



GLOBAL BUSINESS REPORTS

MINING IN ONTARIO AND
TORONTO'S GLOBAL
REACH 2023



Pre-Release Edition

Introduction to Ontario

Mining becomes a key pillar of economic transformation

It is unclear precisely when Ontario decided to establish a dedicated mining ministry. Some speculate that its initiation came alongside the discovery of silver in the town of Cobalt in 1904, or gold in Kirkland Lake in 1906, possibly even when gold was found in Porcupine and Timmins in 1909. Regardless of the precise origin, Ontario's government set the legal parameters for entrepreneurs from all different backgrounds to prospect, engineer, develop, operate, and service mines that have delivered enormously positive benefits to Ontario's local economies, not to mention the province overall. Over a century later, a standalone ministry is back, and the economic stakes are higher than ever.

The need to meet growing demand for metals used in cutting edge technology and electric vehicles (EVs) is more pressing than ever before, while simultaneously, geopolitical tensions are forcing manufacturers and governments to consider pathways to more resilient supply chains. In response, Ontario published its first Critical Minerals Strategy in April of 2022. The report found that it was essential that the province marry the mineral potential of Northern Ontario with the industrial might of Southern Ontar-

io. Minister George Pirie, formerly mayor of Timmins, after many years as a mining industry executive, was brought in to expedite the development of this critical mineral supply chain with Ontario at the epicenter. "Our mandate is to once again become the number one jurisdiction for mining. We want to do that because it is imperative that we modernize into a green, carbon neutral economy. The reality is the world needs Ontario's minerals," Pirie proclaimed.

Fortunately, the province already possesses many of the pieces required to achieve these ambitious energy transition goals. There are a wide array of juniors with promising exploration projects, majors have long been producing in Ontario, and the province has proven itself to be one of the most advanced when it comes to engineering and technological integration. Critical minerals are already a C\$3.5 billion-a-year industry in Ontario, according to government figures. However, the C\$3.8 billion in support over eight years that government has pledged to implement Canada's first Critical Minerals Strategy should generate a far larger industry.

"If you want to be a climate change advocate and someone who can affect change, this industry will need you. The industry itself is in a time of transition, and needs talent that can transition with it."

Lesley Warren,
Director,
Lassonde Institute of
Mining,
University of Toronto



"If the government can spend more money on infrastructure, it opens things up and drives down the cost of exploration and mine development. Furthermore, infrastructure spending has an add-on permanent benefit for nearby communities."

Denis Frawley,
Partner,
Ormston List
Frawley LLP



The early signs are promising. In the past year alone, Vale has spent C\$945 million to bring the old Copper Cliff South mine back to life, generating 270 Sudbury area jobs in an instant. South Korea-based LG Energy Solution (LGES) also deepened its commitment to the province by signing agreements to source lithium and cobalt from two Ontario-based mining companies —Electra Battery Materials, and Avalon Advanced Materials. These offtake agreements will feed the C\$5 billion EV battery plant LGES is in process of building in Windsor, Ontario.

juniors. Close to 50% of companies on the TSX started out on the TSXV, and approximately 20% of those companies that graduate have gone on to be included in the S&P/TSX Composite Index. Dean McPherson, head of business development - global mining for the Toronto Stock Exchange and TSX Venture Exchange, offered: "We are a unique market in the sense that we have a place for mining companies at every stage of the growth cycle; from early-stage exploration through to production. Between the TSX and TSXV we have a place for most companies regardless of stage." ■

Ring of Fire Heats Up

Perhaps the most promising mineral development opportunities for critical minerals in the province lie in the Ring of Fire, 500 km northeast of Thunder Bay. Government has earmarked C\$1.5 billion for infrastructure investments to unlock new mineral projects in critical regions, such as the Ring of Fire. But this is not without its challenges. The region is cut off from the rest of Ontario, and projects require substantial taxpayer investment in roads and infrastructure, in addition to buy-in from surrounding First Nations. Despite this, Perth-based Wyloo Metals offered C\$617 million in cash to buy Noront Resources, outbidding fellow Australian mining giant BHP Group.

"What attracted us most was that we liked what the (Noront) team was doing from a First Nations perspective. We knew the project had a long history, and that it had been stranded for a long time. However, seeing the shift change that Noront's management team had achieved over the last five years was incredibly compelling," Wyloo CEO, Luca Giacovazzi explained.

Toronto Remains the Lifeblood of Mine Finance

No major industrial transformation is possible without free access to capital. This is especially true of industries as capital intensive as mining. Thankfully, the TSX and TSX Venture Exchange (TSXV) exist to keep liquidity flowing to the sector regardless of cycle. The exchange raises more equity capital for mining companies than any other globally, and over the past five years, 35% of equity financing for mining went through the TSX and TSXV. The two-tier system the exchange offers is one that is deeply focused on upward mobility for

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Cultivating the Next Generation of Miners

Fostering an ecosystem of innovation to attract new talent

There is a common perception that much of the research produced by academia dies in academia without ever having any practical real-world application. This dynamic is now changing. Ontario has immeasurable multidisciplinary talent coming from its universities and, in recent years, the mining industry has looked to tap academia to help develop scientific breakthroughs that can be leveraged to achieve their commercial goals.

As the mining industry shifts to meet market demands for lower carbon footprint operations and greater efficiency in exploration, the needs of the mining companies are increasingly converging with the world of academia. In this context, the industry is fortunate to have institutions such as University of Toronto's Lassonde Institute of Mining and Laurentian University's Mineral Exploration Research Center (MERC).

While the Lassonde Institute has a long tradition of exploration and hard rock mining expertise with a strategic focus on the development of advanced models and technologies, it is now adding research themes in the ESG space, under its new Global Resources Stewardship Initiative (GRSI). This reflects the need for cross-disciplinary research to tackle challenges as well as the need for partnership models that enable different ways of doing research that are more effective and timely for industry. "We have a great opportunity to leverage the resources University of Toronto offers in order to develop ideas around multifaceted, multidisciplinary and collaborative research ecosystems," Lassonde Institute director Lesley Warren stated.

Undoubtedly one of the pinch points for miners today are challenges associated with gaining social license. If coupled with an inability to attract investment, the industry's capacity to meet future demand for metals could be hampered. Warren posits: "This speaks to the need for stronger knowledge baselines that can enable sound industry ESG outcomes and gain stakeholder trust," while also highlighting the need for the mining community to recognize that resilience and reducing ESG risks are one in the same: The elixir: "transformative innovation underpinned by research."

To understand the impact University labs can deliver, one can look at Warren's research that centers on integrating emerging molecular biological techniques and applying them to mining contexts. Too often geochemical models fail to predict outcomes in mining contexts, which explains why the industry is so often reactive. It lacks early warning tools that could enable to adaptively manage and prevent environmental impacts. By applying molecular tools developed by microbiologists and applied far more widely in other contexts such as the oceans, soils and the human gut, Warren's lab was able to start interro-



Ross Sherlock,
Director of MERC and
Metal Earth,
Laurentian University

gating what microbes occurring in mining wastewater and reclamation environments were doing.

The findings show that there are uncharted opportunities once we start to identify these bugs and what they are able to do, given the conditions under which they act. Warren explained: "We can immediately see that we open up several levers by which mines can develop smarter designs that do not rely exclusively on the static application of chemicals, which require infrastructure and energy, to treat symptoms. We are now looking at innovating around root cause – design, and adaptive management."

This style of translational finding is enormously beneficial to mining companies, because it is fundamentally rooted in rigorous science, yet it is not something mining companies would implement in their day-to-day work.

A similar rationale drives the work that Laurentian University's MERC and Metal Earth Project are taking on. The focus is on understanding the processes that result in differential metal endowment. As an example, it investigates why some parts of the earth's crust are so metal-rich and other areas with similar geology are metal-poor. Now in year seven, the project has evolved from a focus on field-based survey-intensive projects into one that is prioritizing compilation and data analytics. "By understanding what controls metal endowment, we can inform mining companies with respect to reducing risk for greenfield exploration," said Ross Sherlock, director of MERC and Metal Earth, and Chair in Exploration Targeting at Laurentian University. "Our work is also useful for many stakeholders, such as communities and governments, who are making land use planning decisions by highlighting areas with the best mineral potential."

The vision is for MERC to be the go-to research institution for companies looking for help and guidance in their exploration programs in Precambrian terrains. In Timmins, Metal Earth partnered with several mining companies, including Newmont, Canada Nickel, International Explorers and Prospectors Inc., and Pan American Silver.

These industry partners helped fund the institution to complete much higher-resolution surveys over their properties of interest, and Metal Earth is now integrating those data sets, as well as other publicly available data sets, to create a 3D model of the crustal architecture of the Timmins gold camp. "It is a win-win partnership. Ultimately, all this information becomes public data." Sherlock proclaimed.

Talent is the greatest natural resource

While Ontario's universities are now making important progress in partnering with industry to advance research initiatives, it is important to remember that their fundamental purpose is still to train the next generation of students for careers in mining. This need cannot be understated, be-

cause across the board there is a scarcity of qualified mining workers.

In an interview with Marathon Gold president and CEO Matthew Manson, he stated that the biggest issue for him is labor. "The mining industry went into covid with a chronic labor and skill shortage, and the pandemic compounded the issue."

Recruitment and executive search firms such as Lincoln Strategic and C.J. Stafford & Associates are well aware of the industry's struggle to find talent, which is why they have spent years establishing networks of mining professionals with a diverse range of skills. This enables them to match what are often very specific job role requirements with qualified talent. The unique advantage a firm like Lincoln Strategic provides is its domain expertise. Their client director, Erik Buckland, commented that historically the firm has resisted diversifying because mining requires an "intimate understanding of our client's world." According to Buckland, we are experiencing a collision of an overheated mining market and talent pools that are getting shallower by the year. This is driven by a combination of training and demographic factors, and a resistance or inability of companies to both incubate talent internally and to professionalize their recruitment functions and initiatives. "While there is an increasing talent shortage, I think companies give this too much credit for why they cannot recruit the right people," Buckland stated.

Compounding the talent shortage problem is the fact that immigration policies hinder the industry's efforts to bring in workers from overseas. "We should be lobbying much more strongly to get immigration laws changed to allow qualified mining talent, with job offers easy access to Canada," C.J. Stafford president, Chris Stafford contends. "There has always been a shortage of mining talent and we receive a continuous flow of applications from skilled, experienced mining professionals whom we cannot assist under current immigration law."

Stafford also feels the industry is ill prepared to staff mines that increasingly rely on advanced technology, and therefore require workers with more technology oriented skills. "If the industry has difficulty attracting traditional mining skills, I imagine it will be substantially more difficult to attract those with highly technical backgrounds with I.T. or A.I. experience," he said. ■

George Pirie

Minister of Mines,
Government of Ontario



Can you outline the logic that prompted the creation of a dedicated Ministry of Mines?

Ontario published its first Critical Minerals Strategy in April of 2021, and the emphasis was on marrying the mineral potential of Northern Ontario with the industrial might of Southern Ontario. The province is now going through a significant change. Several billion dollars have been invested by battery manufacturers in Southern Ontario, and they would not build those complexes if the province did not have the minerals to supply them. Given the emphasis on critical minerals in Ontario and the global economy at large, the Premier recognized that we needed a designated mining ministry.

What is the mandate of the Mining Ministry?

Our mandate is to develop the mineral endowment of the province, and that begins with the Ring of Fire, where it is estimated that a trillion dollars of minerals exists in the ground. Of course, critical minerals are not just in the Ring of Fire. They are present throughout Northern Ontario, including niobium deposits 60 miles south of James Bay; we have rare earths and lithium that is 20 miles north of Otter Rapids, we have a huge nickel deposit in Timmins, and Frontier Lithium in Northwestern Ontario is one of the world's biggest and highest grade deposits. There are numerous other lithium deposits, close to Thunder Bay, and on top of that we have tremendous base metal and copper deposits throughout the province. One component of our mandate is to once again become the number one jurisdiction for mining. We want to do that because it is imperative that we modernize into a green, carbon neutral economy.

What issues do you feel are most urgent for the government to effectively address?

One is the need for close cooperation with the Canadian federal government. Throughout Northern Ontario we understand that nothing is going to happen without partnerships with indigenous groups. Therefore, the federal responsibility for indigenous affairs is linked with any development in Northern Ontario. We also created a ministry of red tape reduction, which speaks of our desire to permit facilities quicker than we have in the past.

To what extent do surrounding First Nations support the effort to mine the Ring of Fire?

Within the Ring of Fire, it is important to understand that the chiefs of Marten Falls and Webequie are the ones that are leading the consultation on development of the environmental assessments. Our government, of course, stands ready to support them with the consultation required for these environmental assessments. We have met with the indigenous communities, and they are progressive leaders, who want to see the development of their communities. They want their children to stay in the area, so consequently, they are big supporters of development in Northwestern Ontario.

To what extent is Ontario a competitive jurisdiction from an energy availability perspective?

There is broad consensus that we have to increase our energy capacity. We are very lucky in Ontario because 90% of our grid is already green, and this number will ultimately be 100%. There is also a huge initiative right now on nuclear regeneration. The CANDU reactors are the world's safest reactor. ■

Production, Development & Exploration

Ontario miners weather market volatility



Photo courtesy of Argonaut Gold.

With world-class mining districts such as Red Lake, Hemlo, Thunder Bay, Timmins, and Kirkland Lake, Ontario is peppered with prospective geology. According to the Government of Ontario, the province is one of Canada's top mineral producers, generating C\$11.1 billion worth of minerals in 2021 – representing 20% of Canada's total mineral production value. In terms of gold production, the province produced just under 100,000 kg of gold valued at C\$5.8 billion, which represents 42% of to-

tal production in Canada.

This production is driven by mines such as Detour Lake, Hemlo, Rainy River and Macassa. Reflecting the run up in metals prices, there has been a rush to consolidate, optimize, and extend mine life. This past year has seen significant deals closed that include Agnico Eagles' US\$11 billion acquisition of Kirkland Lake Gold, and Kinross's acquisition of Great Bear Resources, which included C\$1.35 billion in cash and a share issuance of 49.3 mil-

lion shares and around 59.3 million Contingent Value Rights (CVRs) to Great Bear shareholders.

While acquisitions are an essential part of growing reserves and replacing depleting pipelines, in a jurisdiction such as Ontario that has been bringing minerals to market for over a century, many of the most straightforward deposits have been mined. This fact does not dissuade BHP's vice president of metals exploration, Keenan Jennings, from still consid-

"Ontario is a preferred jurisdiction for a mining project. Permitting is demanding, but the rules are structured and understandable."

**Larry Radford,
President & CEO,
Argonaut Gold**



"If you keep hanging around you can wait forever. Therefore, at some stage, if you are building a mine you must commit to it and manage the opportunities, challenges and constant change in the process."

**Matthew Manson,
President & CEO,
Marathon Gold**



ering deposits in the province. "We have had a good crack at the first 400 meters of the earth's crust and as a result often think that exploration is mature. However, we have a lot of uncertainty beyond that. This is a new greenfield search space for us, and we believe there is a tremendous amount of potential in Canada," he commented.

Jennings added that this is an opportunity to build a new generation of mines that are more likely to be underground. In turn, they will have smaller footprints and they will be more discreet, which could potentially help limit environmental disruption and improve license to operate.

Development

Getting from development and into production is an arduous task in any environment. Throw in runaway inflation on essentials like energy, labor, and machine parts, a curtailed supply of cement and explosives, and it is possible that the industry will surpass previous figures that show more than four out of five mining projects come in late and over budget, according to a study conducted by McKinsey & Company. In May of 2022, IAMGOLD revealed a cost blowout of 90% at its Côté gold project in Ontario. Similarly, Argonaut's Magino gold mine in Ontario substantially increased its cost projections from C\$510 million to C\$800 million in December of 2021. A new management team has since been brought in to secure financing and ensure the project progresses on schedule and on budget.

In a conversation with Argonaut's newly appointed president and CEO, Larry Radford, who has executed a number of turn-arounds at Barrick, Kinross and Hecla, he explained that he was brought on to re-

estimate the project and realign the team. The third objective was to refinance, and while the company has not yet completed this objective (as of October 2022), it was able to complete a C\$195 million equity financing. Assuming the debt financing for a banking syndicate comes through, the project will have all the necessary funding in place to move forward.

Despite the cost overruns and challenges that needed to be overcome, Radford underscored that the company is still scheduled to produce first gold in April of

2023. "That will move the needle for Argonaut because when the mine reaches full production it will average 142,000 oz/y for the first five years. Currently we have four operating mines in Mexico and the US, and we produce 200-230,000 oz/y (2022 guidance). The Magino project will not only bring on our fifth operating mine but it will nearly double our overall production, representing significant upside for Argonaut investors," Radford affirmed.

Another key development in 2022 was Toronto-based Marathon Gold's decision

Island Gold's reserve and resource base has grown substantially since 2016, doubling to 5.1 million ounces by 2019 and forming the basis for the Phase 3+ Expansion. The deposit continues to grow with another million ounces of high-grade reserves and resources added in 2020 and the best hole drilled to date in 2021.



ALAMOS GOLD INC.

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MARATHON GOLD
Developing the Valentine Gold Project

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to move forward with construction on its Valentine gold project in Newfoundland. When completed, this is anticipated to be the largest gold mine in Atlantic Canada. The decision to go forward was made in part because it had gone through a full federal and provincial environmental assessment. "Following the completion of the EA process, we felt it was important for the company to make a statement as much for the investment market as for the stakeholders and all supporters that had been advocating for the project," Matthew Manson, president & CEO of Marathon Gold commented.



Marc Sale,
CEO,
First Class Metals

Further justifying Marathon's decision to greenlight Valentine is the compelling geology on the property. It is a big bulk tonnage deposit with a different deformational style, different host rock, and it is at a different scale than other assets in Newfoundland. Marathon is currently sitting at 5 million oz in all categories and about 1.85 g/t. The existing mine plan is two pits and Berry will be the third, with reasonable expectation of adding additional pits, and potentially underground in the future. Fortunately for Marathon, inflationary costs have begun to come down, potentially assuaging some of the cost pressures and making it a more favorable time to construct a mine. "What we need to think about as mine developers is delivery times, pricing, order books, cycles of availability of labor and forward curves of diesel. All those things are improving," Manson observed.

Applying Lessons Learned

One of the benefits of observing the challenges and struggles of fellow development operations is that up and coming projects can preemptively act to mitigate risk. Generation Mining is methodically going about ticking off those risks as it approaches construction on its Marathon project. Three of the biggest challenges mine development hopefuls face are permitting, financing, and social license that includes benefit agreements with nearby First Nations. Generation Mining is progressing on all three of these fronts, and notably secured financing in the form of a C\$240 million dollar stream with Wheaton Precious Metals, and a consortium of banks looking to fund up to C\$500 million.

The company also highlighted that it hopes to further mitigate risks by completing 75% of its detailed engineering before starting construction. "This is important because several projects were negatively impacted by not taking this step," Generation Mining president and CEO, Jamie Levy explained.

Junior Exploration

Despite the high-risk nature of mineral exploration, Ontario has a rich history of discoveries. One of the key success stories driving money into the Red Lake area in recent years was the high-grade gold discovery made by Great Bear

Resources on its Dixie project that culminated in an acquisition by Kinross. Shortly after this discovery, in 2018 BTU Metals acquired its Dixie Halo project located in the southern part of Red Lake. Shortly thereafter, Barrick raised its exposure to the area, which puts BTU in an advantageous position considering its property is sandwiched between those of Barrick and Kinross. BTU Metals' CEO Paul Wood asserts that, despite bleak market dynamics for junior gold explorers, the Red Lake district will press onward on the back of robust activity. "Evolution is doing a lot of work. Kinross has come in and has 11 drills turning, and they have a lot of pressure to do something with the Great Bear asset they acquired. As a result, they are going to devote substantial attention and capital to the asset and further develop the area," Wood offered.

Ontario's Michipicoten greenstone belt in the Wawa region is another area where meaningful exploration continues. The area hosts Argonaut Gold's Magino deposit and Alamos Gold's producing Island Gold mine, both orogenic gold deposits. The Michipicoten greenstone belt has a long history of past production, but many historical mining sites remain underexplored by modern methods.

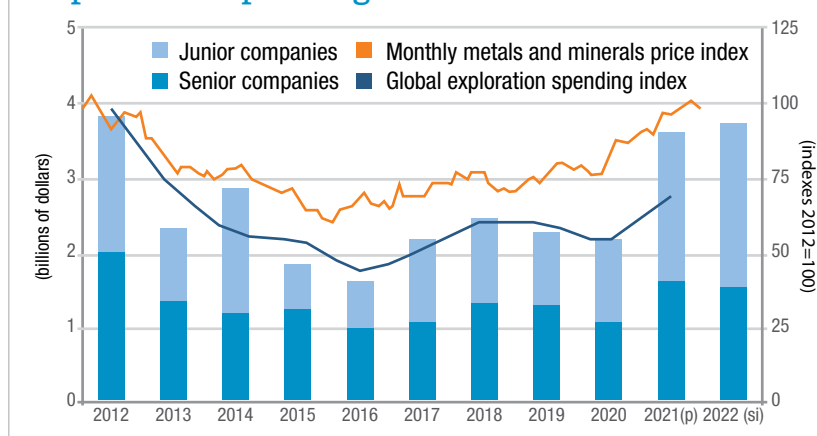
Red Pine Exploration drilled throughout 2022 with between two and four drills constantly in use on its Wawa property. This enabled the company to complete approximately 30,000 meters of exploration drilling on the property, and demonstrate that the mineralization that forms part of the Surluga and Minto deposit extends beyond its current footprint. Red Pine also recently closed a bought deal in September 2022 for C\$5 million, which Red Pine president and CEO Quentin Yarie referred to as a "feat" in the current market. "Dilution is always an issue juniors struggle with, but I think market conditions will be challenging over the next year. Therefore, we are cashed up, and do not intend to need to raise money until our stock price improves," he said.

Enduring the IPO Process

To the extent that doing a bought deal has been complicated by market sentiment, getting an IPO over the goal line could be considered an even greater challenge. Nevertheless, that did not stop First Class Metals from persisting. The company is a mineral explorer that holds 100% ownership of seven claim blocks in the Hemlo-Schreiber-Harte greenstone terrain, and a further block in the Atikokan area. According to First Class Metals CEO Marc Sale: "The listing process was torturous. There were IPOs being canceled, suspended, forgotten about all around us. However, we ultimately got across the line and became one of very few new London listings in 2022."

Perhaps what propelled the company forward was a deal with Power Metals Resources, who also had claims in the Hemlo area, and agreed to combine claims with First Class in exchange for a 30% stake in the company. It could have also been the attractive geological potential of the claims the company thus acquired. For Sale, the nearology is what makes the project so compelling. For example, Palladium One's Tyco project, which includes the high-grade nickel discovery Smoke Lake, is near the claims. He also investigated the vectors on the western side of North Hemlo where Panther Metals' Dotted Lake project is found. "Either geophysically, geochemically, or geologically, those trends continue onto

Exploration Spending and Minerals Price



Source: Natural Resources Canada

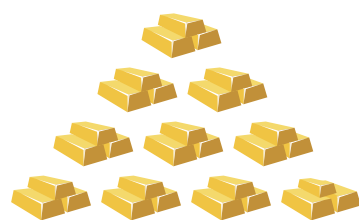
our property," Sale asserts. "In addition, there is a distinct lack of exploration on our properties," he added.

Adapting Strategy

One strategy that has served investors well over the years has been the project generator model, which effectively spreads risk across many distinct assets in the hopes that it will increase the probability of being exposed to a sizable discovery. The idea is to bring in partners to help mitigate early exploration risks, while also preserving an element of upside. Of late, however, the model has fallen out of favor, largely because underdeveloped assets are not resonating with their typical partners. This is potentially due to capital constraints, but it could

also be that companies are taking a wait-and-see approach given macro uncertainties. Consequently, companies like Transition Metals, with 22 projects across Canada, are tweaking their model. "The problem I see with the project generator model is largely one of selling the business model to the market. We are now taking more of a traditional junior view on specific projects, where we are willing to make investment directly and drill the projects and advance them ourselves," Scott McLean, president and CEO of Transition Metals commented. "By doing that, we create more optionality, so if the project is a big winner, we can take it forward ourselves or create higher leverage on our investment if we choose to bring a partner to the project." ■

Gold Production in Ontario

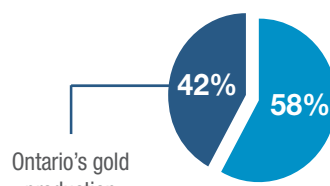


99,793 kilograms

of gold produced in Ontario in 2021,
valued at C\$5.8 billion

One icon represents 10,000 kg of gold produced

Gold production in Canada (by value)



Ontario's gold production

In 2021, 42% of Canada's total gold production came from Ontario

Source: Natural Resources Canada

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Executive Insights

On Financing

"In today's distressed markets, opportunities are there especially because many assets only make sense if you have a team that wants to build them. Many orphaned assets remain orphan because we have far too few mining teams wanting to build mines."



Doug Ramshaw,
President,
Minera Alamos

"It remains challenging to raise early-stage exploration capital – it is like venture capital at its riskiest. However, by having the incentives that are provided by the flow-through tax regime, Canada has been able attract significant investment that certainly would not have been there otherwise."



Lisa Davis,
CEO,
PearTree Securities

"If companies wish to access capital, in any form, in order to thrive, they must disclose their ESG performance obligations to meet the investors' acceptance requirements of their risk profile."



Laurie M. Clark,
Founder & CEO,
Onyen Corporation

"We are very excited about the fundamental gold geology in Ontario, but it needs to be in a location that is accessible and not overly cost prohibitive."



Spencer Cole,
Chief Investment Officer,
Vox Royalty Corp.

On Permitting

"It takes an average of 8 to 12 years to build a mine. It should not take that long. The problem with that length of time is that minerals come in and out of popularity."



Kerry Knoll,
Executive Chairman,
Generation Mining

"It might cost more today to invest in electrical or more technologically advanced equipment, but mining customers have certain environmental and sustainability benchmarks they need to hit. If they do not invest in these benchmarks, they risk losing license to operate, be it social license or actual operating license."



Iggy Domagalski,
President & CEO, Wajax

On Geophysics

"Modern systems allow for three-dimensional subsurface modeling, which is a huge advance compared with older systems where targets at depth were often not well defined. These same targets can now be detected and better displayed for strategic interpretation."



Daniel McKinnon,
President & CEO,
MPX Geophysics

"Compared to active sources airborne electromagnetic technologies, MobileMT has much greater depth of investigation. Most importantly, because most near surface deposits have been discovered by now, many companies are looking for deeper targets."



Andrei Bagrianski,
President & Founder,
Expert Geophysics Limited



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Mining Finance and Investment

Toronto remains the epicenter for mining capital

Take a cursory glance at the Lasso Curve and it is clear that bringing a mine from exploration into production is a remarkably treacherous ride. Although the Lasso curve is a widely respected theoretical framework that mining investors use to analyze equity valuations relative to development stage, it does not account for broader macroeconomic and geopolitical factors that could amplify risks and dampen valuations. In 2022, war between Russia and Ukraine ratcheted up uncertainty and exacerbated already ballooning energy costs, which has compounded inflationary pressures already being felt from rising labor costs across the industry. As a result, miners are in an increas-

ingly tenuous position with respect to managing costs. Although inflationary periods have historically been bullish for commodity prices, even precious metals, which typically act as vehicles of wealth preservation have been struck by a US Federal Reserve that is raising interest rates at a clip not seen since baby boomers were in the early days of their careers.

Given the torrent of risks associated with this macroeconomic setup, and the prevalence of the dreaded head and shoulders technical chart that a host of publicly traded mining stocks have been plagued by, it would be easy to understand why an investor might allocate capital elsewhere. Nevertheless,

mining continues to underpin economic growth, so it is essential that capital remains available for the full range of companies involved in the industry. Financial institutions headquartered in Toronto, such as BMO Capital Markets, continue to play an invaluable role in financing the mining industry and ensuring projects raise the capital required to keep projects progressing toward production. The company has helped finance several notable projects in Ontario, including Argonaut Gold's Magino gold project, where BMO was the sole bookrunner on a C\$52 million offering that the company completed in March 2022. BMO was subsequently the top left bookrunner on a C\$195 million offering

"The industry tends to think everything needs to be large scale – to look like our Escondida mine – but we need to think in a more agile sense. This means exploring new ideas like modular mining, where one can scale projects rapidly and cheaply, and mine to value rather than scale."



Keenan Jennings,
Vice President, Metals
Exploration, BHP

by the company in July.

BMO has also worked with a couple of companies with future facing commodity projects: Frontier Lithium completed a C\$10 million offering in November 2021 to finance exploration activities on its PAK lithium project, and Electra Battery Materials closed a C\$10 million equity offering as part of a larger US\$45 million financing package for a hydrometallurgical refinery the company is building in Ontario.

Given BMO's proximity to many of the most important deals completed in the province, it is a good sign that the company remains bullish on the industry and its potential to outperform other sectors. Ian Bahar, managing director and co-head of global metals & mining at BMO Capital Markets, explained: "We feel more optimistic today about the macro trends for metals and mining than at any time since the 2005 to 2007 period. . . Now we are entering a phase where almost the entire planet wants to decarbonize, including moving to EVs, and all on the same timeline, implying that metal demand will be extraordinary," he affirmed.

Flow-Through Financing

Undoubtedly one of the most encouraging policies intended to incentivize mining investment in Canada is its flow-through tax credit system. Toronto-based PearTree Securities is a leader in structuring these transactions, and is moving quickly to develop its financing capacity for deals related to critical metals. PearTree CEO Lisa Davis commented: "Traditionally in Canada the financing focus has been on precious metals, but the biggest story these past two years has been battery metals and other critical minerals. The introduction of the new 30% critical mineral exploration tax credit by the Canadian government has been a really important driver of flow-through financing and our overall business."

Davis points out that the draft legislation that was released in spring of 2022 has already resulted in explorers and producers of critical minerals getting premium pricing for their flow-through share issuances, and the money is not all coming in from the usual suspects. "Our purchasers are often institutions with ESG considerations, which can sometimes write off mining. However, they are now starting to look at mining from the perspective of furthering clean technologies and the green economy. Critical minerals have also broadened the potential investor base at the back end of the structured arrangements we do," she said.

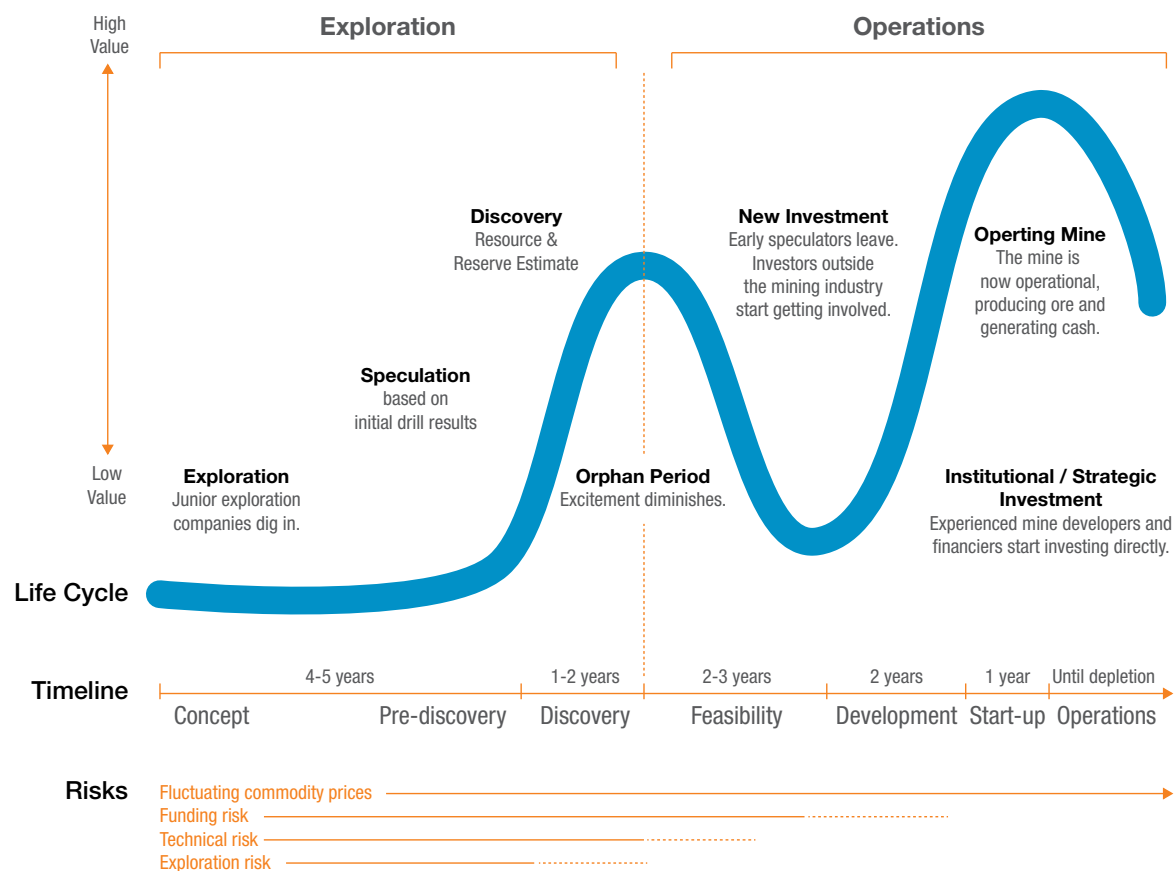
Streaming and Royalties

Toronto has a robust ecosystem of companies innovating in the royalty and stream segment of mine finance. The fundamental model of these companies is useful to the mining sector because throughout history there have been many periods when capital availability was limited. The royalty sector has played an important role in terms of advancing assets and providing capital that only gets repaid when the mine does well. Unlike debt, which can be a burden when starting up an asset, a royalty or stream is leveraged over the life of mine, and royalty companies only do well when the miner does well.

From an investor perspective, they are also an attractive way to gain exposure to mining, while avoiding the excessive dilution and cost inflation commonly experienced by junior miners.

Vox Royalty Corp. was founded on the idea that there were overlooked royalty opportunities on some very attractive assets that could provide an investor with exploration upside, production expansion potential, commodity price leverage, and inflation hedge capability. The royalties that the company identifies and acquires are often 20 - 40 years old and held by the original exploration prospector. However, they are often attached to some of the world's best mining assets. Over the past decade Vox had built out the world's largest proprietary database of these mining royalties, and Vox uses its information edge to source overlooked royalty deals. "Our sweet spot is pre-production royalties between 3 and 18 months from first production that have already been materially de-risked. That is typi-

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cally where we see the most value, because once the royalty holder starts receiving checks on a royalty, value expectations tend to go up materially," Vox Royalty Corp. CIO Spencer Cole noted.

Star Royalties is another Toronto-based royalty provider that has recently developed a differentiated model with the founding of Green Star Royalties. The company was created to capitalize on the numerous opportunities, limited competition, and more attractive returns associated with carbon credit royalties, and is structured as a joint venture between Star Royalties and Agnico Eagle Mines. Green Star's carbon credit royalties in regenerative agriculture and in forestry are both the first of their kind, and function very similarly to traditional mining royalties. They look at metrics like acres of farmland, the carbon sequestration rate, carbon price, and royalty percentage. The primary difference with mining royalties however, is understanding carbon pricing, which varies substantially across carbon markets and carbon project types. "If a mining company has a net zero goal, you can achieve that in three ways. You can stop emitting, go through an energy transition plan, or you can purchase carbon offsets. Companies are now doing a combination of the second and third option, where they have an energy transition plan in place complemented by buying premium carbon offsets," Star Royalties CEO Alex Pernin affirmed.

ESG

One of the inescapable realities for mining companies is that ESG performance and compliance are now inextricably linked with ac-

"The objective for companies that do not generate cash flow should be to extend the option value of their project. If companies can successfully extend that option by raising capital or curtailing spending, and waiting for a recovery in the market, that can be enormously valuable for shareholders."

Ilan Bahar, Managing Director and Co-Head, Global Metals & Mining, BMO Capital Markets



cess to capital. Recognizing the importance of a third party verification system that could be used by everyone, from regulators to ratings agencies, as well as Wall Street and the companies themselves, Onyen Corporation has developed the software that eliminates friction around bringing together all the relevant ESG information a company needs to disclose. Their platform analyzes ESG data, and highlights potential issues, so companies can preemptively address problems before regulators and investors are alarmed. The software also helps companies better understand potential future risks by using scenario analysis to test how their approaches hold up under different climate change and time-based scenarios. This empowers companies to effectively plan to mitigate future ESG risks. "Our vision is to gather a community of small to mid-cap companies – and private companies of all sizes to understand that this is not just about good corporate citizenship, it is about money. If companies wish to access capital, in any form, in order to thrive, they must disclose their ESG performance obligations to meet the investors' acceptance requirements of their risk profile," Onyen Corporation founder & CEO, Laurie M. Clark highlighted.

Another component of failure on the ESG front is that in down markets, governance issues can leave companies vulnerable to activist investors who seek to challenge a management teams' strategy and dictate an outcome that might be counter to the company's long-term interests. Kingsdale Advisors is a strategic shareholder advisory firm that assists companies when they are in difficult situations. Ian Robertson, CEO of Kingsdale Advisors, explained that companies can protect themselves against activists by appointing boards that look at their company from the perspective of an activist. "They should ask themselves where they are falling short. Usually with junior miners it is on the governance side of things. People care about governance because there is compelling evidence that says governance will impact share price and performance of the company. This entails making sure that there is diversity on your board, a compensation program that is in line with peers and matches the shareholder experience, and a succession plan in place," he said.

The market may currently be navigating its way through a period of uncertainty, but jurisdictions such as Ontario with an active financial sector will be best positioned to weather any challenges market conditions may bring. ■

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Chris Hodgson

President,
Ontario Mining Association
(OMA)



“The industry provides safe, well-paying jobs to approximately 75,000 Ontarians, while 77% of mining companies’ GDP contributions stay inside Ontario.”

How do you quantify mining’s contribution to the overall Ontario economy?

Currently, there are 37 active mines in Ontario, ranging from base metals like nickel and copper, to precious metals like gold and palladium, and industrial minerals like salt. Ten of these mines produce critical minerals, and there are more significant critical minerals projects in development. There are also opportunities to recover critical clean-tech minerals through the smelting process. In 2021, Ontario’s mining sector produced C\$11.1 billion worth of minerals, which accounted for 20% of Canada’s total production value. The industry provides safe, well-paying jobs to approximately 75,000 Ontarians, while 77% of mining companies’ GDP contributions stay inside Ontario. 11% of Ontario’s mining industry workforce is Indigenous, which is one of the highest proportions of all industries in the province.

To what extent are communities and citizens in support of mining in Ontario?

The industry is gaining more and more support. In the old days, there were environmental problems, but now we use science and advanced technology to mitigate impacts. Mining is a temporary land use; even before starting production, Ontario miners plan for closure and restoring the land after mining activity is finished. As a result, we are seeing huge investments by our industry in pollution abatement, water recycling, and innovations that allow for minimal environmental impact. The fact that we have so many agreements in place with First Nations is a positive sign. We poll the general public every year, because we want to make sure that our industry is meeting evolving societal expectations. Last year, we saw a record number of people supporting Ontario mining, and wanting more mines here.

Dean McPherson

Head, Business Development -
Global Mining, Toronto Stock
Exchange and TSX Venture Exchange



“Any efforts to capitalize on the energy transition trend must be in the context of ESG/responsible mining and not leaving any stakeholders behind.”

What regions of the world are you seeing capital flow into?

No one can deny that Canada, Australia, and the US are the safest jurisdictions in mining. However, when you look at the significant demand for battery metals, you will find that the flow of capital is really following these commodities. As the fundamentals continue to support the significant demand for certain commodities, investors are willing to support projects in all jurisdictions, hedging any heightened jurisdictional risks by carefully considering other factors, particularly management teams with experience.

Can you speak to industry efforts to reward all stakeholders?

Any efforts to capitalize on the energy transition trend must be in the context of ESG/responsible mining and not leaving

any stakeholders behind. The longevity of social licenses and the consequent lowering of operational/investment risks is optimized when the strategy is to partner with and reward all stakeholders.

What have been some of the most notable deals that have occurred on TSX in recent years?

In 2020, Newcrest Mining added a TSX listing that they needed to raise their profile as they continued to execute on their strategy to expand and diversify their project portfolio globally. A year after the TSX-listing, they announced the significant acquisition of Vancouver-based Pretium Resources. Earlier this year, Gold Fields also announced their intent to add a TSX listing as well. Our expectation is that more global companies will continue to expand; diversify and grow through our global markets.



Toronto’s Global Reach

Headquartered in Toronto, mined abroad

Photo courtesy of McEwen Mining.

For such a global industry, mining has only a few hubs where the majority of listed companies are headquartered. Toronto, like Vancouver and Perth, is a true hub for the mining sector, from major producers to small-cap juniors and engineering companies. It is where deals are made and projects are orchestrated.

Around 42% of the world’s public mining companies are listed on the TSX and TSXV, attracted by the stable and efficient Canadian financial system affording them greater access to capital. This, in addition to the abundance of expertise that resides in Toronto, is why companies with projects in foreign jurisdictions such as Argentina, Brazil, Mexico and Idaho maintain offices in the city and listings on the TSX and TSXV, often bypassing less liquid regional exchanges.

The Southern Cone

With a depleted foreign currency reserve, three different ministers in over a month, and the second review approval for a US\$44 billion extended fund facility program, dollar-strapped Argentina’s economy is battered. However, given political shifts toward leftist governments in Peru, Colombia and Chile, and the potential political risks associated with those jurisdictions, mining companies and investors are now taking a more open view toward the nuances of particular districts.

Rich in natural resources, Argentina’s San Juan Province is among the top jurisdictions in mineral exports. According to the Government of Argentina, in September 2022, San Juan’s mining exports grew 34.2% compared to September 2021, reaching a total of US\$60 million.

Michael Meding, vice president & general manager at McEwen Copper, a spinout

of McEwen Mining, compares the jurisdiction to Nevada: “I think San Juan province in Argentina is analogous to Nevada in the US, where there is a good environment to conduct mining business.”

McEwen’s flagship project is Los Azules, an advanced-stage porphyry copper exploration project that is reported to be the ninth largest undeveloped copper deposit in the world. According to Rob McEwen, executive chairman and chief owner of McEwen Mining, the impetus for

the spin-out came after market interests shifted away from multi-asset models.

McEwen spoke of the advantages of Los Azules compared to similar projects in the province, including the fact that it sits at a lower altitude that is closer to infrastructure. He also noted that the published estimated copper resources and grade are 2-3 times higher than two other projects Filo del Sol and Josemaria, that are also located in San Juan province. The company is waiting to

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“Los Azules is the ninth largest undeveloped copper deposit in the world, and within McEwen Mining, it represents the largest value and greatest excitement in our portfolio of assets.”

Rob McEwen,
Executive Chairman
& Chief Owner,
McEwen Mining



“A significant event in 2022 was La Yaqui Grande coming online, because it brings Alamos back to mining high grade ore, which leads to lower cost production at Mulatos.”

John A. McCluskey,
President and CEO,
Alamos Gold



complete an updated PEA in Q1 2023 to establish its market value and intends to go public by mid-2023.

Another new company created on the heels of an asset spin-out is Lavras Gold, which went public in April 2022, shortly after Hochschild Mining acquired its predecessor company, Amarillo Gold. The company's flagship Lavras Do Sul (LDS) project is located in southern Brazil, and is an intrusive hosted gold deposit measuring approximately 10 km in diameter. "Comparable gold systems to ours in terms of geological model would be Cripple Creek in Colorado, which has around 26 million oz Au, Porgera in Papua New Guinea, and Golden Sunlight in Montana. These gold systems can be very large and very high grade. What we hope to find is a multimillion-ounce type of gold system," Michael Durose, president & CEO of Lavras asserted.

In addition to the flagship asset, Lavras also kept a 2% net smelter return royalty on the Mara Rosa exploration ground, where it drilled 40 holes into the Pastinho discovery to define a gold structure about 1.8 km strike length. "There is a tangible value associated with the Mara Rosa royalty," Durose concluded.

Mined in USA

Mining is embedded into the history of Idaho, as it is called the Gem State for good reason. Revival Gold's Beartrack-Arnett currently ranks as one of the highest grade and largest independently owned undeveloped open pit gold projects in the US. Couple that with the fact that Idaho is one of the most mining-friendly states, and the company is in a strong position to reach production in a relatively quick timeline. The company also benefits because Beartrack-Arnett is on a brownfield site that operated as recently as the early 2000s. Revival Gold has put out an updated resource, increasing the total ounces from 3 million oz to 4 million oz Au, while also revealing that mineralization extends for 5.6 km along strike, with results averaging a grade of 7.7g/t Au in a high-grade core. Revival Gold is hoping to get to production quickly with minimal capex expenditure, while at the same time, is devoted to continuing efforts to explore and build out the larger potential for a much bigger project. "We are taking this route because we want to be able to ride through difficult markets by getting to free cash flow sooner, with lower capital expenditure and less shareholder dilution. All of these actions are meant to preserve our long-term upside while we continue to explore." Revival Gold president and CEO Hugh Agro explained.

Mexico

Mexico is another foreign jurisdiction where Toronto headquartered companies see significant opportunities. Although the leftist Morena party administration of President Andrés Manuel López Obrador (AMLO) has adopted a tougher approach to environmental premitting, resulting in a slowdown in the processing of applications, while freezing new mineral concessions and nationalizing lithium, companies continue to press forward and bring assets into production.

One of the companies that remains undeterred is Minera Alamos, which was founded in 2018 on the premise that a quirky Australian bootstrapped mining model was a sound approach to mine building. The idea is to build low capital cost mines and scale them out to cash flow, and in times of high inflation, rising interest rates, and more scarce capital, this model is one that seems uniquely appropriate. "Our results reflect that we are making money each quarter without seeing much inflationary pressure in our operating costs. The past 12 months have been a steady year of demonstrating our business concept, and I think we have executed on that well, despite many things working against a company building a gold mine," pointed out Minera Alamos president Doug Ramshaw.

The company recently announced a PEA on its second mine, Cerro de Oro, that it plans to build in Zacatecas, Mexico. According to Ramshaw, it will be another mine that fits into the narrative of a low capex build of sub US\$30 million. After the company receives all permits, which it anticipates by the end of 2023, it can then build the mine in approximately five to six months. "This 60,000 oz/y production from the proposed US\$30 million Cerro de Oro mine bolted onto Santana will set the scene for us achieving our initial goal of being a 100,000 oz/y gold producer while demonstrating remarkably low capital intensity," Ramshaw added.

Torex Gold is another company with positive news coming out of Mexico. It continues to report positive operational results at its 100% owned Morelos property, and it will also be ramping up activity at its Media Luna project after receiving approval from Mexico's Secretariat of Environmental and Natural Resources ("SEMARNAT") on the environmental permit, which will allow operations to begin. Media Luna, a low risk brownfield build with a 10 year plus mine life, significant resource upside and meaningful copper exposure, is projected to more than triple the mine life of Morelos Complex. ■



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Critical Minerals

North America moves toward a more secure supply chain

When BHP and Andrew Forrest's Wyloo Metals engaged in a bidding war to acquire Noront Resources' high-grade nickel deposits in the largely untapped region of northern Ontario dubbed the Ring of Fire, it was indicative of a major shift in which mining heavyweights are racing to control more supplies of the raw materials that are key to transitioning to low-carbon energy sources. The justification for the C\$617 million acquisition of Noront was rooted in the fact that, according to International Energy Agency estimates, demand for nickel is set to grow 19-fold by 2040 if the world is to meet the Paris climate goals. Concomitantly, the increase in supply this decade is set to come from Indonesia, a market overwhelmingly powered by coal-fired electricity where Chinese companies are building nickel processing projects. The Noront deal is reflective of the fact that Ontario's position as a geopolitically stable jurisdiction with a relatively low-carbon electrical grid makes it a place that can be relied upon to produce, and possibly process, the metals required for energy transition in a sustainable manner.

The case is similar for many of the critical minerals, such as copper, cobalt, lithium, graphite, and others that are anticipated

"Eagle's Nest is groundbreaking, because it is one of the largest undeveloped, high-grade nickel-copper-platinum-palladium deposits in the world."

Luca Giacobazzi,
CEO, Wyloo Metals



to see precipitous increases in demand as electrification becomes more widespread and supply chains more local.

Despite coming up short on its bid to acquire Noront, BHP's presence in Ontario signaled that its conviction when it comes to identifying long-term exploration plays with exposure to copper and nickel. These decisions will now be made out of the company's Toronto office, since moving the metals exploration team in 2021. "We chose Toronto because it is a center of excellence for talent and mining companies. There is a critical mass of mining companies in the city, and being in Toronto positions us closer to key business partners, news and deal flow, and capital markets activity – all of which supports our growth conversation," noted Keenan Jennings, vice president, metals exploration at BHP.

With nickel's favorable dynamics in mind, Sean Samson, president and CEO of Rogue Resources, spun out its Langmuir project, located Southeast of Timmins, to found newly listed nickel explorer, EV Nickel. Although the historic Langmuir W4 resource is less than 700,000 tonnes, Samson sees it as a starter resource as the deposit is at surface, good grade, and has not been properly explored. The opportunity lies in pulling together more land and ultimately building a good nickel business through a combination of high-grade, starting with the W4 deposit, plus any additional mineralization down the trend, and a huge amount of exploration potential for low-grade ore in the north of EV Nickel's property which they refer to as the "Large-Scale" targets. According to Samson, the OEMs they talk to find EV

"Lithium is vastly abundant and available, but extraction is where the cost lies. Leveraging DLE is a way of accelerating processing technology that will bring unconventional resources to production."

Ali Haji,
CEO, ION Energy



Nickel compelling for three reasons: "One, we have known grade in the ground; Two, we have a production pathway; and Three, Canada is part of the localized supply chain requirements for North America and qualifies under the Inflation Reduction Act as domestic production for the US."

It is also a great advantage that the company has a permitted mill nearby, and if that does not work, Sudbury is just ~300km away.

A final factor that can differentiate a company working with an OEM concerned with carbon footprint is having a low-carbon cost associated with the mining operation. Although most markets are not yet bifurcated based off of carbon metrics, Samson anticipates the market will shift toward greater differentiation in the future based on what quartile of carbon cost comes attached to each nickel unit. "I believe we are going to see that priced into future supply arrangements, and the nickel world is going to start segmenting itself. This is why we want to be positioned in the lowest quartile in terms of carbon cost," he concluded.

Hedging Electric with Hybrids

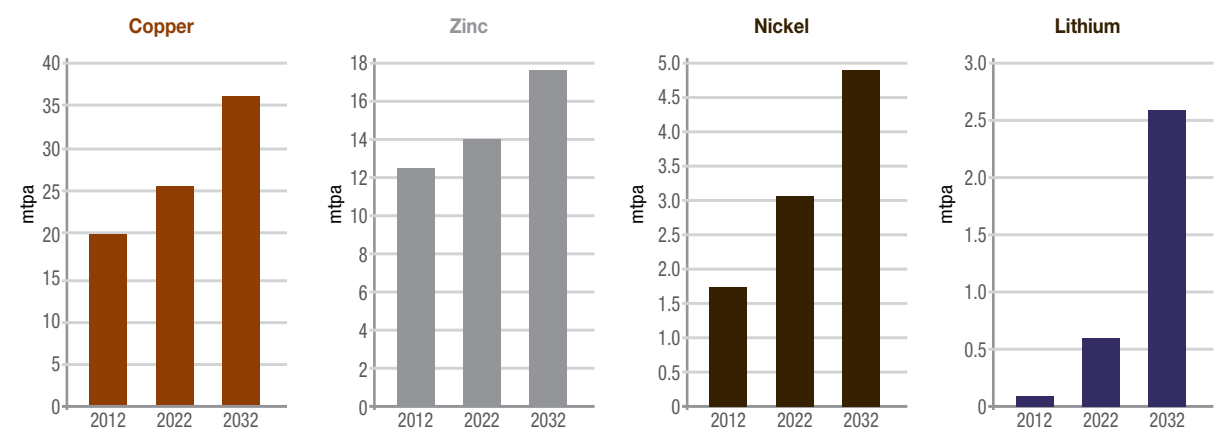
One of the more advanced critical minerals players in Ontario is Generation Mining, which is now on the cusp of construction at its Marathon palladium copper project situated along the Trans-Canada Highway in Northwestern Ontario. Marathon's primary commodity is palladium, a platinum group metal used in catalytic converters and automobiles. One positive demand driver is that China is increasing the amount of palladium required in each car to lower pollution levels. India has followed, where we are now seeing cars manufactured with substantial amounts of palladium for the first time. Hybrid cars are also getting more popular, and they need more palladium than a typical vehicle.

Lithium

While much of the focus in North America today is about building up North American supply chains, it is important to note that beyond securing access to the mineral, it is essential to consider the distance the commodity must travel, and how that might impact its carbon footprint. Ion Energy is a Toronto-based lithium explorer whose 100%-owned flagship Baavhai Uul project represents the largest exploration license ever granted in Mongolia. The company has a distinct advantage given the mines proximity to hungry EV markets in both China and Japan. Ion CEO Ali Haji points out that, if you look at consumption today, China uses over 50% of mined lithium to produce batteries for the world. Most of this lithium is extracted in the lithium triangle in the Andes Mountains, alongside assets in Australia, but people are not accounting for the fact that producers are putting lithium on a ship that has to sail 15,000 nautical miles to China for refinement. "This process is extremely carbon intensive. ION's location 23-150

The bear case for palladium is one in which electric cars begin to dominate the market. However, the secondary commodity Generation intends to produce is copper. While a typical gasoline powered car uses about 40-45 pounds of copper, a typical electric car uses 180 pounds of copper, and every EV charging station requires an additional 40-50 pounds of copper. "This provides Generation Mining with a built-in hedge. If electric cars get really popular, copper is going through the roof. That is why Goldman Sachs is talking about copper potentially reaching US\$6-\$8 per lb," Generation Mining executive chairman Kerry Knoll proclaimed.

Demand Projections for Copper, Zinc, Nickel and Lithium



Source: AME, BNEF, S&P Global Data, RCF Analysis, October 2022

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km from the Chinese border can significantly lower the carbon footprint of the battery manufacturing supply chain," he said.

Haji has been conducting technical site visits to Mongolia this year, and has added Dr. Mark King to his team. He is well known for writing the first 43-101 for lithium brine, specifically for the Canadian market, and is helping the company to kick off the next phase of its fully-funded exploration programs, which includes over 100 line km of TEM surveys at Ugrakh Naran. Haji outlined: "Our exploration program continues to progress rapidly, and we are now drilling diamond holes. This work will enable us to come to an average grade across the entire brine body. Multiply that by the volume that we have calculated and that will take us closer to our inferred resource calculation."



Don Bubar,
President and CEO,
Avalon Advanced
Materials

OEMs with Equity Exposure

All of this progress that Ontario-based companies are making is grabbing the attention of many OEMs that are in desperate need to secure the raw materials required to feed massively increased lithium ion battery manufacturing capacity. In prior years, few would have imagined OEMs taking equity risk in mining companies. However, in an effort to secure preferential access to product at market prices, companies like General Motors are announcing that it will invest up to US\$69 million and take an equity stake in Queensland Pacific Metals to secure a new source of nickel and cobalt for battery cells for use in the US automaker's vehicles. Denis Frawley, a partner at Ormston List Frawley LLP, observed these dynamics through his work with critical mineral clients in Ontario. "The pipeline of projects to support that transition is being built, and the revitalization of a "cold war" like geopolitical order is forcing manufacturing companies to look at alternative pathways to secure future supplies. Consequently, manufacturers are now having direct discussions with exploration companies and not necessarily relying on mining companies to be their intermediaries to supplies," he said.

Rare Earths

One of the most acute vulnerabilities with respect to critical minerals is in the rare earths space. According to USGS figures, China has the world's largest reserves of rare earths, making up over 36%. 78% of US rare earth imports were from China. Toronto-based Appia Rare Earths & Uranium Corp., whose projects are located in the Athabasca Basin area of Northern Saskatchewan and in the historic uranium camp at Elliot Lake, Ontario, is working to provide an alternative source for US rare earth imports. Tom Drivas, president & CEO, explained that the resources Appia has found to date at Alces Lake appear to be some of the richest

rare earth occurrences globally, with grades up to 49% Total Rare Earth Oxides (TREO). The company has completed 100 diamond drill holes for a record 17,480 m of diamond drill core at Alces Lake within four and a half months, and much of the resource lies at or near the surface, with naturally concentrated monazite currently being delineated. Consequently, the mining will be straightforward, and investors can rely on the fact that a rare earths processing plant is being built in Saskatchewan by the Saskatchewan Research Council thanks to the multimillion-dollar investment from the government. "China still controls about 80% of the rare earth industry today, and the world can only supply enough rare earth elements to meet current demand. If, as experts project, increasing EV sales rise five times, it will create a considerable supply gap in the market for rare earths," Drivas commented.

Uranium

Another player making inroads in the Athabasca Basin is Purepoint Uranium Group, which is capitalizing on renewed investor interest and demand for uranium in light of rising energy prices. This follows a difficult decade wherein 10% of the world's nuclear reactors were taken offline by Japan. Meanwhile, production

"Canada excels primarily due to our ore grades. A typical operator around the world is mining at 0.4-0.5%, the mines in Canada are 3-4%, and our biggest mines are 20% ore grade, which is unheard of."

Chris Frostad,
President and CEO,
Purepoint Uranium



out of Kazakhstan increased from zero to supplying 40% of the world's uranium today. That led to a supply overhang of uranium, and a languishing of the commodity price. "As the price of uranium steadily dropped, many mines shut down or reduced production. Over the past three or four years, we have been producing 20 to 30% less uranium than we have been using, and we are now seeing that balance in supply and demand returning to the market," explained Purepoint Uranium president and CEO Chris Frostad.

Now that prices have recovered Purepoint has the capital to advance all of its 12 projects. The company is in a desirable position given it began assembling its portfolio 10-15 years ago, and has been able to maintain it while things were quiet. "We were also able to pick up a lot of projects during that downtime. We believe our portfolio has the highest likelihood of success, as we have had the time to construct the portfolio down to those most prospective projects," said Frostad.

Moving forward, the company will look to focus on advancing its Turnor Lake project that sits on trend and adjacent to the La Rocque corridor, and its Red Willow project, where it has identified a large regional area of uranium mineralization, and the Hook Lake project, which is a joint venture with Cameco and Orano. ■



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Innovative Solutions

Cutting edge technology permeates all aspects of mining

Part of the excellence of Ontario is that its mining ecosystem spans the entire province. Not only do you have a major global city in Toronto with elite universities, start-up accelerators, financial institutions and major mining companies, you also have places like Sudbury that have nurtured an ecosystem of technology businesses that bring Canadian-born innovation to the world. This chapter illustrates the wide range of technologies Ontario-based companies are developing and delivering to the world.

Geophysics—Innovation in the Air

Traditionally there has been a certain mystique that goes hand in hand with a classical boots on the ground reconnaissance of a property. However, in an era where there is pressure to make discoveries faster, with fewer geologists available to make them, it is a huge benefit that new sensor technologies are coming online to augment and expedite the exploration process. One might assume that the further a sensor is from the ore source, the less likely it is to provide a detailed visualization and geological interpretation, but Expert Geophysics has developed a suite of sensors that do just that. The company's flagship MobileMT (Mobile MagnetoTellurics) system works by exploiting passive electromagnetic fields arising from lightning events and storm activity that cause variations in the earth's magnetic field. It possesses several

advantages over existing airborne electromagnetic technologies, and compared to active source airborne electromagnetic technologies, MobileMT has much greater depth of investigation. Expert Geophysics founder and president, Andrei Bagrianski, points out that this is a very important feature of the technology: "Most of the near surface deposits have been discovered by now, and many companies are looking for deeper targets. That is where our technology is most helpful."

Compared to other commercially available AFMAG airborne systems that measure just one component of magnetic variations in the air, Expert Geophysics is able to measure three, which means it can recover the geology of any shape. The technology has also been proven to work in detecting many different commodities. "The fact that the system is versatile and applicable in such a wide range of topographic, geographic and geologic conditions means that if an electromagnetic survey is suitable for your mining and exploration objectives, the MobileMT system can most likely deliver the results you are looking for," Bagrianski affirmed.

Expert Geophysics does not stop at providing customers with raw data alone. The company also delivers the interpretation while working closely with geologists to help them better understand what the data means. According to Daniel McKinnon, president & CEO of MPX Geophysics,

a company that offers advanced modern airborne technologies on fixed and rotary wing platforms, as well as drones, one of the historical drawbacks that geophysics has had is that geologists had not assumed the challenge of being trained to process and interpret the data resulting from geophysical acquisition. For this reason, those who assumed the role were mathematicians or physicists, with minimal knowledge of geology. "Today, in order to carry out processing, and especially interpretation, there has to be teamwork between physicists, geophysicists and geologists who understand the geological model of the area from which the acquisition is being made," McKinnon suggested, adding that MPX employs a team that provides clients with real and adjusted geological information of the surveyed area.

McKinnon has seen remarkable advancements in the sensitivity and resolution of the sensors on board his fleet of aircraft. Depth of investigation, interpretability of the airborne geophysical data, system power, noise reduction, and target detectability have all markedly improved. "Modern systems now allow for three-dimensional subsurface modeling, which is a huge advance compared with older systems where targets at depth were often not well defined. These same targets can now be both detected and better displayed for strategic interpretation," McKinnon said.

Innovation on the Ground

Despite the popularity of airborne surveying, ground surveys remain an important component of exploration. Ground geophysics attains good productivity and often higher definition when applied closer to the buried target. It provides a more stable platform that can maximize survey resolution. In an effort to develop a ground surveying technology that was repeatable, deep, and high definition, Simcoe Geoscience developed a proprietary wireless technology called Alpha IP, which, in addition to operational advantages in the field, also delivers the desired level of definition and depth with the added benefit of eliminating electromagnetic coupling (effects which degrade the quality of standard wired survey data – especially near surface). The technology requires no line cutting, and is a great benefit for explorers in forested and swampy areas.

Innovation Underground

Sudbury-based Clickmox Solutions came to develop its current suite of LiDAR products after working with a 3D laser mobile mapping system at Rio Tinto's Grasburg mine in Indonesia. This quickly became an issue because its third party system was too heavy to mount on a drone, and clients were requesting they fly drones with scanning capability in the underground mines. The reason was that stopes are unsupported, making it unsafe to send people in there. The company needed to develop a lighter and smaller LiDAR with mobile scanning capability, and ultimately did.

In describing the impact that this technology can have on a mines' bottom line, Syed Naeem Ahmed, president of Clickmox Solutions, explained: "Geologists can model the ore flow. However, once some of the ore has been taken out, it is difficult to know how much is left. Unless you get a full 3D profile you cannot get a clear picture of the excavation."

This often results in a mining company spending hundreds of millions of dollars just to get to the orebody and any ore left there is lost profits.

Another founder-led technology company based out of Sudbury is HARD-LINE Solutions, which has been delivering tele-operation systems for mines around the world since 1997. While these technologies

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have evolved significantly, HARD-LINE prides itself on being a supplier that has never deemed a system obsolete. HARD-LINE president, Walter Siggelkow, highlighted that teleoperation takes the operator out of the machine, which in an underground mine allows the machine to get to work immediately after a blast, instead of having to wait for gases to clear for the ground support team to get to work. This increases the time a machine can be in production, and ultimately boosts productivity levels.

Although the value proposition for teleoperation is clear, there remains a lot of hype around autonomous systems gaining momentum. Siggelkow's opinion on the matter is that in mining there are certain things that can be automated and certain things that cannot. Consequently, the industry is reluctant to fully commit to these systems, which explains why teleoperation continues to play an essential role in mining operations.

Mine Equipment

In mining, seemingly simple decisions can be analyzed in excruciating detail. Everything from choosing the appropriate haul truck, excavator, down to the tires is put through a process that considers cost, efficacy, durability, and environmental impact. The sheer number of mines in operation and construction in Ontario makes it a lucrative market to sell into, and the fact that the miners tend to be highly regulated and ESG conscious makes the province an even more logical place in which to focus. For example, John Schellenberg, mining product manager at Hitachi Construction Machinery, who is overseeing development of the company's electric haul truck, noted that social and financial pressures are beginning to mount for companies, so it is beneficial to signal that your company has a vision to mine in a low impact way. One customer of Schellenberg's was willing to spend around US\$7-\$10 million on a battery truck in development because the investment perception provided a better rate of return than the technology that he was investing in.



Michael Gribbons,
President, CEO & Co-
Founder,
Maestro Digital Mine

While the technology may not be ready to scale into the mining industry today, the reason companies like Hitachi are so focused on replacing the diesel haul truck with BEV alternatives is because, as Schellenberg puts it: "A company can only buy so many carbon credits, and there is not enough out there for everyone in the mining industry to offset." He continued: "What I like about a battery haul truck from an energy generation perspective is that we are still looking at 70% efficiency when that wheel hits the ground, from solar panel to rubber on the road."

In comparison to diesel fuel, a variable speed engine is 30% efficient, and another 15% is lost in gearboxes, so there is approximately 25% efficiency in the current systems. "This is what drives me to be involved in these projects—we are going to be able to move a significant amount of materials with considerably less energy."

Wajax, which is the exclusive Hitachi representative in Canada and provides Hitachi shovels, loaders and trucks, observed that the decision on equipment is always a balance of operational and financial goals while still trying to achieve ESG targets. "We often see our mining customers thinking in terms of the broad picture. It might cost them a bit more today to invest in electrical or more technologically advanced equipment, but they have certain environmental and sustainability benchmarks they need to hit," Wajax president and CEO Iggy Domagalski, said. "If they don't invest in these benchmarks, they risk losing license to operate, be it social license or actual operating license. It is about balancing the profitability of today versus the long-term viability of the whole operation."

In the tire domain specifically, companies such as Kal Tire are identifying sizable opportunities. In the past year, the company purchased 17 GCR Tires & Service stores in Eastern Canada, giving Kal Tire exposure to three of the most prolific mining jurisdictions in Canada— Val-d'Or, Chibougamau and Wabush. To meet tire recycling goals in Chile, Kal Tire pursued a thermal conversion

process whereby the tire is converted back to its original components which can then be reused. "Thermal conversion is a much more circular option than just shredding," noted Dave Allan, vice president Canada of Kal Tire's Mining Tire Group. This complements Kal Tire's ESG efforts through its Maple Program, which gives customers accredited data about the fuel and carbon emissions saved in choosing sustainable solutions such as retreading or repairs. Consequently, companies now have very clear metrics to report the environmental impact of their tires.

On the mineral processing and material handling side, FLSmidth has implemented its MissionZero program to help customers trend towards net zero by 2030. The focus is on optimizing water and energy usage by addressing areas like pit crushing conveying (IPCC) systems that could displace a significant amount of haul trucks at mines, significantly reducing greenhouse gas emissions. "We recently closed our acquisition of Thyssenkrupp's mining business (TK Mining), which strengthens our pit-to-plant range of technology, equipment and service expertise, as well as best-in-class digital solutions and market leading HPGR, Eccentric Roll Crusher, and Overland Conveyor technology. With the HPGR technology and our vertical roller mills, we are taking the dry grinding process further into the flowsheet before introducing water, thereby optimizing water and power usage," said John Davidson, North American regional head of capital sales at FLSmidth.

Incorporating ESG

Metrics such as the ones FLSmidth and Kal Tire are able to track are important in that there are now third party ESG companies, like Digbee, who have developed software platforms that cater specifically to the mining industry and its investors. Jamie Strauss, CEO and chairman of Digbee, points out that the industry incorporates ESG on a day-to-day, minute-by-minute basis as part of its permitting process and ESG is embedded into op-



Fred Stanford,
CEO,
Rhyolite Resources

erations to justify their social license. He mentioned: "The purpose of a Digbee accreditation is to provide a clear and credible communication of all elements of ESG to a wide spectrum of stakeholders and to demonstrate a commitment to the ESG journey for both the company and its assets."

Strauss believes that this will allow the mining industry to raise competence and conviction within itself, and ultimately: "pull in new pools of capital and raise perception in society more generally."

Rethinking Mining

Unlike most mining companies that start with a project and then identify the appropriate technologies to mine the asset efficiently, Rhyolite Resources is a company with a powerful technology that is in need of an asset that is amenable to its Muckahi Mining System. The system is a monorail-based underground system with the potential to reduce mine build and sustaining capital expenditures and operating costs by 30% to 50%, and greenhouse gas emissions by up to 95%, while also significantly reducing time between investment and revenue. According to Fred Stanford, CEO of Rhyolite Resources and mastermind behind the Muckahi Mining System: "The technology will materially outperform in any underground mine that uses drill and blast techniques to excavate the ore. That means any metal mine, except those that can be mined with block cave techniques."

Rhyolite has now designed and ordered all the commercial equipment in preparation for the manufacture and commissioning of the first train. "How we will operate our mines is well in hand as are the finishing touches of the equipment and how we will manufacture it," Stanford added.

In parallel with building the fundamentals required to implement the strategy, the company is now in serious discussions with several deposit owners regarding purchasing deposits or mining them for their owners. ■

Engineering, Construction and Consultancy Services

Miners race to optimize for performance and safety

Managing Tailings

One of the areas where things can go awry quickly is if a company does not have a plan that institutes globally recognized best practices in tailings management. Companies like SLR Consulting advise firms on how to effectively approach environmental and social components of the permitting process, and people like Stephan Theben, the firm's managing principal and mining

sector lead, are able to assist firms in meeting the more rigorous engineering and monitoring of tailing dams. "Companies hire SLR because we make sure their site performance increases, and our clients' facilities become safer and more environmentally sound," he explained.

In Brazil, SLR has been working for Vale and the Prosecutor General where they are auditing the upgrades on their tailing's

GDP CONTRIBUTION FROM MINING IN ONTARIO EXPECTED TO GROW 25% BY 2025

New studies find that creating a favourable investment climate for mining contributes to significant GDP gains, as opportunities for industry growth have never been greater.

dams, thereby helping ensure that these facilities are safe and stable.

In Canada, SLR does the engineering for new facilities, but they also do the stability reviews and monitoring of existing facilities, in addition to tailings dam construction quality assurance work. As part of Magino's construction, SLR is supervising the construction of the tailings management facilities. Theben sees sound construction of riskier areas of a mine as an important step in expediting permitting, and going forward he believes that ESG and safety will all be issues that are tackled by mining companies from day one. "I think ESG services will become more of a standard in mine planning, and we will be able to benchmark projects based on ESG-related metrics such as greenhouse gas emissions or carbon footprint," Theben observed.

This paradigm shift represents an opportunity for companies such as Titan Environmental who act as a solutions provider and installer of geosynthetic products, which are mainly resin-based materials used in civil infrastructure construction projects. Specifically for tailings dams, the company's most common offering is a bituminous geomembrane (BGM). Other common geomembranes are polyethylene based such as HDPE or LLDPE, which are different types of plastic liner materials with different thicknesses, in combination with other types of geosynthetics like thick nonwoven geotextiles for protection. "Because our products typically prevent issues such as seepage and contamination of the soil and groundwater, mistakes can be very dangerous. Safety and minimal environmental impact are what our clients want to see," Titan president Juice Lambert points out.

Optimizing and Innovating Underground

As companies go to increasing depths to mine, it presents an opportunity for contractors who are specialized in that space. Redpath Mining and DMC Mining Services both have a long history delivering underground projects to customers. For example, Redpath will provide engineering services and design work for infrastructure that they ultimately end up building. Redpath also does a significant amount of tunneling and lateral development work, different types of vertical excavation, as well as

underground contract mining. The benefit of working with a company like Redpath is that it can provide both management and execution of a project. A former mine operator himself, Paul Healy, president Americas at Redpath Mining, highlighted: "Mine operators are great at operating mines, but are not necessarily as effective at building them. We have great expertise in design, procurement and construction to help clients not only execute the work, but also to manage the work."

The company sees a promising future underground and is already exploring ways to boost the safety profile of a mine using new technologies. One of the areas Healy finds most promising is the progression of automated equipment. "Using automated equipment reduces risks for operators as they do not necessarily have to be underground. It also increases productivity as the equipment can continue operating even during shift changes or if the operator is unavailable for a period of time," said Healy. "In light of the global skills shortage, finding people that are qualified to operate equipment is not easy. If the equipment can do the tasks without human control, then the knowledge and training requirements are not as significant as before."

Michal Jezioro, president and managing director at DMC Mining Services, seconded Healy's view with regards to the impact automation will have in underground mining. "Technology, especially automation, has significantly improved mine safety, allowing operators to work remotely - away from dangerous underground conditions. Equipment and underground vehicles are also designed with operator safety in mind and are most likely the safest place to be in an underground mine," he said.

DMC is particularly well known for having successfully executed shaft sinking projects of varying depths and diameters in some of the most challenging conditions and geologies around the world. While innovation is important, Jezioro underscores the fact that advances must be pragmatic and practical considering safety, cost, and schedule. Most recently, DMC pioneered the world's first Shaft Boring Roadheader (SBR) machine with Herrenknecht and sank the first two mechanically excavated shafts at BHP's Jansen mine. "We have continued advancing this technology and have gained a wealth of valuable experience," Jezioro commented. ■



GLOBAL BUSINESS REPORTS

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If you wish to be interviewed for the report, please contact Margarita Todorova (mtodorova@gbreports.com)

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Mining in Ontario and Toronto's Global Reach 2023

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Senior Project Director: Margarita Todorova

Lead Journalist: Jason Spizer

Business Analyst: Braulio Tresguerres

Executive Editor: Mungo Smith

Graphic Design & Artworks: Özgür Ergüney

Operations Director: Miguel Pérez-Solero

General Manager: Alfonso Tejerina

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