Perhaps some may have rebranded them a little bit as respectful workplace initiatives."

Courtesy of the Femina Collective

At this year's PDAC conference in Toronto, the Femina Collective encouraged female attendees to wear bright colours to stand out.

Drilling down into representation

According to Montpellier, the mining industry has made great headway in hiring women for head office roles but is struggling to attract women to work on the production side.

"In occupations that are not mining-specific, but that are traditional HR, finance and managerial occupations, women make up over 60 per cent of the mining workforce," he explained. "When you get into physical science or engineering occupations, it's about 20 per cent, but when you go down to trades and production occupations, women only make up two or three per cent of the workforce."

He noted that this is not exclusively a mining issue. "Women are not choosing to pursue careers in those occupations," he said. "If we want to significantly increase female participation in the mining industry, we have to start much earlier to attract women into the occupations that our industry needs."

In 2024, MiHR worked with Pamela Schwann, president of the Saskatchewan Mining Association, to conduct a labour market analysis for the province, whose mining sector is currently in a growth phase.

The 2024 Saskatchewan Mining Labour Market Analysis report revealed that while women comprise 46 per cent of the labour force in Saskatchewan, they accounted for only 13 per cent of mining industry workers, despite national and local efforts to draw more women to the industry.

"We're going to need 15,000 more workers over the next decade. That means essentially rehiring our existing workforce over that period," said Schwann.

According to Schwann, the report revealed the same major reason for the slow progression of female representation in the industry as MiHR's national data: a lack of women in production or trades.

"I've been in the industry for over 30 years, and I was definitely one of very few female geologists, and there were fewer female engineers at the time," she said. "Numbers have really increased, and now we are seeing more women in leadership positions in mining."

Schwann added that girls need female role models in mining. "If they are there and you see them, you can aspire to be there," she explained. "The focus has been on trying to get women into careers like engineering, but most of the mining workforce is in production and trades. [However] only two per cent of the women in mining are in trades."

According to Schwann, Canada's education system has not been focused on promoting education or careers in the trades and this has impacted both genders' interest, resulting in a small labour pool. She suggested that industry needs to ramp up efforts to make trades appealing to young people, and of course, to do so in a manner that is engaging to girls.

A goldmine of talent

Schwann pointed to two promising company-run pilot programs in Saskatchewan that she hopes will start a trend: paid training that provides participants with a taste of what it is like to work in the industry and the skills to work in the sector.

One is the Northern Indigenous Training program spearheaded by Saskatoon-based uranium giant Cameco and supported by the Saskatchewan Indian Institute of Technologies, which is partly funded by the provincial government and will provide pre-trades training focusing on industrial and heavy-duty mechanics, carpentry, electrical, plumbing and welding. The three-year program launched its first cohort in January 2025 with 10 participants, all of whom are women.

"We want women to see themselves in non-traditional roles," said Cameco's Indigenous engagement director, Kristin Cuddington, in an article on the company's website.

Hosted at the company's Rabbit Lake mine site, which is in care and maintenance, the program offers a glimpse of life at camp as well as an opportunity to learn on real equipment and to be mentored by company employees. Cameco provides a salary and covers participation costs, and will offer graduates a limited number of apprenticeship positions.

The other is the BHP Potash Academy, run in partnership with Carlton Trail College, a community college based in Humboldt, Saskatchewan, that works closely with industry to support workforce development opportunities.

Also launched in January 2025, the eight-month, paid traineeship provides a mix of classroom learning and on-site training to equip participants with essential skills for production or maintenance technician roles at BHP's Jansen site, which

is expected to begin production in late 2026. The first cohort has 13 participants, over half of whom are women. Upon completion of the program, trainees will be offered permanent, full-time employment at the Jansen mine.

According to Schwann, BHP's remarkable achievement of gender parity at its potash division in 2023 was achieved by a number of strategies—including importing top talent from other BHP global operations, such as Karina Gistelinck, asset president, potash, from its Melbourne head office, as well as being a preferred employer and attracting women from other companies. Now, BHP is prioritizing developing female talent by targeting women and Indigenous people for spots at the BHP Potash Academy.

"They're a new company in Saskatchewan, and quickly ramping up operations, so they haven't had the opportunity to develop a lot of talent independently," said Schwann. "But their new program is one of BHP's initiatives to attract more women into trades and production."

Investment by majors

Rio Tinto remains committed to being among the mining companies leading the industry in attracting women and transforming company culture. In 2024, 32 per cent of the company's global senior leadership team was composed of women.

"Our broader diversity targets include increasing the number of women in our business, including in senior leadership, each year, aiming for 50 per cent women in our graduate intake," said a company spokesperson in an email to *CIM Magazine*.

According to the spokesperson, Rio Tinto has taken actions to support an inclusive culture, including improving site facilities to ensure sufficient access to bathrooms for women, enhancing site and camp safety, offering free sanitary products, and upgrading breastfeeding and pumping facilities. It has also created employee resource groups that bring together employees and allies from diverse backgrounds to drive meaningful change across the business.

Although the November 2024 *Everyday Respect Progress Review Report* revealed serious challenges, including resistance and backlash to company efforts to foster inclusivity, the company remains committed to making meaningful change.

"Change is happening and we are making progress," CEO Jakob Stausholm wrote in a 2024 Rio Tinto report entitled *Our Ongoing Journey*. "We have a long way to go, but we are more committed than ever to transforming our culture."

Teck's leadership is also committed to supporting a cultural transformation that will not only attract women to the company but will ensure women have support to advance in their careers. The company's CEO Jonathan Price chairs the companies' Inclusive and Respectful Workplace Committee, and 25 per cent of the company's senior management and 27 per cent of its board of directors are female.

According to Scales, Teck has a goal of increasing the representation of women in its workforce to 30 per cent by 2030. To support the talent pipeline, Scales revealed, Teck focuses on early outreach through elementary and high school engagement in the communities in which it operates and invests in programs at community colleges.

Scales added that the company provides female staff with support through a global Women's Network and local women in mining groups at each operation. The groups' activities include workshops on career development, peer learning circles, networking with leaders, and advocating for and actioning changes on site that reduce barriers to employment and advancement.

Courtesy of the Saskatchewan Mining Association

Stephanie Shelstad, journeyperson welder at K+S Potash Canada. Women currently only make up two or three per cent of the trades and production roles in the mining workforce.

Teck's 2024 sustainability report revealed a strong commitment to gender pay equity: the company has conducted annual salary reviews for all non-union employees since 2017. In 2024, the reviews—which were evaluated by an external party—found no indication of any systemic gender pay issues within the company.

According to Scales, Teck works to prevent risks of gender-based violence and harassment by providing its entire workforce and all contractors with training on how to foster a respectful workplace and speak up if they witness harmful misconduct. The company has also integrated trauma-informed training for HR, health and safety, and legal and security staff to ensure processes recognize the impact of trauma and that people have the support they need.

The dawn of a cultural transformation

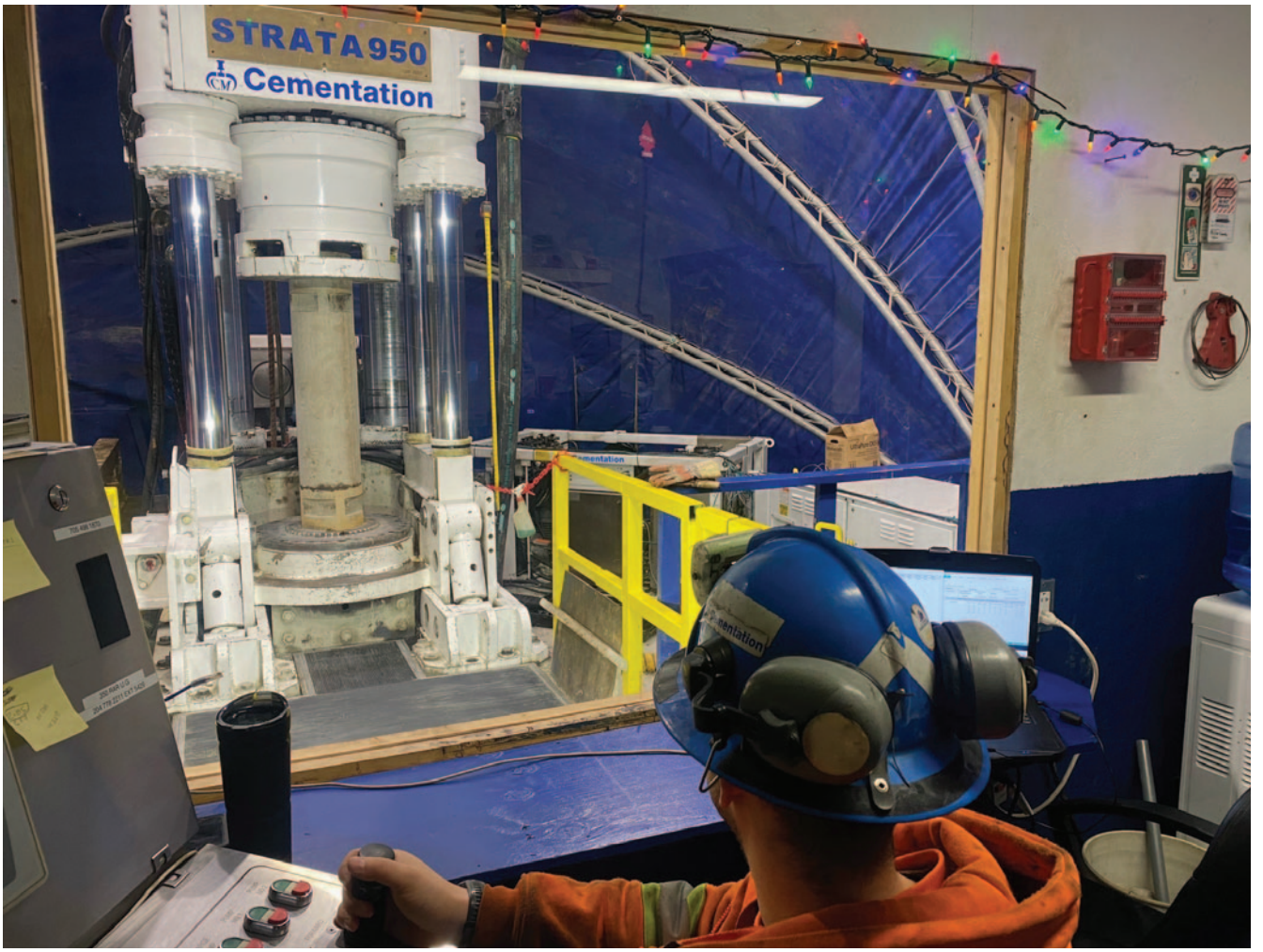
Ellix said that, due to the infamous skills shortage looming over the industry, the past five years have seen many of her clients changing approaches and policies to attract and retain talent by casting a wider net in their recruitment efforts and offering more flexible work arrangements.

These changes, she observed, have rendered the industry more hospitable to women, slowly setting in motion a broader, industry-wide cultural shift towards greater inclusivity, and pushing companies to respond to the evolving needs of their increasingly diverse workforce by investing in things like separate accommodations and gym facilities at sites.

One emerging practice that has helped to increase the representation of women has been an increased openness to recruiting talent from other industries: Ellix reported that some companies have brought in HR executives from retail and manufacturing.

"These [practices] would have been considered irrelevant in the past, but now there's a recognition that there's stuff to learn from other industries on how to better manage people, and there is also more emphasis on soft skills with industry training available for junior and middle management," she said. "As we bring in more experienced, inspirational leaders from other industries, and learn about HR best practices and invest in good supervision and management, these things will start paying dividends in diversity as well." CIM

Courtesy of Vale Canada



Cementation used a Strata 950 raise drill from its fleet to ream both raises at the Thompson T3 mine.

Record-breaking depths

The construction of twin raises at the Thompson T3 mine was a key part of a ventilation upgrade that helped to extend the mine's life by at least a decade

By Mehanaz Yakub

The dual-shaft return air raise at Vale Canada's Thompson T3 nickel mine in Manitoba, developed by underground mine contracting and engineering firm Cementation Canada Inc., reached a milestone in September 2023. After nearly 600 days of operation, the project set a new record for the longest continuous raise bore in the Americas at 1,076 metres (3,529 feet).

A major nickel deposit was discovered in northern Manitoba in 1956 by the International Nickel Company (INCO), and the Thompson mine opened there in 1961. At its peak in the 1960s, it was the world's largest integrated nickel mine, smelter and refinery and second-largest nickel-producing operation globally.

Today, Vale—which acquired INCO in 2006—continues operations at Thompson through two connected underground mines, T1 and T3. According to the latest figures from Vale Canada, the mine produced 11,400 tonnes of finished nickel in the 12 months ending in Q1 2025.

Recognizing the need for long-term sustainability, discussions within Vale in 2018 led to the launch of the Thompson Mine Extension Project (TMEP). This initiative focused on critical infrastructure improvements to support the development of deeper ore bodies, which would extend the mine life. One of the key components of the expansion project was the construction of a new ventilation system for the T3 mine, which would more than double the airflow to its most active zones.

"The whole goal was to expand the life of the mine by an additional 10 years and probably beyond," said Mark Johnson, senior project manager—TMEP at Vale.

To achieve this increased ventilation capacity, Vale needed to develop a dual-shaft return air raise.

"We were putting in return air raise fans to exhaust air out of the mine, so it works as one big circuit," said Johnson. "Fresh air gets pulled into the mine, and then we exhaust out the used air. The whole idea for the raises is to improve the ventilation for the mine to support the ability to mine at deeper depths."

For this type of work, Vale required a company with the expertise and equipment to install the raises. Vale decided to approach Cementation—which has completed 53 raise boring projects across North America—in mid-2021 to excavate two 10-foot diameter surface raises approximately 3,500 feet deep.

Favourable rock conditions

Raise boring, in theory, is a straightforward process to excavate a shaft between two levels of a mine, or from the surface to a lower level: a raise drill is positioned at the upper level, drilling a pilot hole downward towards the lower level. Once the drill breaks through at the lower level, the pilot-hole drill bit is swapped for a much larger reamer head, which is then pulled back up, widening the diameter of the hole as it rotates.

However, before any drilling can begin, one critical factor that could make or break a raise boring project's potential for success is the ground itself.

"The ground is going to tell you what you can and can't do," said Fallon. "The ground is going to tell you how big of a raise you can pull [and] how long it's going to stand up on its own. Once we have that information, then we can determine the size of the raise based on the requirements of what the client needs."

At Thompson, exploratory drilling confirmed that the rock formation was massive gneiss, a strong, metamorphic rock type.

"The Thompson mine commonly has good quality ground conditions—including at the proposed raise locations. The massive gneiss provided for consistent drilling/reaming and a stable excavation," said Ryan Lyle, senior specialist engineer—geotechnical at Cementation.

"Having good ground conditions is always important for these raise projects because you can't support the ground as you excavate," explained Lyle. "One of the key reasons there aren't many raises this long, is that it is not common to find such good ground conditions over such a long distance. If there was weak, unstable ground in the middle—as little as one to two per cent of the total length of the raise—it may not have been feasible to complete this raise."

Overcoming challenges

While raise boring is a well-established method of shaft excavation, the Cementation raise boring team encountered several significant challenges in tackling a project of this scale.

The first major hurdle was the unstable surface conditions. While the rock below was solid, the ground above it was essentially a swamp.

"Where these raises were being proposed, there was 40 feet of overburden. We couldn't set up the drill on weak overburden or raise through it," said Lyle.

To solve this, Cementation partnered with a third-party contractor to implement a secant piling method used to stabilize the weak surface ground. The teams were able to excavate the weak soil and replace it with concrete piles to both support the raise drill and the raise walls upon excavation.

Cementation used a Rotary Vertical Drilling System (RVDS), designed and manufactured by Germany-based manufacturer, Micon, to drill and control the vertical pilot holes. The RVDS had challenges with the fibre-reinforced concrete that replaced the overburden, but it ultimately delivered accurate results.

"With these pilot holes, we were within 1.5 feet of vertical over 3,529 feet," said Fallon. "That's a deviation of just 0.00045 per cent—which is amazing."

Another major challenge was the extreme weather in Thompson, Manitoba. The raise boring project required two surface set-ups, both completed in the dead of winter—January 2022 and January 2023—when temperatures averaged minus 45 degrees Celsius. Keeping equipment operational in such conditions was no small feat.

"When you're drilling a pilot hole, you also have a 40,000-gallon surface sump system where you [have] got to be able to

Courtesy of Cementation Canada

The raise boring project at the Thompson T3 mine needed two surface set-ups, which were both completed in the middle of winter.

Courtesy of Cementation Canada

The Cementation team marking the completion of drilling the first pilot hole at the Thompson T3 mine in June 2022, which was the longest raise bore pilot hole completed in the Americas.

keep that water moving," said Fallon. To prevent the water from freezing, Cementation tapped into the Earth's natural heat while supplementing with external heaters and power sources.

On top of all that, the weight of the drill string presented a high-risk challenge.

At full depth, Cementation used over 700 drill rods, totalling 1.1 million pounds (410.6 tonnes). The team had to be extremely careful with each and every connection within the drill string each and every time rods were tripped into or out of the pilot holes.

Despite all this, said Fallon, the reaming of both raises exceeded expectations as reaming conditions were exceptional over the entire length of both raises. Cementation used a Strata 950 raise drill from its fleet, which the company built and developed in-house.

"In the end, for two raises of this length, the execution went really well," Fallon noted. "We were on schedule with both raises being so close together. We started in January 2022 and completed the project by September 2023—just over 18 months."

Success with safety

Both Cementation and Vale credit the success of the raise boring project to their strong partnership and shared commitment to safety. From the outset, collaboration was the driving force behind every decision, they said.

"The good thing about the project is that we had the buy-in with the client," said Fallon. "We had early engagement, [and] we worked together as a team to achieve a common goal of a successful incident-free project on budget and schedule. We were very open to suggestions, and they were very helpful."

For Vale, Cementation's willingness to embrace safety and continuous improvement was invaluable, said Johnson.

"We identified some deficiencies on a safety front with them and rather than pushing back and saying, 'This is the way we've always done it,' they were very collaborative and, in fact, a perfect partner," he added.

One of the key safety enhancements came during the process of protecting the workers from rotating drill rods during the raise boring process. Since adding and removing drill rods required frequent human interaction with rotating heavy equipment, Vale saw a potential hazard and suggested a safeguard.

Cementation not only agreed, but at its own expense, the company developed a safety mat interlock system that ensured that if anyone was standing in the area close to the rotating drill steel, the raise drill rotation would shut down.

"They took it a step further," said Johnson. "We noticed that sometimes the workers would be off the mat as they were trying to reach around the far side of the drill. [Cementation] made it so that every time they engaged the mat, they would have to go to a safe area and press a reset."

This commitment to safety paid off at the end: Cementation completed the raise boring project with no injuries and no lost-time incidents. The company also won the Ontario Mine Contractors Safety Association's 2023 safety innovation award for the safety mat interlock system developed for this project.

"Everything we work with is heavy," explained Fallon. "Each cutter weighs 275 pounds, a pilot bit 400 pounds, and drill pipe can be over 1,450 pounds per five-foot length. We're using high-voltage—upwards of 13,800 volts—hydraulic pressures up to 5,000 pounds per square inch and torques upwards of 400,000 foot-pounds to operate the raise drill. The Strata 950 is capable of almost three million pounds of thrust pressure. Everything we do is big, heavy, high pressure and challenging."

However, while setting the record for the longest raise bored raises in the Americas is a remarkable achievement, Fallon believed there was another milestone the project achieved.

"Our safety record," he said, "that is something we take great, great pride in." CIM

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Courtesy of Sandvik

Newtrax's Mining Data Platform allows for real-time monitoring of people at mine sites using its Newtrax Cap Lamp, which enables tracking and proximity detection and can also send emergency distress signals.

Smarter safety

New digital technologies are reshaping emergency preparedness and rescue operations, making underground mines safer, more productive and cost-efficient

By Mehanaz Yakub

Modern advancements in safety protocols, operational procedures and regulations have helped the industry make major strides in ensuring injuries and fatalities in mining are kept to a minimum.

Technology companies are also playing a crucial role in making mines safer than ever. From preventing accidents before they happen, to improving emergency response when they do, innovative technologies are transforming how the industry safeguards its workers underground.

Beyond safety, these companies are prioritizing advancing technologies that boost mine efficiency by helping mine operators respond faster to emergencies, minimize downtime and optimize overall operations.

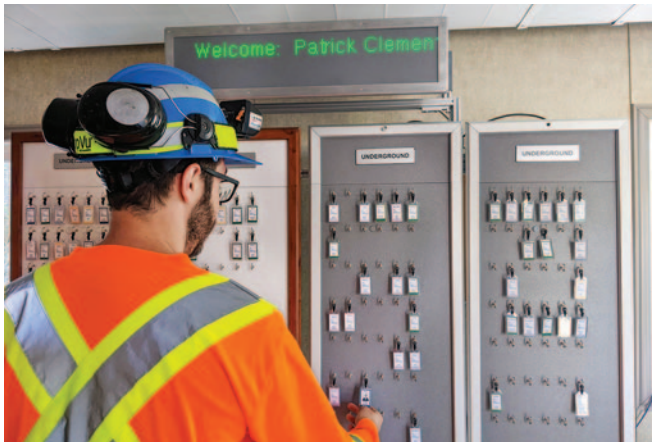
Smart tracking

In underground mining, ensuring every worker is accounted for is critical, but conventional personnel tracking methods often fall short. That is why Sudbury, Ontario-based TopVu developed a comprehensive emergency preparedness system centred around its patented smart eTag Board, designed to eliminate errors in traditional tagboards.

Traditionally, mines have relied on physical tag boards—also known as a check-in-check-out system—where mine workers manually move their identification tag to the "check-in" board when entering a mine and placing it in the "check-out" board when leaving.

"It's well known throughout the industry that a lot of people don't trust their tag board," said Yvan Brulé, technical director at TopVu. "Workers often forget to tag in, and they forget to tag out all the time."

Courtesy of TopVu



TopVu's eTag Board sends worker information to TopVu's web-enabled Q7 software.

This seemingly innocuous oversight can have life-or-death consequences in an emergency, he added. To solve this problem, TopVu's eTag Board uses radio frequency identification (RFID) technology embedded in stickers and chips that can be attached to hard hats, keychains and ID tags. A network of checkpoint antenna trackers—positioned at key mine access points like the cage entrance—automatically detects if a miner has failed to check in. The system then triggers alerts via relays, audible alarms, emails and local message display notifications for the worker to correct the mistake.

TopVu further enhances safety in a mining operation with RFID-enabled turnstiles for access control, integrated into its Q7 web-enabled software platform. This platform combines all RFID and location-tracking data into one interface. It includes a watchdog feature that allows mine operators to customize entry permissions based on individual profiles, schedules and training records. This flexibility makes it easy to adjust the system to fit different work requirements and safety rules of a mine's operations.

"[Our system] is the most efficient and cost-effective way to cover large areas because it requires no batteries or battery maintenance," said Brulé. "It minimizes infrastructure needs, is scalable and minimizes the pressure of having a complex system. Being both affordable and adaptable, it allows mines to expand as their needs grow."

The TopVu system also includes muster tap stations, which are designated meeting points where personnel can report to in order to streamline emergency responses. Installed at underground refuge stations or assembly points, these stations allow workers to tap their RFID tags upon arrival during an emergency. It instantly records their location, which is presented in the dashboard of TopVu's Q7 platform.

Brulé explained that a typical manual check-in process during real emergencies or drills can take up to two hours to account for all workers. With TopVu's real-time electronic tracking system, that time can be reduced to just 20 minutes.

"Delays could be directly related to loss of profit," said Brulé. "If we can accomplish that same emergency drill in 20 or 30 minutes and then release the workforce back to work, we can save them that much time and cost of production."

The system also collects other critical data that is useful in emergency response, including last known worker locations and recent checkpoint activity.

"This provides valuable information that mine rescue teams can use to make educated decisions and better manage the deployment of their resources where they are needed," added Brulé.

Cap lamp communication

Montreal-based Newtrax, part of Sandvik, has developed an advanced tracking system designed for underground mining.

At the heart of the system is the Newtrax Cap Lamp, which enables tracking and proximity detection and can also send emergency distress signals. When workers check into the mine, they tap their unique RFID tag on a tablet near the cap lamp rack. This assigns them a fully charged lamp and registers their presence underground. Their movements are subsequently tracked in near real-time on a 3D map through Newtrax's Mining Data Platform (MDP). The Newtrax MDP integrates vehicle collision avoidance, telemetry data, productivity data and real-time personnel tracking into a single, comprehensive platform.

In addition to providing near real-time positioning and tracking, which is dependent on network infrastructure, the Newtrax Cap Lamp is an advanced smart lamp device within the Newtrax product line's Proximity Detection and Collision Avoidance ecosystem. Equipped with ultra-wideband and other technologies, it enables peer-to-peer proximity detection without relying on any external network infrastructure.

According to Ryan Fusina, business line manager of automation for North America at Sandvik Mining and Rock Solutions, most customers initially approach the company for collision avoidance solutions to prevent vehicle-to-vehicle or pedestrian-to-vehicle incidents. However, he said that its potential for mine rescue remains largely untapped, as many customers are still unaware that the Newtrax Cap Lamp is equipped with a tracking mechanism capable of providing precise location data during emergencies, contingent on the coverage of the network infrastructure.

"The way [Newtrax Cap Lamp and MDP] operates is a combination of either Wi-Fi or LTE coverage, and that is combined with Bluetooth low energy (BLE) tagging underground," said Fusina.

BLE tagging is a type of battery-powered tracking device that can be attached to an asset and then used to detect the location and movement of people, objects and vehicles using wireless Bluetooth technology.

Courtesy of Sandvik

The Newtrax Cap Lamp sends mine-wide instant evacuation notifications.

"We're able to track the movements and the location of an individual within a few feet of their location," added Fusina.

From a mine rescue perspective, the Newtrax Cap Lamp and MDP system offers several life-saving advantages.

The system features an electronic tagboard that automates check-ins and check-outs. Newtrax employs BLE technology in wearable cap lamps that tracks the check-in-check-out process when workers retrieve or return their cap lamps. This ensures mine operators can quickly account for all personnel and streamline rescue efforts. It also improves shelter-in-place procedures by locating both the number and identity of workers in designated refuge areas.

The BLE-enabled Newtrax Cap Lamp allows for two-way communication between devices, making it ideal for applications that need current location updates and seamless data exchanges.

"[By] utilizing the cap lamp system with the people positioning, you also have a distress signal that [workers] can send through that cap lamp," said Fusina. If a lamp detects no movement for a set period (which is customizable by the mine operator), it flashes to alert the worker. If they do not acknowledge the flashing through any movement, the system waits another 90 seconds before sending a worker-down alarm to vehicles close by, and to the surface control room.

Another critical safety feature, Fusina added, is the ability to trigger a mine evacuation alarm from the surface control room. When triggered, the cap lamp will emit both an audible alarm and start rapidly flashing to signal to workers to evacuate.

Beyond safety, Newtrax's tracking technology is also boosting mine productivity. "Several customers have told us that they've seen a 10 to 20 per cent increase in productivity because they're able to identify where their people are at any given time," said Fusina. Knowing the exact location of personnel and equipment eliminates wasted time during shift changes and equipment retrieval.

Creating a digital advantage

For North Bay, Ontario-based SafeSight Exploration, the company's goal was to develop digital tools that enhance mine rescue operations by reducing the risks that first responders typically face when relying solely on manual search methods underground.

"In mine rescue, it's a four-step process," said Mike Campigotto, president of SafeSight. "You assess the emergency, you search and rescue, you evacuate and then you wrap up the emergency to get operations back on track. We looked at each one of those phases and asked the question: 'How might we create a digital advantage in each of these situations?'"

What SafeSight came up with is a suite of digitally powered tools designed to improve safety, efficiency and overall mine productivity during emergency response situations.

Leading SafeSight's Emergency Response Tool Kit is DeepTraxx, an advanced robotic ground-based vehicle able to assess underground emergencies, which can be controlled manually from 300 metres away or remotely from the surface using 5G technology.

Equipped with thermal imaging, high-definition cameras and 3D mapping capabilities, DeepTraxx scans emergency zones, locates trapped workers and provides real-time data to mine rescue teams on the conditions underground, allowing responders to stay safely above ground. "Once deployed, it can create a 3D model of the emergency area and help responders map out the safest path to recover people," said Campigotto.

Courtesy of SafeSight Exploration

The DeepTrax ground vehicle provides real-time video streaming that supports emergency response.

Over the past two years since DeepTraxx was first launched, the technology has further evolved for emergency readiness. "It can now carry a fire hose and remotely deploy fire responses," said Campigotto. "I can remotely create a water curtain to protect responders and [DeepTraxx] can go close to a fire to assess the situation without melting."

In addition, added Campigotto, DeepTraxx plays a significant role in post-incident analysis. "After the fact, teams can use the model to review what happened so they can improve operations and the rescue response in similar circumstances."

Complementing DeepTraxx in emergency assessment is the company's SafeScout emergency response drone. Launched three years ago, SafeScout brings the same capabilities as DeepTraxx to the air, from thermal imaging to multispectral sensors and high-definition cameras.

"If you can't navigate on the ground because of some roadblocks, you can deploy our drone," said Campigotto.

The final innovation in SafeSight's Emergency Response Toolkit is the powered Rescue Wheel—an electric wheel that attaches to a rescue basket stretcher that enables responders to evacuate injured workers with greater speed and efficiency.

"In today's world, rescuing an injured worker involves six people and a carry-out process that consists of stopping every 20 steps to rest while wearing heavy oxygen gear," said Campigotto. "An evacuation of 500 metres can take half an hour to 45 minutes."

With the Rescue Wheel, that same evacuation can be completed in just three to five minutes. The device helps to reduce the physical strain on responders and allows them to conserve oxygen. This extended oxygen supply enhances responders' ability to carry out search-and-rescue operations more efficiently.

"I think of the Rescue Wheel like a defibrillator—it can make the difference between life and death," said Campigotto. Beyond the life-saving benefits, he added that there is also a compelling business case for adopting SafeSight's technology.

"If you can get all injured workers out five times faster, you not only improve safety but also reduce downtime. A typical emergency outage in a mine lasts two days. If you shrink that in half, you've saved half a million dollars," said Campigotto. "An investment of our Rescue Wheel is around $13,000. You could recover a half a million dollars in savings just because you are back in the regular operation quicker—not to mention the potential to save lives." CIM

ITS

The Innovation & Technology Society of CIM

The innovation imperative

Learn more about ITS here

CIM introduces Innovation & Technology Society to help drive industry competitiveness

By Rosemary Mantini

The Innovation & Technology Society (ITS) was launched at CIM CONNECT in Montreal in early May to unite innovators and companies across the mining value chain. At the heart of this initiative is the drive to accelerate the development and adoption of solutions to the industry's most pressing challenges.

ITS is a call to action stemming from CIM's latest strategic plan, and was inspired by many conversations with people across the industry who are dissatisfied with the current pace of innovation and the loss of value this represents.

"Through ITS, we can help make the Canadian minerals, metals and energy sectors more competitive, relevant, sustainable and responsible," explained ITS chair, Laura Mottola, who is a specialist in mining optimization and continuous improvement. "We need industry partners, vendors, manufacturers, researchers, government and community leaders who are committed to this cause."

Diversity of thought, experience and perspectives are all seen as integral to developing high-quality innovations and solution-driven collaborations.

ITS will work with all CIM societies and branches and other industry organizations to catalyze connections along the value chain and all facets of the industry. While the scope of ITS is still being defined, Mottola emphasized the importance of both technological and business process innovations.

According to CIM CEO Angela Hamlyn, the new society "will support CIM's mission to advance knowledge and leading practices in Canada's minerals and metals industry by bringing together key players to address major challenges through innovative ideas, new technologies and collaborative solutions." The impact of this new society will be seen through meaningful collaborations that lead to positive outcomes for everyone involved.

ITS members will have the opportunity to harness their collective strengths, apply existing solutions and create momentum that attracts investment in future innovations.

Early discussions for the ITS executive team will include shaping the first ITS symposium in 2026 and determining the focus and methodology that the society will take to achieve its mission. CIM

Upcoming events

CIM Calgary Luncheon
May 21 | Calgary, AB

CIM Northern Gateway: 100 Years of Mining
May 30-31 | North Bay, ON

Mines and Environment Symposium
June 8-11 | Rouyn-Noranda, QC

Mining Society of Nova Scotia Conference
June 11-13 | Western Shore, NS

Data to Decisions: AI Adoption in Mining
June 11 | Toronto, ON

CIM Sudbury Lobster & Laughs Gala
June 13 | Sudbury, ON

See our Calendar of Events

CIM Awards

The CIM Awards honour industry's finest for their outstanding contributions in various fields. Their achievements and dedication are what make Canada's global mineral industry a force to be reckoned with.

Career Excellence | Carrière d'excellence

Vale Medal for Meritorious Contributions to Mining
Médaille Vale pour des contributions méritoires à l'exploitation minière

Jack Zhang

CIM Distinguished Service Medal
Médaille ICM pour services remarquables

Richard Arnold McIvor

Selwyn Blaylock Canadian Mining Excellence Award
Prix d'excellence Selwyn Blaylock pour l'exploitation minière canadienne

Roussos Dimitrakopoulos

CIM Fellowship
Confrérie de l'ICM

A. Paul Labbe

Steve Wilson

Niels Verbaan

Greg Romain

Andrew Taylor

Christopher Cormier

Branch and Society | Sections locales et sociétés techniques

District Distinguished Service Award
Prix de l'ICM pour services remarquables par district

Eastern District

Don Jones

Julian Boldy Geological Society Service Award
Prix Julian Boldy de la société de la géologie

Stella Searston

Mel W. Bartley Outstanding Branch Award
Prix Mel W. Bartley pour les accomplissements remarquables d'une section locale

CIM Quebec | ICM section Québec

Mining Engineering Outstanding Achievement Award
Prix pour des accomplissements remarquables en génie minier

Simon Nickson

Robert Elver Mineral Economics Award
Le prix d'économie des minéraux Robert Elver

Christopher Twigge-Molecey (Posthumous)

CIM Rock Mechanics Award
Prix pour la catégorie mécanique des roches

Ming Cai

Barlow Medal for Best Geological Paper
Médaille Barlow pour le meilleur article dans le domaine géologique

"Tourmaline breccia pipes of the Giant Copper porphyry system: Extending the Cascadia porphyry district into southern British Columbia, Canada" by W. T. Fischer, D. D. Marshall & J. Miller-Tait

Early Career | Début de carrière

CIM-Bedford Canadian Young Mining Leaders Awards
Les prix Jeunes Leaders Canadiens du Secteur Minier ICM-Bedford


Hannah Lang


Annabelle Rioux


Chad Sorba


Ben Scott

Safety | Sécurité


Janice Martell

Mining Safety Leadership Medal
Médaille pour le leadership dans la sécurité minière

Hatch-CIM Mining & Minerals Project Development Safety Award

Prix pour la sécurité des chantiers dans le domaine des mines et du minerai de Hatch-ICM


Voisey's Bay Mine Expansion

Excellence in Sustainable Development Award
Prix pour l'excellence en développement durable


Jenifer Hill

Towards Sustainable Mining Excellence Awards
Prix de l'initiative vers le développement minier durable

Environmental Excellence

Diavik Diamond Mine Solar Plant (Rio Tinto)

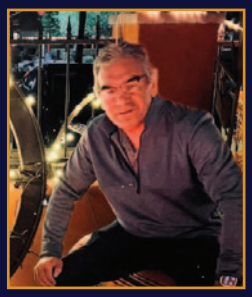
Community Engagement Excellence

Agnico Eagle's First Reconciliation Action Plan with Indigenous Peoples

Social Responsibility and Education | Responsabilité sociale et éducation

CIM Indigenous Partnership Award
Prix de l'ICM pour le partenariat avec les Autochtones

Cementation Canada Inc. and Mishkosiminiziibiing (Big Grassy First Nation)



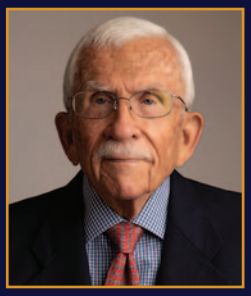
Eric Kohtakangas (left) leads Indigenous partnerships at Cementation; James Comegan (right) is founder of Mishkosiminiziibiing Development Corporation, where he works to foster economic growth and opportunities within the Big Grassy First Nation.

Diversity & Inclusion Award
Prix pour la diversité et l'inclusion

Stacy Kennedy

CIM Distinguished Lecturers | Éminents Conférenciers de l'ICM

Joël Kapusta



Terry McNulty

Nadia Mykytczuk

Lesley Warren

John T. Ryan Safety Trophies | Trophées John T. Ryan

Mine Safety Technology Imperial Oil Resources – Kearl Operations for "Track Topper – Dozer Track Kneeling Pad"

National Coal Westmoreland Mining, Poplar River Mine

National Metal Vale Canada, T1 Mine; Vale Canada, T3 Mine

National Select Suncor Energy Baseplant Projects and Common Services – Contract Mining

Regional Metal BC/Yukon New Gold Inc., New Afton Mine

Regional Metal Ontario Glencore, Kidd Operations

Regional Metal Prairies/Territories Agnico Eagle Mines Ltd., Meliadine Mine

Regional Metal Quebec/Atlantic Glencore, Raglan Mine

Regional Select East Agnico Eagle Mines Ltd., Canadian Malartic Mine

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Mohsen Mohammadi	University of New Brunswick
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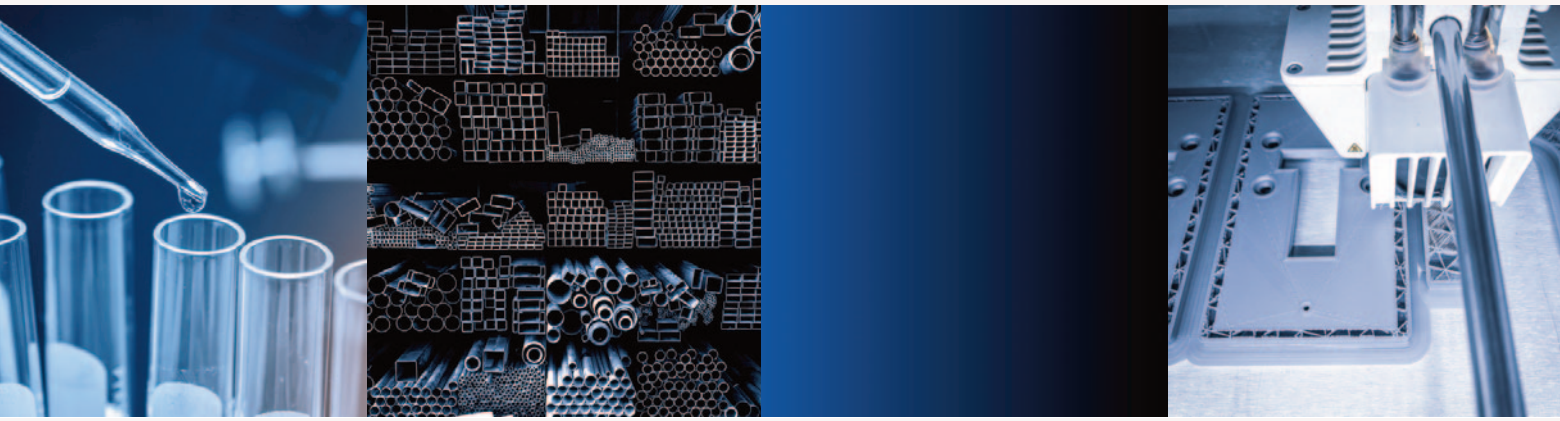

Plenaries

History of the aluminum industry in Canada: over 120 years of history

François Racine

President and CEO, AluQuébec

Challenges and future directions pertaining to in-situ characterization in additive manufacturing

Nikhil Gupta

Professor, Department of Mechanical and Aerospace Engineering, New York University

The Future of Responsible Aluminum: Connecting the entire value chain metals

Saurabh Sedha

Product Metallurgy, Rio Tinto

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WE WOULD ALSO LIKE TO RECOGNIZE OUR TIRELESS VOLUNTEERS AND SUPPORTING COMPANIES THAT ARE MAKING THIS HAPPEN!

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Continuous Improvement Methodologies to Assure Sustainable Metallurgical Operations

The course will offer a deep understanding on why projects fail, and the tools required to minimize financial/overall project risk. A detailed model of Operational Readiness will be covered, including how to assess based on the model. And finally, an introduction to Monte Carlo simulations with in-class exercises to understand how to set them up and use the information properly. In addition, the course will provide an introduction to some of the more robust and popular approaches to continuous improvement. This includes classic tools associated with Lean and Six Sigma, Control Charts and practical statistics on how to best identify significant factors affecting metallurgical performance.

Course Organizer: Analyze & Improve
Carmine Ciriello, Managing Director
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Introduction to Life-Cycle Assessment

This focused one-day workshop is designed to equip industry leaders, professionals and researchers in the minerals and materials sector with a comprehensive understanding of Life-Cycle Assessment (LCA). This interactive training will cover key modules, including LCA fundamentals, sector-specific applications, data collection and analysis, integrating sustainability metrics, and practical implementation for decision-making and reporting through hands-on exercises. Participants will gain actionable insights into applying LCA to evaluate environmental, social and economic impacts, and to foster innovation within their operations.

Course Organizer:
Qian Zhang, Queen's University
TBA, Minviro, LCA Software & Consultancy

Cost: $600 professional, $300 student

These professional development courses can be purchased without attending the conference or combined with your COM registration with an added discount.

SECTION
FRANCOPHONE

MAI 2025

Questions de politique

Il y a quelques années, lors d'un congrès et salon commercial sur l'industrie minière aux États-Unis, j'ai rencontré un homme qui avait été mineur dans l'est des États-Unis. Il était à la fois aimable et bourru. Il m'a raconté certains détails de son travail dans les mines de charbon souterraines et les accidents évités de justesse auxquels il avait survécu. Lorsqu'il se remémorait qu'il avait failli mourir enseveli sous du charbon et qu'il avait dû s'extirper seul des décombres, ce n'est pas avec soulagement qu'il évoquait cette époque révolue, mais avec fierté d'avoir eu le courage de travailler dans un environnement aussi risqué et de s'en sortir sain et sauf.

Il parlait avec dédain de la *Mine Safety and Health Administration* (MSHA, l'administration de la santé et la sécurité dans les mines), chargée d'assurer le respect des réglementations en matière de sécurité. Selon lui, l'agence n'a fait qu'empêcher les personnes de faire leur travail. De son côté, la MSHA a eu un impact considérable sur la sécurité dans les mines américaines. Dans les cinq années qui ont suivi sa création en 1977, les accidents mortels par nombre de houilleurs ont diminué de 30 % par rapport aux cinq années précédentes. Au fil du temps, toutefois, le nombre de houilleurs a décliné, mais pas aussi brusquement que le nombre d'accidents mortels.

Cet ancien houilleur était toutefois présent à l'événement pour promouvoir le *National Institute of Occupational Safety and Health* (NIOSH, l'institut national pour la sécurité et la santé sur les lieux de travail). Tout comme la MSHA, le NIOSH a été créé dans les années 1970. Il n'avait pas pour mission de renforcer les réglementations, mais de chercher la cause des blessures, maladies, handicaps et décès en lien avec le lieu de travail, et de fournir une orientation afin de les éviter. Si la MSHA contraint les mineurs à appliquer les réglementations en matière de sécurité à grand renfort de mesures punitives, le NIOSH est là pour les aider à éviter les accidents.

Le NIOSH, par exemple, a contribué à une recherche récente qui a identifié la raison de la hausse drastique des cas de pneumoconiose du houilleur chez les mineurs travaillant dans les mines de charbon des Appalaches, malgré des contrôles plus stricts sur l'exposition à la poussière de charbon. Les machines modernes d'exploitation du charbon, semblerait-il, génèrent plus de poussière de silice car elles peuvent découper la roche située au-dessus et en dessous des filons de charbon. Toute cette poussière de silice supplémentaire détruit les poumons des mineurs à un rythme alarmant.

De nouvelles réglementations visant à résoudre ce problème ont été mises en application l'année dernière. La conformité à ces dernières est requise d'ici le mois d'avril cette année.

Bien entendu, les choses ont pris une tournure toute différente ces derniers mois. L'administration Trump encourage l'exploitation du charbon, les ressources de la MSHA ont été considérablement réduites, l'entrée en vigueur de nouvelles limites pour la poussière de silice dans l'exploitation du charbon a été provisoirement suspendue, et le département du NIOSH dédié à l'exploitation minière a été en grande partie supprimé.

Bien sûr, j'ai mon opinion sur la chose, mais je préférerais savoir ce qu'il est advenu de ce houilleur devenu fonctionnaire, et entendre son opinion quant à la conjoncture actuelle.

Ryan Bergen, Rédacteur en chef
editor@cim.org

Avec l'aimable autorisation de Candace MacGibbon

Des liens pour un avenir solide

En tant que nouvelle présidente de l'ICM, c'est un privilège d'accueillir une année qui s'annonce transformatrice pour notre industrie. Nous sommes témoins d'une incertitude sans précédent sur le plan des politiques et des marchés. Nos membres joueront un rôle important pour maintenir la croissance dans l'industrie des ressources du Canada et pour soutenir notre économie au cours des décennies à venir.

Dans l'esprit de la collaboration, de l'innovation et de l'amélioration continue, je suis heureuse de partager quelques thèmes d'actualité que nous avons récemment présentés lors du congrès CIM CONNECT 2025 et dans cette édition du magazine.

CIM CONNECT : minéraux, innovation et transition énergétique

Plus qu'un simple congrès, CIM CONNECT est le battement de cœur de notre communauté professionnelle. Cette année, l'événement a eu lieu à Montréal du 4 au 7 mai. Il a permis aux chefs de file, aux professionnels, aux étudiants et aux membres de la communauté, hommes et femmes, de se réunir pour partager des idées, aborder les difficultés et imaginer l'avenir des mines et des matériaux pour soutenir la transition énergétique.

CIM CONNECT est aussi une plateforme nous permettant de mettre à l'honneur l'excellence dans notre industrie. Le gala de remise des prix de l'ICM a mis à l'honneur des individus et des organisations dont les contributions ont révolutionné notre industrie et renforcé notre communauté (voir p. 50 pour la liste des lauréats et lauréates de cette année).

Les femmes dans l'industrie minière : le moteur du changement et de l'esprit de décision

La diversité est un moteur de performance, d'innovation et de sécurité. Nous sommes fiers d'appuyer des initiatives qui promeuvent la diversité au sein du secteur des ressources. Nous nous engageons à garantir que notre industrie accorde aux parties prenantes la valeur et l'autonomie qui leur revient. L'ICM est fier de soutenir les femmes qui transforment l'industrie minière, depuis la salle de conseil d'administration jusqu'à la paroi rocheuse (voir notre article de fond en p. 38, uniquement en anglais).

Sécurité et sauvetage minier : au cœur de nos actions

La sécurité reste la base de notre travail. Rien n'est plus important que de nous assurer que chaque travailleur et travailleuse rentre chez lui ou chez elle en toute sécurité. L'ICM est un fervent défenseur de la promotion de la culture de la sécurité, de la technologie et de la formation. Nos membres partagent activement les meilleures pratiques en matière d'intervention en cas d'urgence, de santé mentale, d'automatisation et d'atténuation des dangers, dont l'objectif est d'éliminer les incidents et accidents (lire notre article en p. 46, uniquement en anglais).

Métallurgie et matériaux : l'innovation dans chaque atome

L'innovation dans le domaine de la métallurgie et de la science des matériaux est essentielle à la transformation efficace de nos ressources en matériaux qui soutiennent l'infrastructure internationale et les systèmes énergétiques. Qu'il s'agisse d'améliorer la récupération dans les minerais complexes, de réduire l'impact sur l'environnement ou de développer de nouveaux matériaux et des technologies émergentes, nos métallurgistes et ingénieurs des matériaux sont à la pointe de l'innovation (voir p. 34 et 36, uniquement en anglais).

Tournés vers l'avenir

L'ICM est un lieu d'idées, d'esprit de décision et d'apprentissage tout au long de la vie. Que vous soyez étudiant·e en pleine découverte de votre passion, professionnel·le en quête de perfectionnement ou dirigeant·e modulant la politique et l'orientation, l'ICM est là pour vous soutenir dans votre parcours. Continuons à bâtir un avenir qui reflète nos valeurs : la sécurité, l'inclusion, l'excellence et la durabilité.

J'ai pris beaucoup de plaisir à vous rencontrer à CIM CONNECT, et j'attends avec impatience de rencontrer d'autres personnes dans l'année à venir. Faisons connaissance, collaborons et continuons à façonner ensemble l'avenir de l'industrie minière.

Candace MacGibbon
Présidente de l'ICM

Les actualités

Le Canada renonce à l'approbation fédérale de certains grands projets

En amont d'une élection fédérale anticipée, le Premier ministre a dévoilé une série de mesures visant à renforcer l'économie du Canada dans un contexte commercial difficile

Par Ashley Fish-Robertson

Avec l'aimable autorisation de Cedar LNG

Le projet Cedar LNG (rendu en photo ci-dessus), une proposition de centre d'exportation de gaz naturel liquéfié dirigé par des Autochtones en C.-B., recevra un financement fédéral qui lui permettra de se concrétiser.

Le 21 mars dernier, peu de temps après la réunion de ses premiers ministres avec les premiers ministres provinciaux à Ottawa, le Premier ministre Mark Carney annonçait plusieurs initiatives visant à soutenir l'économie du Canada et à réduire les obstacles au commerce interprovincial. Parmi ces mesures figure une politique visant à permettre la concrétisation de projets miniers et d'infrastructure majeurs sur simple approbation des provinces et des territoires, éliminant ainsi la nécessité d'une approbation fédérale, qui ferait double emploi.

« Cela signifie donc un projet, un examen, et nous collaborerons avec les provinces et les autres parties prenantes, les groupes autochtones, pour identifier les projets ayant une importance nationale, et pour accélérer le délai de construction », déclarait M. Carney lors d'une conférence de presse le 21 mars.

Au vu de l'appel de M. Carney à une élection fédérale anticipée, le dirigeant conservateur Pierre Poilievre a renforcé sa campagne, notamment en incluant une visite le 19 mars à Sudbury, en Ontario, pour annoncer son projet d'accélérer le développement de la région du Cercle de feu dans les six mois s'il était élu. Toutefois, l'évaluation environnementale pour le projet de liaison des routes du Nord, qui relierait la région du Cercle de feu au réseau autoroutier de l'Ontario, ne devrait pas être terminée avant 2026, ce qui contrevient à la promesse de M. Poilievre de terminer le projet dans les six mois.

Le 28 janvier, le gouvernement de l'Ontario s'est engagé à investir plus de 90 millions de dollars pour rénover l'infrastructure vitale dans le nord de la province, dans l'optique de soutenir l'exploitation minière dans la région du Cercle de feu et de relier les communautés des Premières Nations aux principales autoroutes.

L'annonce du Premier ministre d'un système d'obtention de permis sur la base d'une « évaluation unique » s'est accompagnée de plusieurs autres mesures visant à débloquer d'autres projets économiques nationaux. Le gouvernement fédéral a accepté d'investir jusqu'à 200 millions de dollars pour la construction, la mise en service et l'exploitation du projet de Cedar LNG, une proposition de centre d'exportation de gaz naturel liquéfié dirigé par des Autochtones, situé près de Kitimat, en Colombie-Britannique (C.-B.). Ce projet est un partenariat entre la nation Haisla et la Pembina Pipeline Corp. Sa construction devrait coûter environ 5,8 milliards de dollars. Le projet a réuni toutes les approbations réglementaires nécessaires. Les premiers travaux de construction sont en cours et les activités devraient commencer d'ici la fin 2028.

« Cela signifie donc un projet, un examen, et nous collaborerons avec les provinces et les autres parties prenantes, les groupes autochtones, pour identifier les projets ayant une importance nationale, et pour accélérer le délai de construction »

– Premier ministre Mark Carney

Pour les années à venir, M. Carney soulignait plusieurs projets qui pourraient bénéficier d'un processus d'examen plus rapide, notamment le projet de route et port de Grays Bay dans l'ouest du Nunavut, qui vise à relier la province géologique Slave dans le Nunavut et les Territoires du Nord-Ouest, riches en gisements de minéraux, à un port en haute mer par l'intermédiaire d'une route praticable en toutes saisons, et le développement de la région du Cercle de feu dans le nord-ouest de l'Ontario.

Le gouvernement fédéral investira également 175 millions de dollars dans le chemin de fer de la baie d'Hudson et le port de Churchill au Canada pour ouvrir de nouveaux couloirs de transport, promouvoir la croissance économique et la réconciliation dans l'Arctique et le grand Nord, et renforcer l'accès aux marchés internationaux pour les produits canadiens. Ce financement vient à la suite de l'engagement du gouvernement de Manitoba en février dernier d'investir 36,4 millions de dollars au cours des deux années à venir dans l'Arctic Gateway Group en vue de soutenir les projets d'infrastructure au port. ICN

Acquisition d'Angus Gold par Mines d'Or Wesdome

Le 7 avril, Mines d'or Wesdome annonçait son projet d'acquisition de la petite société minière Angus Gold dans le cadre d'une transaction d'actions émises contre espèces estimée à environ 40 millions de dollars. Cette acquisition étendra la taille du territoire de Wesdome à son exploitation d'Eagle River, située à 50 kilomètres de Wawa, en Ontario, en consolidant deux propriétés adjacentes, dont le projet d'exploration Golden Sky d'Angus Gold, en un ensemble de terrains stratégiques contigus d'environ 400 kilomètres carrés (km^2) situés sur la ceinture de roches vertes du lac Mishibishu.

Le site d'Eagle River comprend une mine d'or souterraine et un concentrateur, en production depuis 1995, ainsi que la mine d'or à ciel ouvert de Mishi, en production depuis 2002.

L'arrangement nécessitera l'approbation d'au moins deux tiers des votes exprimés par les actionnaires d'Angus Gold, ainsi que celle de la Cour supérieure de justice de l'Ontario. Une assemblée extraordinaire des actionnaires d'Angus devrait se tenir en juin. La conclusion de la transaction est prévue pour le deuxième trimestre 2025. La valeur d'Angus Gold a augmenté de 60 % à l'annonce de cette transaction.

L'acquisition permettra à Wesdome de pleinement exploiter l'infrastructure existante à sa mine et son concentrateur d'Eagle River pour soutenir l'exploration et le développement potentiel à son projet de Golden Sky, à proximité.

« Au nom du conseil d'administration d'Angus Gold, nous sommes ravis d'avoir conclu une entente avec Wesdome », déclarait Breanne Beh, présidente et directrice générale d'Angus Gold dans un communiqué de presse le 7 avril. « Depuis 2020, grâce à une série d'acquisitions de propriétés, nous avons consolidé un ensemble de terrains à l'échelle du district, réalisé plus de 40 000 mètres de forage et fait d'importantes découvertes d'or. »

« Depuis 2020, Angus a investi plus de 20 millions de dollars dans l'exploration du projet Golden Sky, générant un portefeuille de cibles et confirmant la continuité géologique avec Eagle River », indiquait Anthea Bath, présidente et directrice générale de Wesdome, dans ce même communiqué. « Wesdome continue de croire fermement aux perspectives de découverte du camp d'Eagle River et au potentiel plus large de notre stratégie de remplissage de l'usine. Cette transaction représente un investissement stratégique dans cette vision et souligne notre engagement à long terme à dégager de la valeur à Eagle River. »

Avec l'aimable autorisation de Wesdome Gold

L'année dernière, le site de Wesdome à Eagle River en Ontario a produit 94 561 onces d'or, dépassant ainsi les estimations de 89 000 à 93 000 onces.

Wesdome espère mener rapidement le projet de Golden Sky jusqu'à la phase de production, compte tenu de la proximité de ses infrastructures existantes à l'exploitation d'Eagle River.

Il convient également de noter que cette transaction marque un arrangement entre deux sociétés minières canadiennes dont les PDG sont des femmes.

– Ashley Fish-Robertson

PRESSURE POINT

The origin stories of our industry are contained within the digital archives of the *CIM Bulletin*, the predecessor to *CIM Magazine*. In this issue, we examine how a collaboration between industry and academic researchers led to the pioneering of a nickel sulfide ammonia leach process

By Ailbhe Goodbody

The Sherritt Gordon ammonia leach process was originally developed to process nickel-copper sulfide ore from deposits in Lynn Lake, Manitoba. "It was [the] fortunate turn of events that brought Sherritt Gordon and Chemico together, and the piloting that followed, that gave birth to commercial pressure hydrometallurgy," wrote M.E. Chalkley, P. Cordingley, G. Freeman, J. Budac, R. Krentz and H. Scheie (*Proceedings of Pressure Hydrometallurgy 2004)*.

Sherritt Gordon Mines had been operating a copper-zinc mine at Sherridon, Manitoba, since 1931, but by 1946 it was estimated that it had just four years of production left. The company intended to use the mining and milling equipment from Sherridon to treat ore from a planned mine at Lynn Lake, approximately 240 kilometres to the north.

Professor Frank Forward, then head of the department of mining and metallurgy at the University of British Columbia (UBC), wrote in *CIM Bulletin* (November 1953) that "a number of unusual problems were faced in transferring plant and operations from the one mine to the other, and particularly in preparing to undertake nickel production."

Preliminary tests of the Lynn Lake ore at Sherritt's laboratory in Sherridon showed that it could be concentrated by flotation to produce a copper concentrate that contained 28 to 30 per cent copper with less than one per cent nickel, as well as a nickel concentrate containing 11 to 14 per cent nickel, 0.3 to 0.4 per cent cobalt and less than two per cent copper, with high recovery of the three metals in the concentrates, according to Forward (1953).

However, the economics were unattractive for a standalone smelter at Lynn Lake. "It was indicated that operating costs might be high due to the location of the mine, the cost and availability of fuel, fluxes and power, and the high labour requirement usually associated with smelting and refining processes," wrote Forward (1953). "Another disadvantage of these processes is that much of the cobalt is usually lost in the smelting operation."

Research and development

The results of this early work were promising enough to convince Sherritt Gordon to finance a test program. The company sent Forward some nickel concentrate samples from Lynn Lake for evaluation.

"Although the period between discovery and commercial operation of a new process is usually about 10 years, the development period had to be considerably shorter than this, as it was necessary to start production at Lynn Lake as soon as possible after the Sherridon mine was shut down," wrote Forward (1953). "This meant that the maximum period available was about five years."

In 1947 and early 1948, the Sherritt-funded test program at UBC focused on adapting the Caron process—recently commercialized at Nicaro in Cuba to treat nickel laterite ore—to roasted Lynn Lake concentrate.

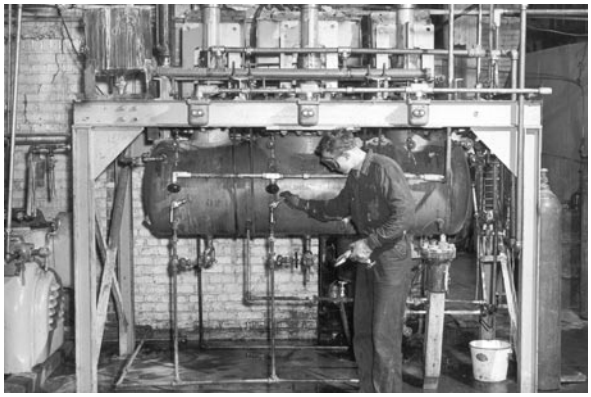
"With the introduction of certain variations, [it] could be used to extract and recover both nickel and copper from a nickel-copper sulfide concentrate, ore or matte," wrote F.A. Forward, C.S. Samis and V. Kudryk (*CIM Bulletin*, June 1948). "If electrolytic hydrogen could be employed as a reducing agent, the process might be operated in an area where low-cost power is available."

However, D.G.E. Kerfoot (*CIM Bulletin*, June 1999) noted that during the course of their work, Forward's team stumbled on the discovery that nickel and copper sulfides could be leached directly in the ammoniacal ammonium carbonate solution in an oxygen atmosphere.

Sheritt Gordon, Forward and Chemical Construction Corporation (Chemico)—a subsidiary of American Cyanamid that had also been studying techniques for pressure leaching sulfide ores—met in December 1948 to discuss the design and engineering of a pilot plant to develop the novel ammonia leach process.

"Of particular interest was the fact that Chemico engineers had found that nickel could be readily precipitated from ammoniacal solutions by hydrogen under pressure. As it appeared that this technique would greatly simplify the production of nickel metal from the leach solution, plans were made to incorporate the hydrogen reduction treatment in the ammonia leach process," wrote Forward (1953).

Sherritt and Chemico collaborated on a series of four increasingly sophisticated pilot plants, through which the commercial process was developed.



Neil Colvin operating a Sherritt pilot plant autoclave in Ottawa circa 1951 (*CIM Journal*, 2018)

"The comprehensive investigations carried out in laboratories and pilot plant during the next four years provided extensive technical information on a process in which the nickel sulfide concentrate is leached with ammonia and compressed air, the nickel, copper and cobalt are dissolved and subsequently separated and recovered, and the sulfur is converted to ammonium sulfate, which is recovered as a by-product," wrote Forward (1953).

"The new process can produce high-purity nickel, copper and cobalt at a cost appreciably lower than if conventional smelting and electrolytic refining were used."

Fort Saskatchewan refinery

In January 1952, Chemico got the contract for the design and construction of a nickel refinery. Forward (1953) noted that the integration of an ammonia plant with the metal recovery plant would place Sherritt Gordon in a favourable position to produce chemicals in addition to the planned production of nickel, copper and cobalt.

"When the plant commences operation in 1954, Sherritt Gordon will not only become a producer of refined metals but will also be entering the field of chemical production. From the outset, ammonium sulfate will be one of the chief products of the plant, its value exceeding that of either copper or cobalt," he wrote.

The site selected for the nickel refinery was an 800-acre parcel of land outside Fort Saskatchewan, Alberta, approximately 24 kilometres from Edmonton.

"The Alberta site was dictated by the requirement for natural gas as the feedstock for ammonia production, this being prior to the development of widespread pipeline networks," wrote Kerfoot (1999). "A site on the Canadian National Railway was mandatory, because this was a condition under which the CNR had agreed to build the rail link to Lynn Lake. A further consideration was that the site should have good access to the Port of Vancouver to facilitate the export of the ammonium sulfate by-product for which at that time there was no local market."

Construction work began on the refinery in May 1952. The railway reached the Lynn Lake mine at the end of October 1953, and ore production and concentrate shipment started on schedule in November.

According to Chalkley et al (2004), leaching of concentrate started on May 24, 1954. "By June 19, the leach circuit was filled and by July 15 feed liquor was available for the metal recovery section," they wrote. "On July 21, 1954, the first nickel metal was produced and met specifications. The plant reached 90 per cent of design capacity by the end of 1954 and operated at design capacity during 1955."

In 1957, Sherritt Gordon acquired the Chemico patents related to autoclave processes. "These patents covered inventions, which were made or developed during the period 1947 to 1956, leaving Sherritt as sole owner of jointly developed technologies," wrote Chalkley et al (2004).

D. Maschmeyer and B. Benson (*CIM Bulletin*, September 1965) reported on the first 10 years of utilizing the ammonia leach process at the Fort Saskatchewan refinery. "A continuing development program, along with the expansion of certain facilities, has enabled the refinery to attain a production rate of 31,000,000 pounds of nickel per year by hydrogen reduction," they wrote. "This represents an increase of approximately 85 per cent over the original design capacity of the plant."

R. Stauffer and S. Lindsay (*CIM Bulletin*, June 1967) recorded that a supplementary acid leach circuit, installed in May 1962, had increased total cobalt production capacity to over 700,000 pounds per year.

Legacy

Kerfoot (1999) noted that much of Sherritt's current metallurgical and product technology can be traced back to work done during the development of the ammonia leach process. "Pressure leaching of sulfide ores and concentrates, using continuous horizontal autoclaves, has provided the basis for a thriving pressure hydrometallurgical process licensing business which currently offers processes for treating nickel mattes and concentrates, zinc concentrates and refractory gold ores and concentrates," he wrote. "By 1980, 40 per cent of free world refined nickel metal was produced by this technique."

When the Lynn Lake mine was shut down in 1976, Sherritt was forced to look elsewhere for its main supply of feed, according to Chalkley et al (2004). "The refinery had been augmenting mine output by treating small amounts of mattes and secondary materials since the early 1960s. For the next 15 years, numerous types of feed were processed," they wrote.

In 1991, Sherritt started obtaining feed as a mixed sulfide from the Pedro Sotto Alba plant in Moa, Cuba. The Moa Joint Venture, which was created in 1994, is 50:50 joint venture between Sherritt and General Nickel Company S.A. of Cuba. "Today, Moa sulfides account for 95 per cent of the refinery feed," noted Chalkley et al (2004).

On Feb. 23, 2019, the Fort Saskatchewan refinery produced its three billionth pound of finished nickel. CIM

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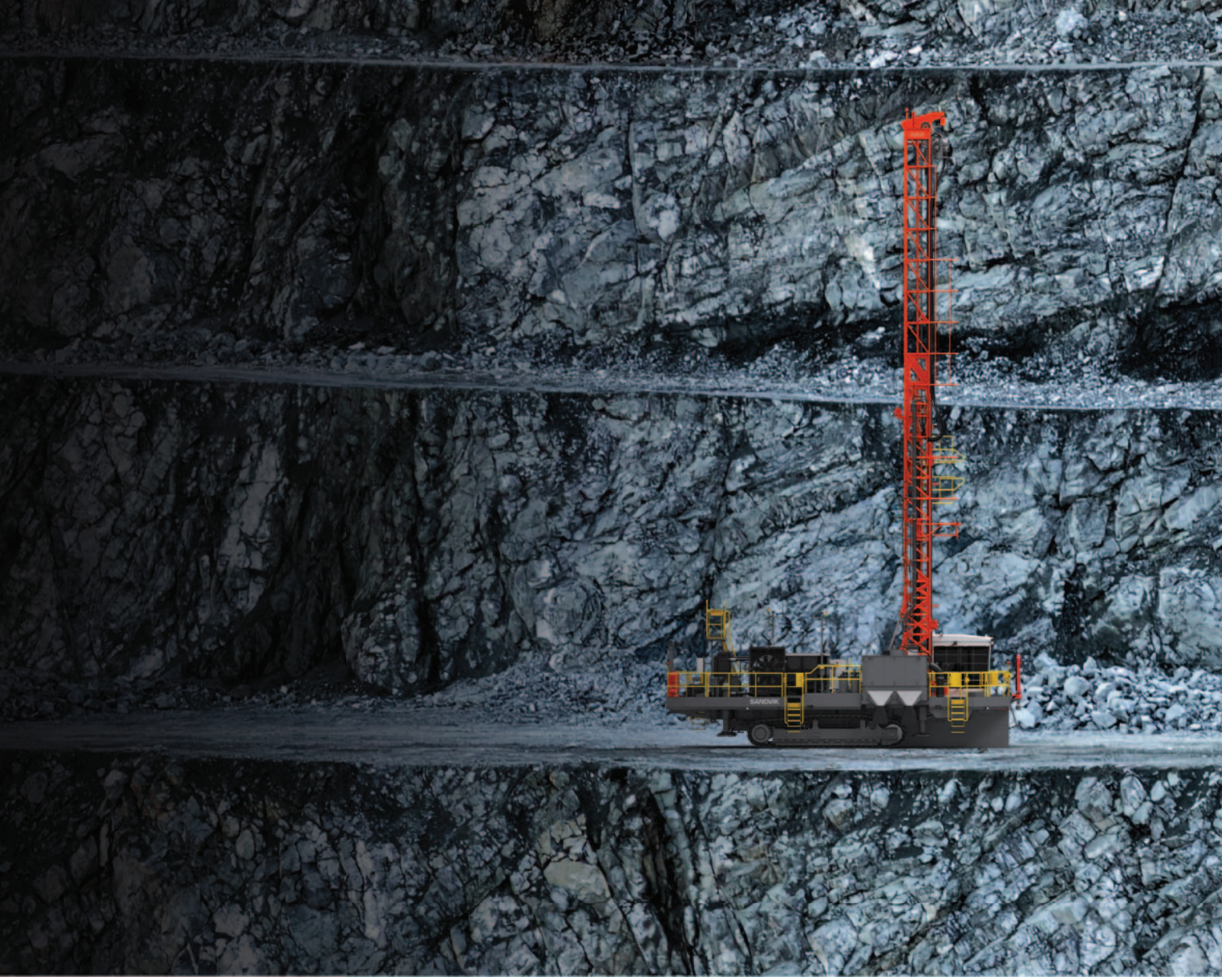

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