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MINING IN ONTARIO AND TORONTO'S GLOBAL REACH 2023

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Engineering & Consulting - Battery Materials - Innovation

Dear Reader,

Global Business Reports (GBR) is delighted to be back in Ontario to provide our 2023 edition of *Mining in Ontario and Toronto's Global Reach*, which provides an in-depth look at the current mining landscape in Canada's largest mineral producing province. Through analysis based on more than 120 interviews with leading executives from major producers, associations, juniors, consultants, investors, and technology and service providers, this report offers a comprehensive view of what is happening now and what could be happening in the months and years ahead. Like in previous editions, this report is not just about mining in Ontario, but also about the province's outstanding global projection through the Toronto finance hub.

Ontario has been a leading mining province for a long time, but it has been surpassed in recent years by other jurisdictions that offer more attractive incentives, faster permitting, and less red tape. However, Ontario now has a dedicated mining ministry for the first time in decades, which aims to bring the province back to the top of the league table. In today's environment, it is more essential than ever to bring mines online efficiently, as a precarious mix of geopolitical tension and acute underinvestment in raw materials has exposed significant vulnerabilities in mineral-hungry supply chains. Fortunately, Ontario possesses all the necessary tools, including mineral endowment and know-how, to position itself as a hub of mining activity that powers global economic development as well as the energy transition.

Encouraging early signs are emerging. Vale spent C$945 million in the past year alone to revive the old Copper Cliff South mine, creating 270 jobs in the Sudbury area. South Korea-based LG Energy Solution (LGES) also strengthened 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. After a bidding war with BHP for positioning in the Ring of Fire, Wyloo Metals acquired Noront Resources for C$617 million, and Agnico Eagle continued to prioritize its work at Macassa and Detour Lake after acquiring Kirkland Lake Gold to become the world's third-largest gold producer.

We would like to extend our sincere gratitude to all our interviewees for their invaluable insights, as well as to our partners at OMA, TMX Group, and PDAC. We hope this report will serve as a valuable resource for understanding the present and future of Ontario's mining industry, and Toronto's role in the global mining markets.

Alfonso Tejerina
Director and General Manager
GBR

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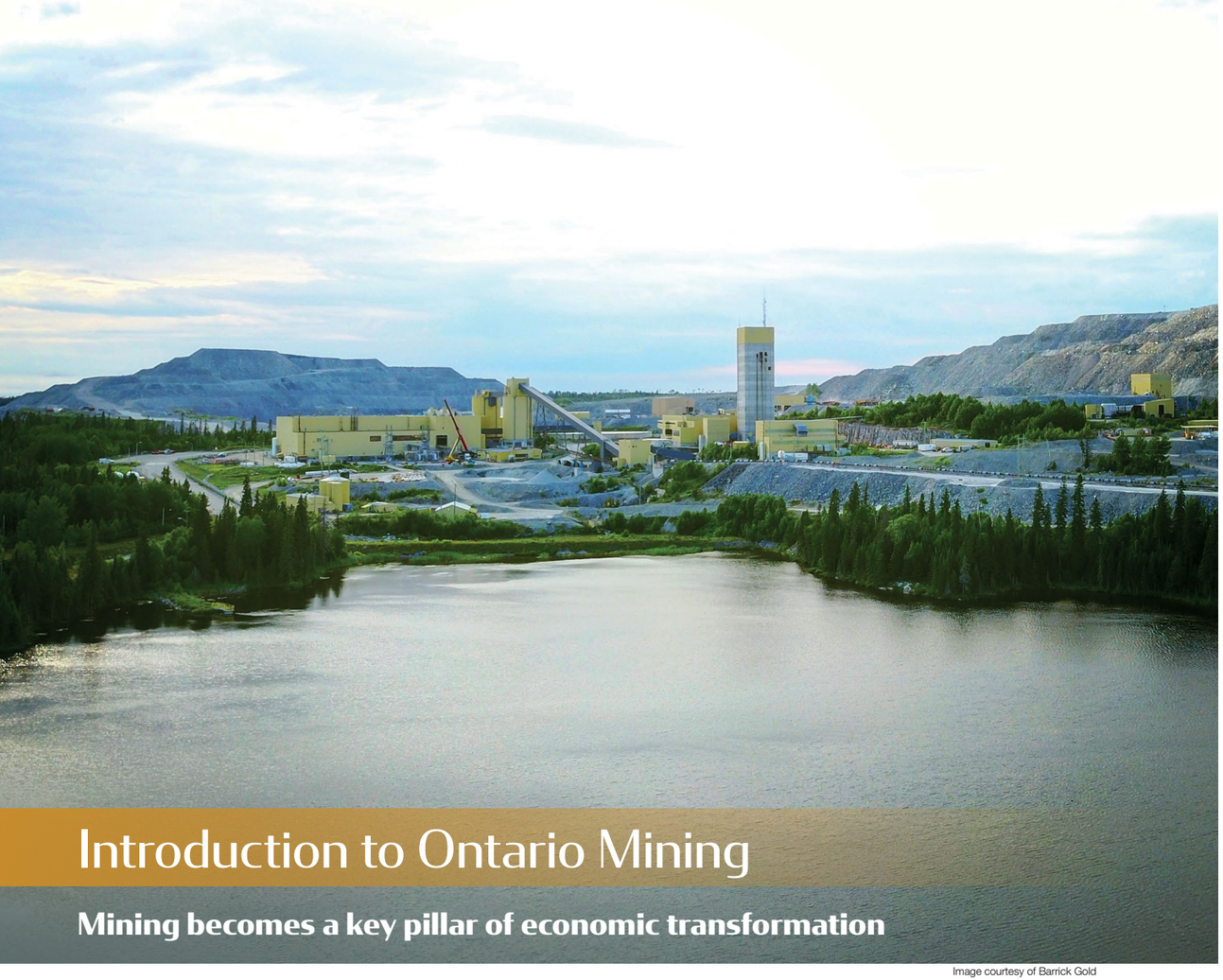
INTRODUCTION TO ONTARIO

"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. The reality is the world needs Ontario's minerals. If we are going to be green, we must mine."

George Pirie,
Minister of Mines,
Government of Ontario

Image courtesy of R.M. Nunes through Adobe Stock



Introduction to Ontario Mining

Mining becomes a key pillar of economic transformation

Image courtesy of Barrick Gold

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 concluded that it was essential that the province marry the mineral potential of Northern Ontario with the industrial might of Southern Ontario. 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 is a wide array of juniors with promising exploration projects, majors have long been producing successfully 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 incentivize a far larger industry.

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

"There are 29,000 direct jobs for individuals working in mines. On top of that, we have a vibrant supply and service sector that provides 40,000 more jobs. 11% of Ontario's mining workforce is indigenous, and 77% of mining companies' GDP contributions stay inside Ontario.

Chris Hodgson,
President,
Ontario Mining Association (OMA)

"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

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 the process of building in Windsor, Ontario.

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 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 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." ■

> **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.**

George Pirie

Minister of Mines
GOVERNMENT OF ONTARIO

Can you outline the logic that galvanized 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. 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. I was lucky enough that they chose me to lead the execution of this transformation.

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; rare earths and lithium 20 miles north of Otter Rapids; a huge nickel deposit in Timmins, and Frontier Lithium in Northwestern Ontario is one 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.

What issues are most important for the government to address?
One of the low hanging fruits 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 to our desire and requirement to permit facilities quicker than we have in the past.

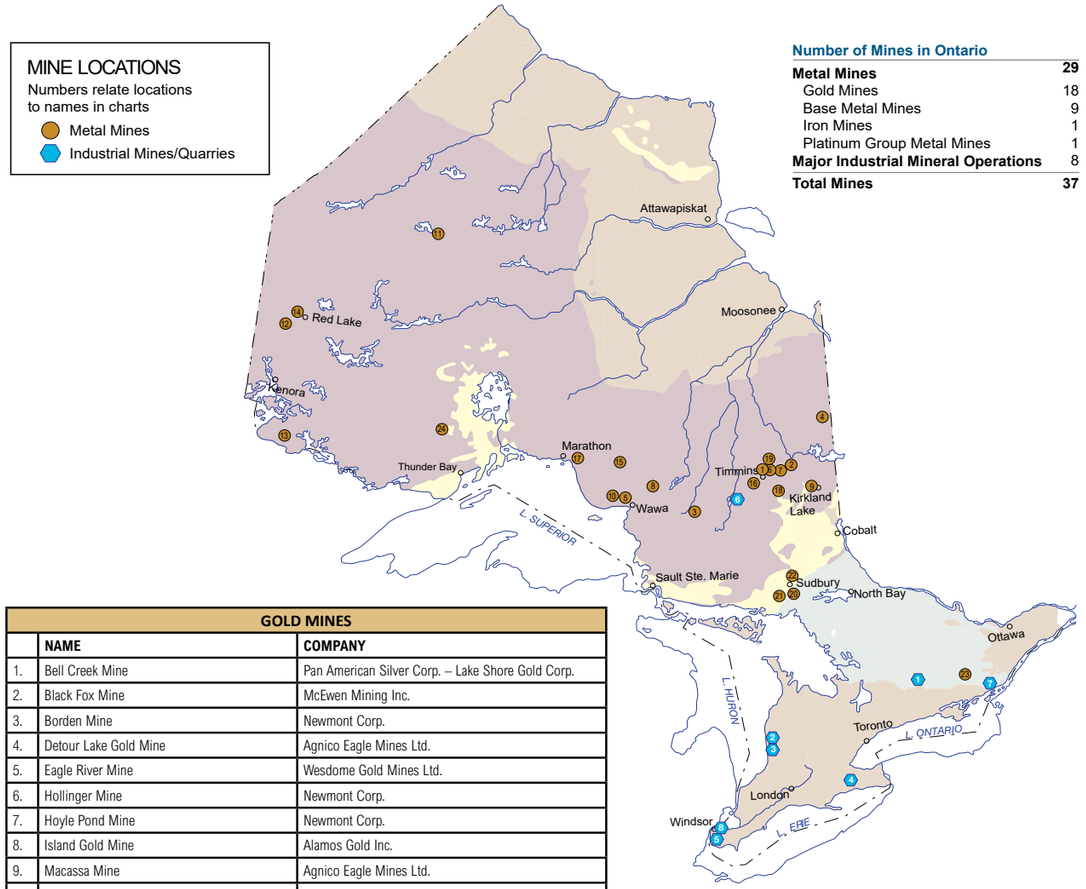
To what extent are surrounding First Nations in support of the effort to mine the Ring of Fire?
Within the Ring of Fire, the chiefs of Marten Falls and Webequie are the ones that are leading the consultation on development of the environmental assessments. Our government, of course, stands ready to support 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.

Do you feel that your ministry has a responsibility to facilitate discussions between OEM's and mining companies to ensure development of the battery material supply chain?
I do not think there needs to be any government involvement in that process, because individuals recognize that we are moving quickly to the end game, which says by 2035 there will not be any automobiles built with internal combustion engines.

Where is the government prioritizing its infrastructure spending to enable more economic mining projects?
In Ontario, a billion dollars are earmarked for development. We are investing in roads, broadband, and hydroelectric. These are the types of developments that allow those resources to be developed.

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%. Contrast that to places like Ohio that are only 6% green. That is one of the reasons why Ontario is such an attractive place for sustainable operations. There is a huge initiative right now on nuclear regeneration. The CANDU reactors are the world's safest reactor. When you couple that with small nuclear modular reactors that are being developed and coming on stream in 2026, we are well aligned to meet the increased electrical requirements in Ontario. There is also a big focus on the phenomenal potential to generate hydroelectric power. There is 100% consensus to develop the electrical potential that we have in in Ontario. ■

Ontario Mining Operations 2023



Number of Mines in Ontario	
Metal Mines	**29**
Gold Mines	18
Base Metal Mines	9
Iron Mines	1
Platinum Group Metal Mines	1
Major Industrial Mineral Operations	8
Total Mines	**37**

GOLD MINES		
	NAME	**COMPANY**
1.	Bell Creek Mine	Pan American Silver Corp. – Lake Shore Gold Corp.
2.	Black Fox Mine	McEwen Mining Inc.
3.	Borden Mine	Newmont Corp.
4.	Detour Lake Gold Mine	Agnico Eagle Mines Ltd.
5.	Eagle River Mine	Wesdome Gold Mines Ltd.
6.	Hollinger Mine	Newmont Corp.
7.	Hoyle Pond Mine	Newmont Corp.
8.	Island Gold Mine	Alamos Gold Inc.
9.	Macassa Mine	Agnico Eagle Mines Ltd.
10.	Mishi Gold Mine	Wesdome Gold Mines Ltd.
11.	Musselwhite Mine	Newmont Corp.
12	PureGold Mine	PureGold Mining Inc.
13.	Rainy River Mine	New Gold Inc.
14.	Red Lake Mine	Evolution Mining Ltd. – Red Lake Gold Mines
15.	Sugar Zone Mine	Silver Lake Resources Ltd.
16.	Timmins West Mine	Pan American Silver Corp. – Lake Shore Gold Corp.
17.	Williams Mine	Barrick Gold Corp.
18.	Young – Davidson Mine	Alamos Gold Inc.
BASE METAL MINES		
	NAME	**COMPANY**
19.	Kidd Creek Mine	Glencore PLC – Glencore Canada Corp.
20.	Sudbury Operations: McCreedy West Mine	KGHM International Ltd.
21.	Sudbury Operations Coleman Mine, Copper Cliff Complex, Creighton Mine, Garson Mine, Totten Mine	Vale S.A. – Vale Canada Limited
22.	Sudbury Operations: Fraser Mine, Nickel Rim South Mine	Glencore PLC – Sudbury Integrated Nickel Operations

IRON MINES		
	NAME	COMPANY
23.	Tomclid Iron Mine	Ferromin Inc.
PLATINUM GROUP METAL MINES		
	NAME	COMPANY
24.	Lac des Iles Mine	Impala Platinum Holdings Ltd. – Impala Canada Ltd.
MAJOR INDUSTRIAL MINERAL OPERATIONS		
1.	Blue Mountain Operations (nepheline syenite)	Covia Holdings Corp.
2.	Goderich Brine Field (salt)	Compass Minerals Canada Corp.
3.	Goderich Mine (salt)	Compass Minerals Canada Corp.
4.	Hagersville Mine (gypsum)	CGC Inc.
5.	Ojibway Mine (salt)	K+S Windsor Salt Ltd.
6.	Penhorwood Mine (talc)	Magris Talc Canada Inc.
7.	St. Lawrence Mine (wollastonite)	Canadian Wollastonite
8.	Windsor Brine Field (salt)	K+S Windsor Salt Ltd.

Source: 2022 Ontario Mining and Exploration Directory and Resource Guide

> The average weekly wage for a person working in a mine is over 60% higher than the industrial average, and the minerals we produce are indispensable for the transition from carbon fuels to electrification and a green economy.

Chris Hodgson

President
ONTARIO MINING ASSOCIATION (OMA)

Can you provide background on the role and evolution of OMA in supporting Ontario's mining producers?
The OMA has been around since 1920, and our mission has always been to ensure Ontario's mining industry is globally competitive. Our number one priority is safety, and our goals are zero harm and increased productivity, so that mining continues to supply society with essential minerals, while working toward achieving zero waste and zero carbon targets.

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.

There are 29,000 direct jobs for individuals working in mines, and then on top of that, we have a vibrant supply and service sector that provides 40,000 more jobs. The average weekly wage for a person working in a mine is over 60% higher than the industrial average, and the minerals we produce are indispensable for the transition from carbon fuels to electrification and a green economy.

What makes Ontario an advantageous jurisdiction for mining companies?
Everybody talks about geology, and we are blessed to have good geology, but that is not the only reason companies want to operate here. What attracts capital are clear rules that are honestly applied. If you follow the rules, you will get a return on your investment. Consequently, companies can borrow money cheaper than in some other jurisdictions in the world.

What should the mining industry advocate in terms of an energy strategy that would help facilitate more viable mining projects?
Behind labour, energy is the second highest cost, and the mining industry cannot control the market. All it can do is look at cost structure. The projections for the cost of energy have risen, not just because of Russia, but because of policy decisions around North American pipelines and drilling permits. Natural gas prices are critically important to the bottom lines of mining companies. Within Ontario, we must build out infrastructure and existing transmission lines need to be strengthened for some of our mines to expand.

We want to make sure that we have a carbon-free grid that is accessible to potential new mines and strengthened for existing mines. Having nuclear is a huge advantage, but we should also be looking to replicate what Québec has done with respect to hydropower.

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. Citizens recognize that the world needs what we offer, and if we want a cleaner world, we need more responsible mining and a localized supply chain. ■

Alex Christopher

38th President
PROSPECTORS & DEVELOPERS ASSOCIATION OF CANADA (PDAC)

What has PDAC achieved in terms of critical minerals exploration tax credits?
We are calling for improved tax treatment of Canadian critical mineral development expenses to improve our domestic competitiveness and incentivize new mines. We are also looking for additional incentives that target the territories to help bridge gaps in infrastructure and offset high operating costs. This should create a more competitive industry in those areas.

Given your background as an exploration geologist, how has exploration changed over time?
PDAC is pushing for more robust geoscience databases from the government to better understand the underlying geology. This is needed for regions and commodities that have been much less in focus in the past, but are now becoming increasingly relevant as demand for critical minerals increases.

Using every bit of data as effectively as possible requires computational power, and the application of artificial intelligence is an excellent example of how the industry is leveraging large data sets to look for trends and target new areas.

In terms of exploration, there are a plethora of tools such as drones that allow us to explore at a larger scale and at different speeds. Today, with XRF and handheld devices in the field, we can get immediate feedback on what we are seeing, which really helps to accelerate exploration programs.

Is society's opinion of the mining industry changing?
One of PDAC's goals is to change the hearts and minds of society through education and communication to ensure that everybody is aware and understands the value and the need for mine development to reach that low carbon future.

Where will PDAC's advocacy efforts be focused moving forward?
To be successful, our industry must have good relations with the government, the ministries as well as the regulators. ■

Angela Hamlyn

CEO
CANADIAN INSTITUTE OF MINING, METALLURGY AND PETROLEUM (CIM)

What have been the most important developments impacting Ontario's mining sector over the past year?
The challenge for the sector is the same as it has been over the last number of years – the shortage of skilled labour. We are in collaboration with the Mining Industry Human Resources Council (MiHR) and helping to address it through efforts including an annual Virtual Career Fair and our recently launched Career Ambassador program.

How are perceptions toward mining, particularly in Ontario, impacting the progress and permitting of projects?
Based on recent polling from Abacus Data and the Mining Association of Canada, we are seeing sentiment around mining begin to change. Placing more of a focus on the significant role that mining plays in decarbonization highlights the relevance the industry has. The conflict between Russia and Ukraine has also opened people's eyes to the importance of securing access to natural resources and local supply chains. Critical minerals are needed in so many of the products we use every day, so we are helping the industry change the narrative. Although it is too early to say how that will manifest on the ground, we know that engagement with local stakeholders remains essential to a successful permitting process. We are providing resources – through in-person and online events and through the work of committees, like the CIM Environmental and Social Responsibility Society (ESRS) and the CIM Diversity and Inclusion Advisory Committee (DIAC), that help decision-makers ensure that they are engaging with, and including, all stakeholders.

What commodities do you believe will drive industry momentum?
Ontario is rich in critical minerals, such as copper, nickel, cobalt, the platinum group elements, uranium, tellurium and selenium. Building the capacity to recycle materials, such as electric vehicle batteries and other wastes, will be an important part of creating effective local supply chains. ■

Cultivating the Next Generation of Miners

Fostering an ecosystem of innovation to attract new talent

Image courtesy of Lassonde Institute of Mining

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 its commercial goals. Conversely, universities find industry partnerships valuable because they help advance their capacity to conduct high quality research, which can be an influential factor in attracting high level academic talent and top tier students.

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, Ontario is fortunate to have institutions such as University of Toronto's Lassonde Institute of Mining, Laurentian University's Mineral Exploration Research Center (MERC), Northern College's Haileybury School of Mines, Cambrian College's Centre for Smart Mining, Queen's University's Robert Buchan Department of Mining, and Collège Boréal.

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."

» 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. Mining has an imperative and an opportunity to be a leader in sustainable development.

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

» Operationally speaking, all mines must establish a memorandum of understanding (MOU), exploration agreements, and continued working agreements with locals and First Nations communities in order to progress their assets. We want to develop future employees that understand how important that social process is to the company they are working for.

Audrey Penner,
President and CEO,
Northern College

From Lab to Mine Site

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

The findings show that there are unchartered 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 be ready to 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 earths 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.

Advancing Predictive Geometallurgy

Julián Ortiz, head of the Robert M. Buchan Department of Mining at Queen's University, which ranks in the top 10 in the world as a mining program, and is currently engaged in research projects with several mining and consulting companies, has focused his work on predictive geometallurgy and geostatistics. According to Ortiz: "Predictive geometallurgy and geostatistics will help us create something like a twin of the material streams and processes involved in different stages of a mining project so that we understand how uncertainty and variability propagates downstream."

Ortiz added that this type of fundamental and basic research is often funded by government agencies and federal funds, and creates a base of ideas and seed projects that have potential to scale up to applications, tests, pilots, and can eventually be commercialized.

> Current immigration policies do not assist the industry in recruiting overseas. I believe we should be lobbying much more strongly to get immigration laws changed to allow qualified mining talent, with easy access to Canada for job offers.
>
> **Chris Stafford,**
> **President,**
> **C.J. Stafford**

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, because 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

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> The mining community must recognize that resilience is going to come from reducing ESG risks, and that can only come from transformative innovation underpinned by research.

Lesley Warren

Director,
Lassonde Institute of Mining
UNIVERSITY OF TORONTO

How has the mission and focus of the Lassonde Institute evolved over the years?

The Lassonde Institute has been a flagship Institute for mining research over the last 20 years at the University of Toronto. We have a long tradition of exploration and hard rock mining expertise with a strategic focus on the development of advanced models and technologies in these areas. Recently, we have expanded our research themes into the critical emerging risks in the ESG space under our new Global Resources Stewardship Initiative (GRSI), which reflects both the need for cross-disciplinary research to tackle these challenges as well as the need for partnership models that enable different ways of doing research that are more effective and timely for industry. Today, we represent global experts across the entire value chain through our Research and Innovation areas of: Energy & Sustainability; Exploration; Digitalization & Robotics; Safer Mines; Society & the Economy; and Water & Tailings.

How will the mining industry attract a new generation of innovative thinkers to join its ranks?

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 they need talent that can transition with them. Mining has an imperative and an opportunity to be a leader in sustainable development. By achieving that, they will attract people who see the value the industry provides.

Developing an ecosystem where there are strong connections between academia and industry players, that are strategic and long term, underscores the value and need for knowledge discoveries and innovation pursuits; ultimately, increasing attraction and retention of these HQP in our industry.

What is most exciting to you about your research on integrating emerging molecular biological techniques to apply them to mining contexts?

We apply molecular tools developed by microbiologists and applied far more widely in other contexts such as the oceans, soils, and human gut. This allowed us to start interrogating what microbes occurring in mining wastewater and reclamation environments are doing. We found that these tiny engineers are playing instrumental roles in influencing wastewater quality associated with tailings ponds as well as tailings reclamation stability and closure outcomes.

What are the implications of this research from a water management perspective?

Management of water at mine sites is increasingly inefficient. Companies are unable to predict significant impacts before they happen, and when they do happen, they often cannot reverse course. This is why the industry is beset by legacy issues. There is evidence that we need better models and tools, and it is clear that microbiology is going to be an important player in this. Mining systems are bioreactors, and organisms that are present in tailings ponds or mining impacted waters are novel. What that tells us is that we have unchartered opportunities once we start to identify these bugs and what they are able to do, given the conditions under which they act. 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 opportunity is starting to gain traction because companies are recognizing that the value proposition bedrock for the industry has to change to include improved environmental stewardship.

Do you have a final message as to why companies should consider partnering with the University of Toronto?

Lack of social license and the inability to attract investment continue to hamper the industry's capacity to meet future demand for metals. This speaks to the need for stronger knowledge baselines that can enable sound industry ESG outcomes and gain stakeholder trust. Catalytic knowledge discoveries addressing these key ESG risks are an essential component of the value the University of Toronto's GRSI provides; our research improves bottom lines and enables partners to be proactive in mitigating risk. The mining community must recognize that resilience is going to come from reducing ESG risks, and that can only come from transformative innovation underpinned by research. ■

> We want to be the go-to research institution for companies looking for help and guidance in their exploration programs in Precambrian terrains.

Ross Sherlock

Director of MERC and Metal Earth, Chair in Exploration Targeting
LAURENTIAN UNIVERSITY

Can you provide background on MERC and the Metal Earth project?
At Metal Earth, we are focused on understanding the processes that result in differential metal endowment. As an example, why some parts of the crust are so metal-rich and other areas with similar geology are metal-poor. We are now in year seven, and over time the project moved from field-based survey-intensive projects into compilation and data analytics. By understanding what controls metal endowment, we can inform mining companies with respect to reducing risk for greenfield exploration. 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.
Moving forward, MERC will continue to focus and develop expertise on mineral deposits in Precambrian terrains. That is what we have always done. We want to be the leading research institution with those criteria, and we want to be the go-to research institution for companies looking for help and guidance in their exploration programs in these terrains.

Can you highlight some of the accomplishments of MERC and Metal Earth in recent years?
One of our key achievements is that we developed criteria that enable mapping of fertile fault systems. We see this through a combination of geophysical and geological features. One of the main tools we use is magnetotellurics, a resistivity mapping tool that uses natural electrical currents within the crust. It is not necessarily the data collection that has been improved. It is more the processing and the inversion of the data, which has shifted from 2D to 3D frameworks. This gives us better resolution, and we are applying this in a different way to allow us to image the upper parts of the crust.

What do you find to be the most exciting exploration technology today?
One of the most exciting developments over the last decade has been in portable geochemistry. Portable XRF instruments are a field application that allow analysis of soils, stream sediments, and rock samples. The instruments provide near real-time, high-quality multi-element data. This is an incredible advantage for the industry, particularly in Canada, where field seasons can be quite short, and projects need to generate targets in a single field season.

Why do you think Earth Science enrollment figures are so low in North America?
Enrollment has dipped across all Earth Sciences departments in North America, and the trend reflects low enrollment when the industry is depressed and improvement as the industry strengthens. With increased activity in the exploration sector, we expect enrollment to rise as there are plenty of opportunities for students.

What partnerships has Laurentian established with industry partners?
For example, in Timmins, we partnered with several mining companies, including Newmont, Canada Nickel, International Explorers and Prospectors Inc., and Pan American Silver. Metal Earth conducted a relatively wide-spaced geophysical survey, and industry partnered with us to complete much higher-resolution surveys over their properties of interest. Metal Earth is integrating the 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.

What is the source of Metal Earth Funding?
Metal Earth is a research program publicly funded through the Canada First Research Excellence Fund (CFREF). Metal Earth was the only geoscience-related project funded through CFREF, and we have received over C$49 million in support. Consequently, all the data we generate becomes public. We have also received a considerable amount of in-kind support, totaling more than C$80 million. That includes support from provincial geological surveys, which have contributed a significant amount of data, as well as the mining industry. As a research centre, MERC tends to leverage industry money with public money, so we have a number of projects that are funded through provincial and federal agencies as well as mining and exploration companies. ■

Mike Commito & Steve Gravel

MC: Director of Applied Research & Innovation
SG: Manager, Centre for Smart Mining
CAMBRIAN COLLEGE

Can you provide an overview of Cambrian College?
MC: Cambrian College is the largest college in Northern Ontario with more than 90 programs across the college. Given the importance of the mining industry to Sudbury, many of our programs serve as a pipeline generator that fills the workforce needs of the industry. We offer a Mining Engineering Technology program, but we also offer many mining applicable skilled trades and mining adjacent programs.

What is the goal of Cambrian R&D and what is the Centre for Smart Mining?
MC: Cambrian R&D is the college's applied research arm, where we work with companies to solve practical problems. Sometimes companies have an idea for a new process or prototype but lack the resources or time to carry it out. In these instances, we build the project for them, and they provide funding to subsidize it.
SG: Our goal is to help de-risk new technology adoption in the mining sector through upskilling programs, and we want to bring in more partners as we try to make Sudbury a BEV hub.

What are the technology trends that you see in the mining industry, and how is the Centre for Smart Mining poised to play a leading role in facilitating adoption?
SG: The trend toward electrification will set the course for technological development. It is difficult to find an OEM that services the underground market and is not working on an EV version of their vehicles. At the Centre for Smart Mining, we are poised to lead in the EV field by helping companies understand the impact that adopting these technologies will have on mine infrastructure. We are constructing a battery electric vehicle lab and a performance testing lab, which is the first of its kind in Canada. Our vision is for researchers to work with BEV manufacturers and end-users that want to adopt the technology to give them better data and a realistic picture of the performance of BEVs in actual operating conditions. We also offer a BEV industrial training certificate program, and we upskill in-service, heavy-duty diesel equipment mechanics and technicians in troubleshooting underground BEVs. ■

Daniel Leduc

Dean, School of Trades and Applied Technology, School of the Environment and Natural Resources
COLLÈGE BORÉAL

Can you give us an overview of Collège Boréal?
Collège Boréal is a community college with 36 sites including 7 campuses located in 26 communities throughout Ontario. We are an innovative educational, cultural and community hub offering a wide variety of post-secondary and apprenticeship programming, corporate training and applied research opportunities dedicated to the mining industry's needs. Our mining-related programming and training offerings are mainly taught from our Timmins and Sudbury campuses located in Northeastern Ontario.

Research & Innovation Boréal (RIB), our applied research department, responds to ongoing and emerging economic, industrial and social needs of communities within the territory we serve. The research projects lead to the development of products, processes, prototypes, industrial design and marketing strategies, among other possibilities. Environmental sustainability through land reclamation efforts and green energy adoption are some of the areas of research focus and expertise.

What role are partnerships and internships playing in Collège Boréal's strategy?
Partnerships allow on the job work, integrated learning experience through apprenticeship, internships, and co-op placements. They are an excellent way to immediately solve the workforce shortage and engage employers with training. Communication with industry is essential because we better identify what we are doing well and what changes we must implement to improve. Current partnerships exist with multiple employers and particularly with Epiroc and the emerging needs for maintenance of battery electric vehicles. We also have several partnerships though our Glencore Centre for Applied Research for Biodiversity working towards proposing ecological solutions towards environmental sustainability. ■

Audrey Penner

President and CEO
NORTHERN COLLEGE

Can you outline the history of the Haileybury School of Mines and its effort to prepare the next generation of mining professionals?
Haileybury School of Mines (HSM) turned 110 years old in 2022, and has historically been a rich cultural and economic resource for the Haileybury region. The amalgamation of HSM with Northern College happened in 1967, and through that, HSM still exists as a branding entity and corporate acknowledgement. There are HSM graduates working in mining jurisdictions all over the world, because we have an exceptional reputation for high quality and innovative work around mining, with graduates that are in high demand.

Can you speak to the connection between the industry's labor needs and the training HSM provides?
Northern College is known for our very strong links to industry. We partner with all the major mining companies in the region, and we offer our mining partners a "talent pipeline" agreement, which opens doors for them to access our students before they are even students. Companies can be involved in the recruiting process, have an opportunity to support students through their learning, and have dibs on those students as they become graduates and come into the work field. This agreement has been extremely helpful in staffing the mines in the region.

Is the mining industry embracing continuous learning and skill development for its employees?
In mining, there is also the need to "earn and learn," and we have a division within the College that is dedicated to upskilling in-house employees. Our two most commonly demanded programs are surface diamond driller and surface miner common core. These programs last eight weeks. Our employment rate out of these programs has been between 90% and 100% for the last five years. ■

Julián Ortiz

Head of Robert M. Buchan Department of Mining
QUEEN'S UNIVERSITY

Can you give an overview of Queen's University?
Queens's University has a history of more than 150 years. The institution and its programs are globally renowned and approximately one quarter of all mining engineers in Canada are from Queen's University. We offer a traditional undergraduate Bachelor of Engineering program with a focus on mining technology, methods and design, as well as a component of mineral processing and metal extraction.

Our graduate programs include a one-year course-based Master of Engineering, a two-year research-based Master of Applied Science program, and a four-year research focused PhD program. We also have a graduate diploma focused on social performance management in the extractive industries, as well as a Certificate in Mining Technologies. We are proud that Queen's University ranks in the top 10 in the world as a mining program, and the exit outcomes in the job market or our students are excellent.

How does Queen's University bridge the gap between industry and academia, and what efforts you are making to get academic research into practice?
We are focused on developing research areas that are key for the modern mining industry, and have different stages of research. There is fundamental and basic research which is often funded by government agencies and federal funds, and creates a base of ideas and seed projects that have potential to scale up to applications, tests, pilots. There is also research that stems from engagement with companies and industry, and we connect with companies to implement and demonstrate the potential of some ideas that are seated at a basic level through joint projects, funded by both the company as well as potentially the government agencies. The third level is where companies already see the economic potential of an idea and they invest in a more direct way to test the idea at their site. These are ways in which knowledge, research, and technology advancements are transferred from universities to the private sector. ■

>>16

and skill shortage, and the pandemic compounded the issue."

Figures published by the Mining Industry Human Resources Council (MiHR) confirm the pressing need to replenish and grow the mining industry's talent pool with expectations of a shortfall of 80,000 to 120,000 workers by 2030. While graduates of Northern College's Haileybury School of Mines (HSM) have been filing into the mining industry for over 110 years now, the school continues to introduce new programs to meet the evolving needs of the mining industry. According to the school, mining program enrollment is seeing continued growth, and exit outcomes are laudable. To address the desire of many students to "earn and learn," HSM developed a division dedicated to upskilling in-house employees. Two of the most commonly demanded programs are surface diamond driller and surface miner common core, where over the course of eight weeks, students learn how to effectively utilize mining equipment underground. The results speak highly of the quality and necessity of the program, because the employment rate out of these programs has been between 90% and 100% for the last five years. Audrey Penner, president and CEO of Northern College pointed out: "Our students are either staying in their job or coming in and taking the course on their own and they are employed immediately afterwards because the skills they acquire are in high demand."

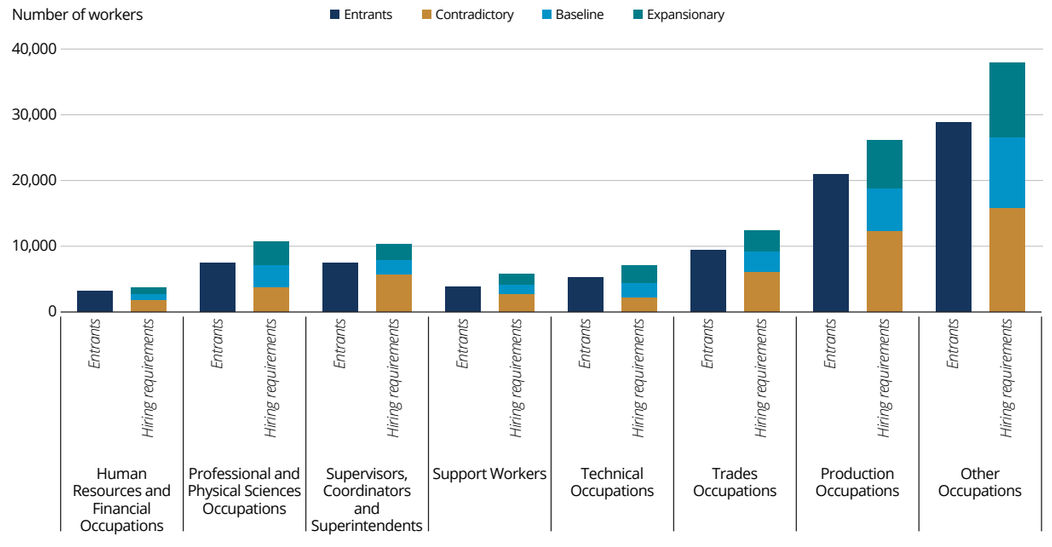
The success of these programs can be attributed in part to a focus on experiential learning and applied research that continues to shift as the heavy-duty equipment industry is adopting today requires deeper knowledge of subjects like electrical and computer engineering. In order to bring together students and industry, Northern College opened an innovation hub in 2022 where companies can do prototyping and experimenting, while students learn and contribute to problem solving any issues that may come up. "This often leads directly to employment as students get the experience of applying what they learned in a new and innovative way. A semester of applied research is often equivalent to a year's worth of experience from what I have observed," Penner noted.

University Partnerships Enable Green Transition

Similar to Northern College, Collège Boréal and Cambrian College have taken an approach where, through industry partnerships, students can gain the requisite preparation to immediately contribute their skilled labor. Collège Boréal has partnered with Epiroc to address the emerging needs for maintenance of battery electric vehicles, and also partnered with Glencore for several years to work on re-greening solutions. Daniel Leduc, Dean of Skilled Trades and Applied Technology at Collège Boréal, commented that Mechanical Millwright Technician and Heavy Equipment Technician are two of the most requested programs. "The focus is on skilled trades because that is what the industry demands," Leduc said.

Cambrian College's Centre for Smart Mining is a specialized research hub within Cambrian R&D with the goal of helping to de-risk new technology adoption in the mining sector through upskilling programs. These ensure that companies have the in-service staff to deal with new technology coming in, and they are poised to lead in the EV field by helping companies

Cumulative New Entrants versus Hiring Requirements by Broad Occupational Category (2020-2030)



Source: Mining Industry Human Resouces Council, Statistics Canada (System of National Accounts, 2016 Census), 2019

understand the impact that adopting these technologies will have on mine infrastructure. Cambrian's battery electric vehicle and performance testing labs are a first of kind in Canada, and Steve Gravel, who manages the Cambrian's Centre for Smart Mining noted: "Our vision is for researchers to work with Battery Electric Vehicles (BEV) manufacturers and end-users that want to adopt the technology to give them better data and a realistic picture of the performance of BEVs in actual operating conditions."

Tailored Search

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. Client director, Erik Buckland, commented that historically the firm has resisted diversifying because mining requires an "intimate understanding of our client's world."

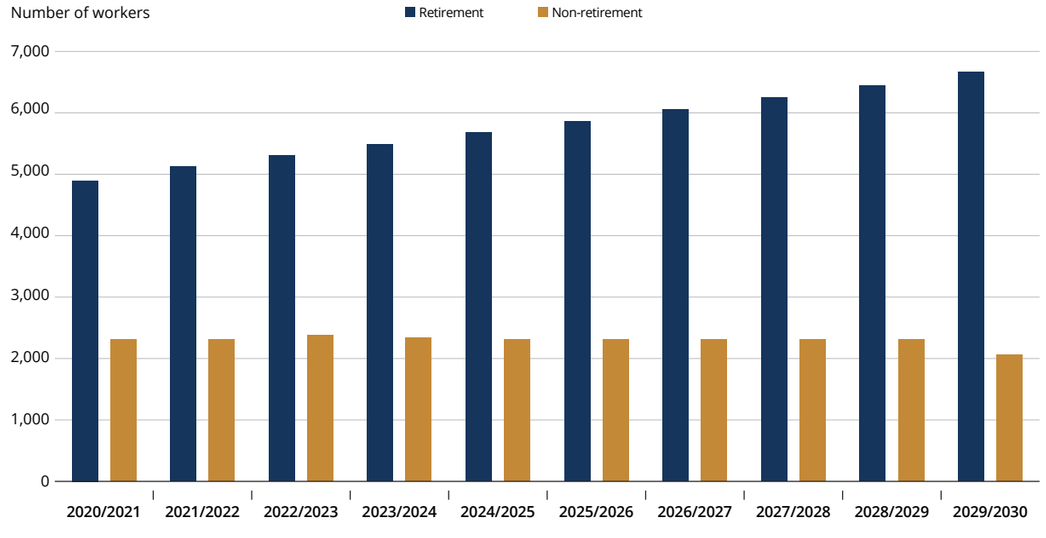
According to Buckland, we are experiencing a collision of an overheated mining market with a talent pools that has become shallower by the year. This is driven by a combination of training and demographic factors, and a resistance or inability of companies to both incubate talent internally and to professionalize 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," he stated.

Chris Stafford, president of C.J. Stafford, is concerned that the talent shortage is a real threat to the success of mining companies. Compounding the problem is the fact that immigration policies hinder the industry's efforts to bring in talent from overseas. "I believe we should be lobbying much more strongly to get immigration laws changed to allow qualified mining talent with job offers easy access to Canada," he 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 requires 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 IT or AI experience," he said. ■

> Sometimes companies have an idea for a new process or prototype but lack the resources or time to carry it out. In these instances, we build the project for them, and they provide funding to help subsidize it. We staff the project with students who help execute and develop it.
>
> **Mike Commito,**
> **Director of Applied Research & Innovation,**
> **Cambrian College**

Forecast of Annual Workforce Exits from Mining Industry, Baseline Scenario (2020-2030)



Source: Mining Industry Human Resouces Council, Statistics Canada (System of National Accounts, 2016 Census), 2019

Erik Buckland

Client Director
LINCOLN STRATEGIC INTERNATIONAL

Can you introduce Lincoln Strategic?

Lincoln Strategic is a human resources and recruitment consulting firm with an exclusive focus on the mining and metals industry. We provide a comprehensive suite of staffing, headhunting, and market research and, increasingly, human resources consulting services. Our value-add is our domain expertise – basically mining is all we know because it's all we do.

What are your observations on the limited availability of talent companies are competing over?

We're experiencing a collision of an overheated mining market, talent pools that are getting shallower by the year, and a resistance or inability of companies to both incubate talent internally and to truly professionalize their recruitment functions and initiatives. It's the latter that companies can truly control. While there is an increasing talent shortage, I think companies give this too much credit for why they can't recruit the right people.

How can mining companies do a better job appealing to candidates?

Work/life balance is more important than ever – a global pandemic tends to refocus priorities – and compensation, while important, is less critical than many companies think. The companies that enjoy the best recruitment success have focused on crafting their messaging to prospective candidates around these criteria. Also, we advise our clients to accept that talent is more transient than ever and to get creative about formal commercial arrangements with their candidates.

How does Lincoln Strategic filter through candidates to ensure they are well suited for the job?

Our job is to provide our clients with the kind of data they need to make informed, confident hiring decisions with as little finger-crossing as possible. To this end, we deploy a multivariate evaluation methodology that starts with a clear delineation of the scope, deliverables, and success factors for the role our clients need to fill. We then define the ideal candidate profile: certainly, skills and experience, but also behaviors, cognition, values, and drive. ■

Chris Stafford

President
C.J. STAFFORD

Can you provide an overview of C.J Stafford and the evolution of the company?

C.J. Stafford is a mining focused executive search and recruitment company connecting executives, engineers, scientists and managers for mining and related industries across Canada and globally since 1981.

Are Canada's immigration policies lenient enough to bring in labor to fill skills shortages?

Current immigration policies do not assist the industry in recruiting overseas. I believe we should be lobbying much more strongly to get immigration laws changed to allow qualified mining talent, with job offers easy access to Canada. 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.

The number of graduates from mining related programs has significantly decreased over the years. What does this mean for the future of mining?

It is devastating because graduates are the future of mining. Research we conducted demonstrated that enrollment in the 'Earth Science' programs indicated that the numbers followed the commodity cycle. Not all roles demand professional engineers and we strongly advocate for stronger relationships with Colleges and apprenticeship programs tailored for mining. The industry must be more creative in attracting talent if it wants to thrive, particularly as we enter a new era of where life/work balance is front and center.

What has the scarcity of talent meant for wages?

I believe inflation is going to have a bigger impact on wages than the shortage of talent. Mining companies are considered to pay well and offer good benefits and incentives. However, they may need to reconsider how to incentivise employees in a manner that will impact upon retention.

More important today is how employees are treated, recognised and rewarded. ■

PRODUCTION AND DEVELOPMENT

"If you have a lot of ounces, and high grade in a safe jurisdiction, that is the holy grail."

John McCluskey,
President and CEO,
Alamos Gold

Image courtesy of Agnico Eagle

Production and Development

Ontario miners weather market volatility

Image courtesy of McEwen Mining

With world-class mining districts such as Red Lake, Hemlo, Thunder Bay, Timmins, Ring of Fire 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 total production in Canada.

This production is driven by mines such as Detour Lake, Porcupine, Young-Davidson, 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 million 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 considering 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.

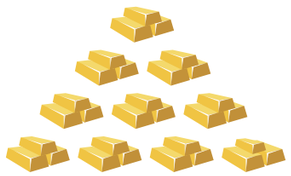
Jennings added that this is an opportunity to build a new generation of mines that are more likely to be underground. In turn, they will have smaller footprints and they will be more discreet, which could potentially help limit environmental disruption and improve license to operate.

Majors Act to Expand Ontario Presence

When it comes to companies making considerable bets on Ontario, few have been more strategically significant than Agnico Eagle's merger with Kirkland Lake Gold. The merger created one of the industry's highest-quality and lowest-risk senior gold producers, because both companies have proven assets in leading jurisdictions. Before the merger, Kirkland Lake was in the process of building a new mine at Macassa. Now, under Agnico Eagle, the combined company is in the final stages of completing its number four shaft, which will unlock substantial value.

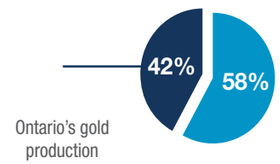
With respect to synergies resulting from the deal, Agnico Eagle's VP of Ontario operations, Andre Leite, explained: "Our plan is to explore and better delineate the ore body at our near surface deposit, but the merger also brought in the AK zone, which is an ore body that is very close to our existing infrastructure for the near surface. We are currently in the process of evaluating when that ore body will be coming into production. If the deposit existed solely under Agnico's purview it would probably not be viable, but because of synergies associated with the merger, the deposit can now be part of an effort to bring on additional ounces earlier than expected. "

Gold Production in Ontario



99,793 kg = 3.21 million oz t
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

Our current mix focuses on copper, nickel, potash and iron ore, all commodities that can help the world with regards to growth and better managing environmental challenges.

Keenan Jennings

Vice President, Metals Exploration
BHP

What makes Canada an advantageous location to explore and develop nickel and copper mines?
Canada sits right at the heart of the opportunity for both copper and nickel. It is a country with a proven track record and a strong pedigree of exploration and production in those two commodities. Where the opportunity and the big challenge sits is going deeper, which I refer to as the "Next 400". 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. It is a challenge because we can't see it, and it requires new technologies. This is a new greenfield search space for us, and we believe there is a tremendous amount of potential in Canada. It also plays strongly into the likelihood that the next generation of mines will be underground. That means they are going to have much smaller footprints, and less impact on other land users and stakeholders.

What was the rationale for BHP moving its exploration headquarters for nickel and copper to Toronto?
Historically, BHP had an expansive global spread, but when metals prices collapsed at the time of the Great Financial Crisis, we shrank as an exploration unit back to what was essentially a South American copper exploration company. This profile would only get us so far with respect to replenishing BHP's asset base, so BHP CEO, Mike Henry was keen to create a more ambitious growth lever. That is when the decision was taken to move the Metals Exploration team to Toronto and to co-locate it with our Business Development group. 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.

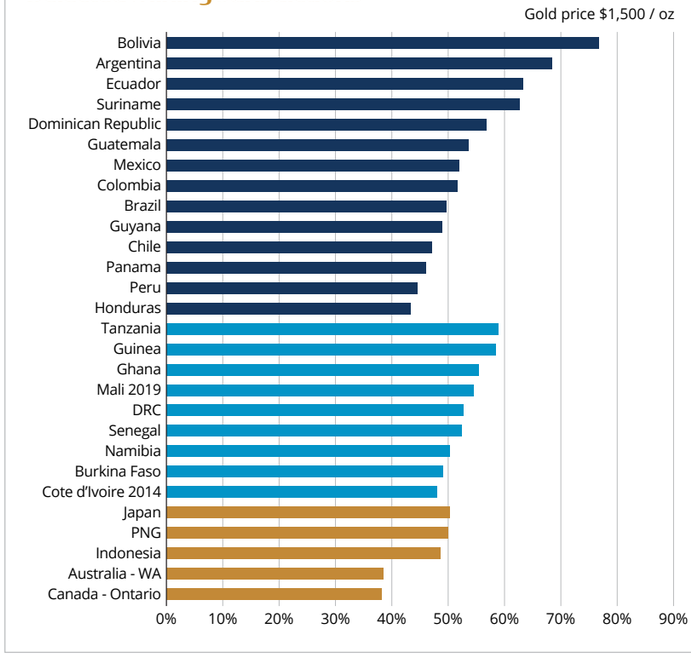
Canada is a fantastic place to go for nickel and copper. We are already working with Canadian partners and looking to acquire and discover new nickel projects across the country.

How does BHP go about defining the right balance of commodities to pursue to fuel its growth strategy?
We are constantly challenging our beliefs around what is the right basket of commodities. At this point in time, for both nickel and copper the consensus is that they are going to be needed in a big way for the world to decarbonize and electrify its economy. Our current mix focuses on copper, nickel, potash and iron ore, all commodities that can help the world with regards to growth and better managing environmental challenges. BHP is very much geared toward the long term. We are looking at developing the next generation of deposits that we may not see the fruits of for another 20-50 years. What is absolutely certain is in that timeframe, we will be in a greener world, and copper and nickel play very strongly into that.

How is BHP reimaging mining to improve the economics associated with deposits that are more mature or technically challenging?
It has always been about grade, and likely will always be about grade. We must get smarter at identifying higher grade deposits earlier in the lifecycle of an exploration program. We also need to reimagine how we build new mines once discovered. In this regard, we are searching for ways to further optimise our capital spend. The industry has a tendency 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.

If we look at the asset base of mineral inventory, it typically takes approximately 20 years from discovery to operating a base metals mine. We want to make that 10 years, because if it takes 20 years, it will not have the same impact in delivering a decarbonized and electrified world. This is how we need to reimagine mining in the 21st Century. ■

Percentage of Gold Project Returns Going to the State in Selected Mining Jurisdictions



Source: Barrick Gold

At Detour Lake, formerly a Kirkland Lake asset, 2021 was a record year in production. However, 2022 is expected to exceed the 700,000 oz produced in the year prior. According to Leite: "The reason for our success can largely be attributed to the fact that we completed several different projects in relation to the plant that optimized our process."

Since the merger, Agnico Eagle has increased reserves by approximately 5.6 million oz at Detour, which extends mine life an additional 10 years out to 2052. "This allows Detour to become a very long-term play, because we will have 30 years of operation that will allow us to explore the potential for the asset. Much of our focus in 2023 will be towards better understanding the potential for underground at Detour," Leite said.

At Barrick, 2022 was about hitting production guidance, continuing to build a strong balance sheet with a sustainable dividend, and shoring up life-of-mine plans to ensure a 10-year production profile remains intact. While Nevada Gold Mines is Barrick's value foundation, and its presence Africa and the Middle East region is its most consistent producer, Barrick president and CEO, Mark Bristow stated: "Barrick is under-invested in Canada and we mean to correct that."

Barrick is particularly focused on Northern Ontario's Uchi Belt. Since assembling a high-powered exploration team to identify Tier-One and Tier-Two opportunities, it has consolidated an exploration property portfolio of 124,000 hectares in the underexplored belt. Bristow highlights that the goal from here is to continue to build on that: "The Uchi Belt is host to the world-class Red Lake deposit which, in addition to recent new discoveries in unconventional host rocks, has supported our views that this district remains highly prospective."

Barrick is also not yet ready to let go of Hemlo after 34 years of value creation there. Operations at Hemlo are being modernized and refocused to secure the gold mine's continued viability. Several programs have been introduced to improve its performance and the mine has moved to an underground contract mining model. "The objective is to upgrade Hemlo to a Tier Two asset and extend its Life of Mine well into the future," Bristow said. "By repositioning Hemlo as a smaller but more profitable business, we are ensuring that it will continue to deliver value to its community, employees and other stakeholders for years to come."

Venturing Out of Africa
The Lac des Iles mine has been operating since 1993 and currently employs just under 900 workers plus a few hundred contractors who currently operate the open pit and underground mine, as well as a mill. However, since the asset was acquired by Implats in December 2019, the availability of capital has vastly increased. Lac des Iles was Implats' first acquisition outside of the African continent, and today, Impala Canada contributes 20% of the group's palladium and about 8% of all PGEs. According to Impala Canada CEO, Tim Hill, the company significantly expanded the underground operation, increasing underground production by approximately 65%, with current production rates of about 11,600 t/d. At the time of acquisition, the mine was producing approximately 7,000 t/d. "At this increased production rate, our operation is one of the largest underground mines in Canada. Our goal in 2023 will be to achieve an average production rate of 12,200 t/d from underground," Hill stated.

In 2022, Impala also completed construction on its new crushing circuit, which is the first phase of a three-phase optimization program for its mill. The commissioning is the next phase, and will be complete by in spring 2023, and this consists of a number of initiatives for downstream processes in the mill. "We led with the construction of the new crushing circuit because our current crushing plant has had difficulty processing the increased quantity of underground ore. The new crushing circuit will provide additional throughput capacity."

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We have significant deferred tax assets in Canada, making new discoveries and/or assets even more attractive from a free cash flow and net asset value perspective.

Mark Bristow

President and CEO
BARRICK GOLD

How would you assess Barrick's performance in 2022?
We are continuing to build our balance sheet, our dividend policy is delivering sustainable returns and we have shored up our life-of-mine plans to ensure that our 10-year production profile remains intact. Our successful exploration programs are feeding high-quality prospects into an already bulging pipeline and we expect to grow our reserves net of depletion again this year.

Nevada Gold Mines is Barrick's value foundation. As far as the original objectives of the joint venture are concerned, I can safely say: Mission Accomplished! We have created a whole that is truly greater than the sum of its parts. From this sound base, NGM can now exploit the wealth of opportunities in its ambit, and we have recruited a future-facing management team – including a new North American regional chief operating officer and a new NGM executive managing director – to lead the company into its new growth phase.

What are the primary drivers of Barrick's future growth, and what balance are you hoping to achieve between copper and gold?
Barrick's core strategy is one of long-term value creation. We continue to maintain a strong balance sheet and to develop our wealth of organic growth projects. Sustainability is the cornerstone of our business, as it has been for the past 20 years. We have adopted a holistic and integrated approach to this critical issue and are not only prioritizing the environment portion of ESG metrics. This is more attuned to the ethical and developmental needs of many of our host countries and is already delivering results.

Key gold projects that will help drive Barrick's future growth include Goldrush underground at Cortez in Nevada and the Pueblo Viejo expansion in the Dominican Republic. Both projects are expected to secure the Tier One status of these assets for decades to come. On the copper side, key growth projects include Reko Diq in Pakistan and the Lumwana superpit in Zambia.

Barrick was the first gold company to clearly articulate a strategy to grow in copper, which we see as a strategic commodity of the future that is critical to decarbonize our world. We see our copper portfolio as a source of differentiation to our gold industry peers, providing shareholders with meaningful exposure to a key commodity of the future. In terms of balance, we do not set specific targets but instead look at all opportunities against our stated investment filters.

Can you outline Barrick's growth strategy in Canada and Ontario specifically? What steps is Barrick taking to explore in the Uchi Belt?
I've said before that Barrick is underinvested in Canada and we mean to correct that. The perception that Canada is a mature gold producer is being challenged by new discoveries of deposits with different model styles hosted in unconventional rocks. We have established a high-powered exploration team, with specializations ranging from geophysics through geochemistry to structural geology, dedicated to discovering new potential Tier One and Tier Two opportunities in prospective Canadian belts and to ensure that each opportunity is viewed holistically. In the short time the team has been in place, we've already consolidated an exploration property portfolio of 124,000 hectares in the underexplored Uchi Belt of northern Ontario and we're now building on that. The Uchi Belt is host to the world-class Red Lake deposit which, in addition to recent new discoveries in unconventional host rocks, has supported our views that this district remains highly prospective.

Does Hemlo still fit into Barrick's future growth strategy?
Operations at Hemlo are being modernized and refocused to secure the gold mine's continued viability. Several programs have been introduced to improve its performance and the mine has moved to an underground contract mining model. The objective is to upgrade Hemlo to a Tier Two asset and extend its Life of Mine well into the future.

Barrick is a Canadian company, and we are building a foundation of greenfield projects driven by an energetic team of local experts and skilled explorers. We have significant deferred tax assets in Canada, making new discoveries and/or assets even more attractive from a free cash flow and net asset value perspective. ■

Our asset base across Ontario and Québec is very robust, so much so that we are now the third largest gold producer in the world, and we are producing in some of the safest jurisdictions.

Andre Leite

Vice President Ontario Operations
AGNICO EAGLE MINES

Can you outline the rationale behind Agnico Eagle's merger with Kirkland Lake Gold?
The combination of Agnico Eagle's assets with those of Kirkland Lake gives Agnico a significant land concession for exploration and production. Our asset base across Ontario and Québec is very robust, so much so, that we are now the third largest gold producer in the world, and we are producing in some of the safest jurisdictions. A second advantage of the merger is that we benefit from the combined technical expertise of the two companies. Macassa and Detour Lake will both be able to leverage the expertise and synergies that come from Agnico's assets in Québec.

Can you provide an overview of progress made at Macassa and Detour Lake since the merger? What synergies does this create along the Abitibi-Kirkland Corridor?
Before the merger, Kirkland Lake was in the process of building a new mine at Macassa. Now, under Agnico Eagle, we are in the final stages of completing our number four shaft, which will unlock a lot of value. We also significantly increased our ventilation infrastructure with two raise bores that were completed this year. We also are working hard to become a more reliable mine. Our maintenance strategy plays a central role in reliability, so we are focused on ensuring that we have an extremely well-functioning fleet. We invested in battery electric gear that continues to allow us to operate in certain regions of the mine that diesel equipment would not be able to operate in given ventilation limitations. Our plan is to explore and better delineate the ore body at our near surface deposit, but the merger also brought in the AK zone, which is an ore body that is very close to our existing infrastructure for the near surface. We are currently in the process of evaluating when that ore body will be coming into production. If the deposit existed solely under Agnico's purview it would probably not be viable, but because of synergies associated with the merger, the deposit can now be part of an effort to bring on additional ounces earlier than expected.

At Detour Lake, 2021 was a record year in production. We produced over 700,000 oz, but in 2022, we are on track to beat that record. The reason for our success can largely be attributed to the fact that we completed several different projects in relation to the plant, which optimized our process. On top of that, we continue to explore at Detour, and in 2022 we released a new mine plan that significantly unlocked value. We increased reserves by approximately 5.6 million oz, which extends mine life an additional 10 years out to 2052. This allows Detour to become a very long-term play, because we will have 30 years of operation that will allow us to explore the potential for the asset. This includes open pit resource, reserves and underground. Much of our focus in 2023 will be towards better understanding the potential for underground at Detour.

How will you go about achieving 30% emissions reductions from Agnico's Ontario-based mines by 2030?
Macassa is a pioneer in battery electric deployment in an operational setting. When Kirkland Lake implemented the technology years ago, we went through the entire process of operating with prototype gear and making that gear operational ready. Consequently, at Macassa, emissions are very low relative to other mines. The biggest emissions reductions therefore will occur at Detour, because we have a large diesel truck fleet. Over the past four years we have been working on a trolley assist project that could potentially reduce emissions up to 27%.

Can you outline Agnico Eagle's strategy to make meaningful investments in junior companies? Are there any areas of interest in Ontario?
Agnico and Kirkland Lake both have a proven track record of looking at the market and identifying opportunities. We have a very strong corporate development team that is always looking in Ontario, and globally for opportunities to add value and collaborate in the junior space when it makes sense. We have largely focused in safe jurisdictions, and I think that is one of the differentiating factors we have as a company in relation to our competitors. Our production is concentrated in the safest jurisdictions. ■

When you think about the technology revolution that has occurred in the last 25 or 30 years, there is a real opportunity to apply that to the mining industry and discovery space in a way that will enable the discovery of the next generation of giant deposits.

Jake Klein,
Executive Chairman,
Evolution Mining

It is a good time to invest in the gold market, because there is a shortage of capital. Our view is that you want to be aggressive when capital is scarce. When you get to a stage in the market where everybody is putting capital in, that is the point where you want to pull back.

Paul Brink,
President and CEO,
Franco-Nevada

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Multi Asset Senior Mid-Tiers

Throughout 2022, Alamos Gold continued to double down on organic growth, completing construction at La Yaqui Grande in Mexico. The asset is made up of high-grade, good leaching ore, which provides Alamos with low-cost production, and helps the broader Mulatos operation. In Ontario, Island Gold and Young-Davidson also contributed strong production numbers and, despite inflationary pressures, production costs still fell within cost guidance for 2022.

Although Alamos has grown via notable acquisitions in the past, today the company is allocating its capital primarily toward its Island Gold asset. A Phase 3+ expansion study was completed in 2022 that revealed expectations to produce 287,000 oz Au on average every year from 2026 onwards at Island Gold, which is 22% higher than the company's previous estimate made in 2020 and more than double its 2021 production. "With all the high-grade gold we found at Island Gold, it made sense to expand the infrastructure of that mine to accommodate higher throughput. Effectively, we are taking Island Gold from producing 1,200 t/d to 2,400 t/d," said John McCluskey, president and CEO of Alamos Gold.

Reserves and resources at Island Gold are now in excess of 5 million oz, and given the stated level of production, the company still has 17 years of production ahead.

Regarding his M&A outlook, McCluskey observed: "It is clear to the market that investments made in our existing projects are highly profitable and lower risk, and shareholders look encouragingly at that. In contrast, stepping out into this market and doing M&A has proved to be very problematic."

One of the notable deals of 2021 was Equinox Gold's acquisition of Premier Gold and its Greenstone project in Ontario. Greenstone is the biggest project Equinox Gold has ever owned, and the deposit has over 5 million oz in reserves for a 14-year mine life in the main open pit. It has a life of mine grade of 1.27 g/t and is going to produce more than 400,000 oz/y Au for the first five years, making it one of the largest, highest-grade open pit mines in Canada. Equinox currently owns 60% of the project, so Greenstone will add close to 250,000 oz/y of low-cost gold production to the company's portfolio. According to Equinox president and CEO Greg Smith: "We are progressing well with construction and the project is on schedule to pour gold in the first half of 2024."

Smith expressed his belief that Greenstone has the potential to be a transformative asset for Equinox, as the project possesses a number of favorable elements beyond prospective geology. "It was an incredibly rare opportunity to buy a permitted project in Canada, of scale, almost construction ready, with a great team, fantastic infrastructure, and with good community relations and government support," Smith reflected. "Currently we are focused on getting Greenstone into production, but our number one M&A target over the next few years would be to consolidate Greenstone. We would love to have 100% ownership of Greenstone in the future."

All three mines are generating good production, and they are doing it within the cost guidance we set for 2022, which very few companies can claim given inflationary pressures that have impacted the industry.

John McCluskey

President and CEO
ALAMOS GOLD

How would you assess the performance of Alamos Gold throughout the course of 2022?

2022 has been strong for Alamos Gold. It was designed to be lighter on the front end and stronger on the back end due to construction at La Yaqui Grande in Mexico. The mine was completed in June, and we saw the first full quarter of production in Q3. The asset is high grade, it is very good leaching ore, and therefore, it has provided us with low cost production, which helps the whole Mulatos operation. We are also getting good production coming out of our Canadian operations at Island Gold and Young-Davidson. Combined, all three mines are generating good production, and they are doing it within the cost guidance we set for 2022, which very few companies can claim given inflationary pressures that have impacted the industry.

What have been the keys to establishing a declining cost profile over time?

The big changeover was La Yaqui Grande coming online, because it brings Alamos back to mining high grade, fresh ore, which leads to lower cost production. We are also benefiting from the relative strength of the US dollar against the Canadian dollar.

Given current market conditions, does Alamos have a preference regarding allocation of capital toward organic growth vs acquiring new assets?

Until now, it has been far better for Alamos to focus on organic growth because our assets are very strong. La Yaqui Grande has a very high internal rate of return. Moreover, with all the high-grade gold we found at Island Gold, it made sense to expand the infrastructure of that mine to accommodate higher throughput. We are taking Island Gold from producing 1,200 t/d to 2,400 t/d. That is going to increase production from current levels of 130,000 oz/y to around 285,000 oz/y. We were able to maintain that level of production for a long time, and we have pushed reserves and resources at Island Gold in excess of 5 million ounces. With that production rate, we still have approximately 17 years of production in front of us.

It is clear to the market that investments made in our existing projects are highly profitable and lower risk, and shareholders look encouragingly at that. In contrast, stepping out into this market and doing M&A has proved to be very problematic. It is hard to make reasonable deals, and even when you do, it is not necessarily well received by the market. Until the market is sending us very strong signals that they are going to encourage M&A and that they are going to welcome good quality deals, we are going to focus on organic growth.

Alamos is dedicating a sizeable allocation of its exploration budget toward Island Gold. Can you speak to the exploration potential of this asset?

The potential was certainly all there back in 2017 when we made the acquisition. We have since mined over 638,000 oz out of Island Gold, and as of our last reserve update it was sitting at roughly 1.3 million ounces of reserves. It had 750,000 ounces of reserves when we acquired it, so net of depletion, reserves have almost doubled, and reserves and resources have gone from 1.8 million oz to roughly 5 million oz.

I am confident that Island Gold will be among the lowest cost producers in the country for a mine of its scale. To be producing close to 300,000 ounces of gold per year, at all in sustaining costs in the neighborhood of US$600 per ounce is extraordinary.

What are the keys to continued value creation over time?

The best defense against market volatility has always been to be in the bottom quartile of costs. I also think that there has been a poor appreciation for the importance of reserves and the ability of a mining company to be able to operate through multiple cycles. Companies are not being paid for establishing long reserves. ■

Gold 8-Year Cycle

Source: Florian Grummers 2022, Midas Touch Consulting

Adequate Size Leads to Outsized Returns

Jake Klein, executive chairman of Evolution Mining, holds the view that the senior mid-tier space (one to two million ounces of production) is the best space to be from a risk-return perspective. At this stage he suggests: "Discovery can make a material difference to your value and you can do M&A or asset deals which are accretive. This is the space in which Evolution operates and we feel it has the potential to provide superior returns to investors over the long term."

One transaction Klein hopes will deliver over the long run is Evolution's cornerstone Red Lake asset acquired in 2020. Currently an operational transformation plan is underway to restore Red Lake to a premier Canadian gold mine. The key to Red Lake's future, according to Klein, lies in establishing a new mine in the Upper Campbell area. "It has a decline access that will give us an alternate, independent, new high-grade area to mine. That is

Gold to S&P 500 Ratio

Source: Bloomberg; Crescat Capital

really important because there are three other mines that are accessed via the two shafts. All of these lower areas are capable of delivering close to a million tonnes of high-grade ore per year."

The high-grade feed coming from Upper Campbell will enable Evolution to establish a baseline of 200,000 oz/y of production, and from there Klein anticipates Red Lake will be a 300,000 to 500,000 oz/y operation.

Poland Meets Sudbury

When Polish multinational KGHM acquired Quadra FNX and its Victoria project located in the Sudbury basin over a decade ago, it was optimistic the transaction would guarantee future profits and open new horizons for company growth. Unfortunately, the project was mothballed shortly thereafter due to slumping mineral prices. Thanks to the renewed enthusiasm for critical mineral projects in safe jurisdictions, KGHM's C$1 billion Victoria mine in Sudbury is now moving ahead. The asset contains a multi-element ore body with high-grade copper, nickel, cobalt, and a host of precious metals.

Steven Dunlop, general manager-Canada for KGHM International outlined that KGHM's vision is to develop a lower energy intensity project through green initiatives such as BEV. He noted: "If Canada is going to succeed in its efforts to decarbonize, copper and nickel will play an important role

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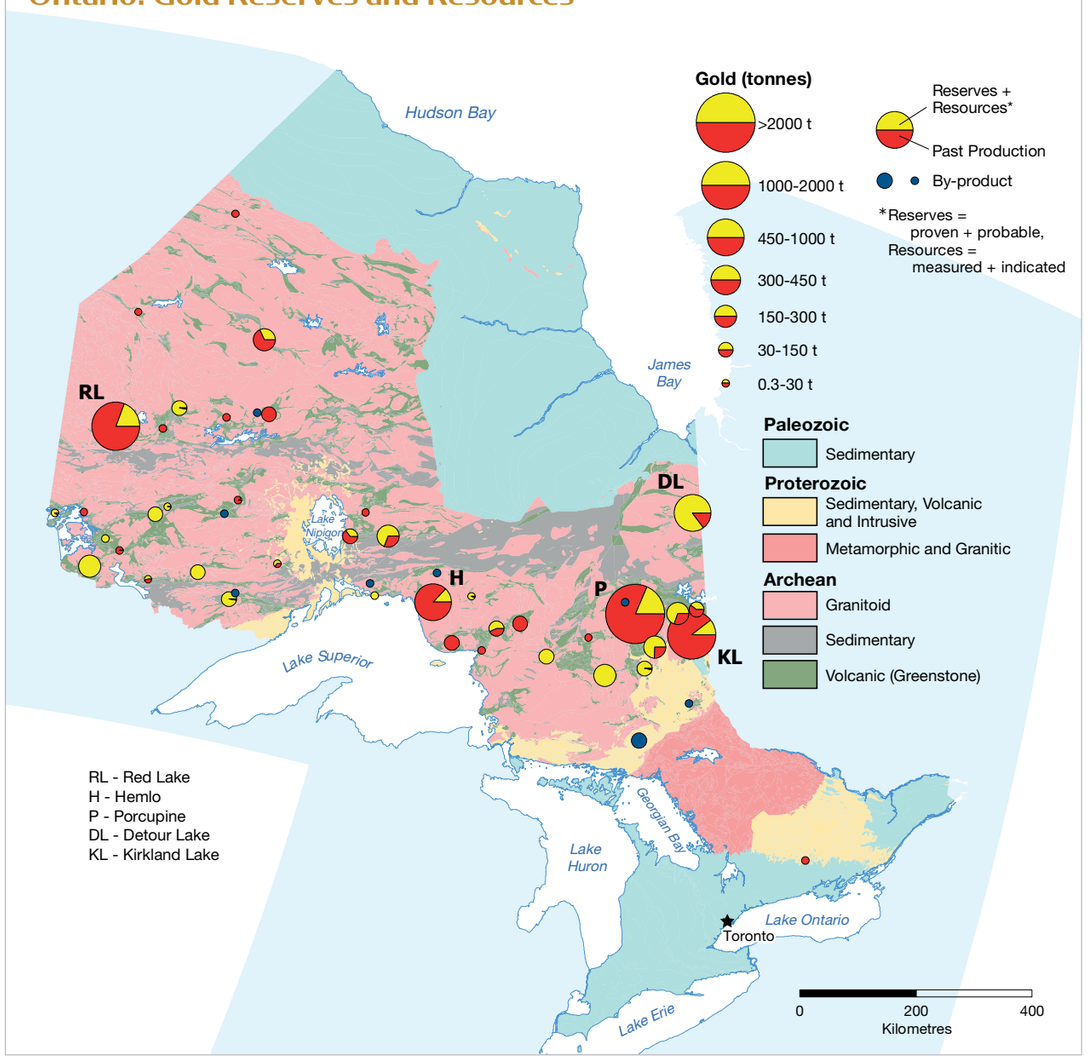
Ontario: Gold Reserves and Resources



Source: ontario.ca

Jake Klein

Executive Chairman
EVOLUTION MINING

Can you outline the long-term vision for Evolution in Red Lake?

We are looking to establish Red Lake as a beachhead for Evolution to grow in Canada. It has a world class 11 million oz resource base and very exciting exploration potential and our current focus is to ensure that we can mine the gold out efficiently, safely and profitably. When we acquired this asset a couple of years ago, we said it was going to be a three to five year turnaround. We are well into that now, and our confidence has only increased that this is going to be restored to a premier Canadian gold mine in the next couple of years.

What aspects of the operation will receive the most focus in 2023?

The key to Red Lake's future is establishing a new mine in the Upper Campbell area. It has a decline access that will give us an alternate, independent, new high-grade area to mine. That is really important because there are three other mines that are accessed via the two shafts. All of these lower areas are capable of delivering close to a million tonnes of high-grade ore per year. The Upper Campbell mine will become an increasingly important source of high-grade feed and we are confident it will allow us to establish a baseline of 200,000 oz/y of production. The second milestone is taking it over 300,000 oz/y.

To what extent is AI a useful tool for the industry today?

Fifty years ago, we were dependent on prospectors taking rock chip samples and figuring out whether there was mineralization. The positive for that period was that some of the great gold deposits of the world had not yet been discovered and it worked pretty well. Today, most of the outcropping deposits have been discovered. Therefore, you need to use technology in a different way to try and identify those areas that may provide you with subsurface or hidden deposits.

When you think about the technology revolution that has occurred in the last 25 or 30 years, there is a real opportunity to apply that to the mining industry and discovery space in a way that will enable the discovery of the next generation of giant deposits. ■

Rob McEwen

Executive Chairman
& Chief Owner
MCEWEN MINING

Where does Los Azules rank in the list of undeveloped copper projects, and how does it compare to other copper projects in San Juan, Argentina?

Los Azules is 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. In contrast to two other projects in the San Juan province, Filo del Sol and Josemaria, we are at a relatively low elevation of 3,100 3,600 m. In addition, our published estimated copper resources and copper grade are 2-3 times higher, and we are in closer distance to infrastructure, power grid and roads. The combination of these factors projects Los Azules in the lowest cost quartile of copper producers.

What prompted the decision to spin out McEwen Copper?

The market has shown a preference for pure plays. Therefore, we made the decision to split out McEwen Copper. For 2023, we will complete an updated PEA in the first quarter, and in the first half, we plan to go public. This will help us establish a market value that we can show on our balance sheet accurately reflecting the quality of our Los Azules asset.

Can you tell us about the recently signed investment from Rio Tinto's Nuton group?

We were looking into how to best process Los Azules' ore while consuming the least amount of water. We started thinking about heap leach rather than having a milling scenario, which is very heavy in water usage. Nuton claims to have a heap leach process that has a faster recovery, at a rate closer to that of a mill. As they were working with us, they took notice of Los Azules and expressed their interest in investing in it. ■

While our roots date back to the 1800s, one of our aims going forward is to diversify through two growth opportunities – namely standing up our announced lithium and fire-retardant businesses.

Kevin Crutchfield

President and CEO
COMPASS MINERALS

Can you provide background of Compass Minerals?
Compass Minerals is a global, essential minerals company comprised of a number of advantaged assets. Today, we are a leading salt producer in North America and the UK, with most of that salt used for de-icing snow and ice conditions. We also market other grades of salt products used for water conditioning and purification, pool salt, food-grade salt, and pharmaceutical-grade salt. We call those latter categories our consumer and industrial business. We also produce sulfate of potash, salt, and magnesium chloride from the Great Salt Lake in Utah. While our roots date back to the 1800s, one of our aims going forward is to diversify through two growth opportunities – namely standing up our announced lithium and fire-retardant businesses.

Compass Minerals has its Goderich salt mine and Goderich salt plant for mechanical evaporation. What is the significance of these assets in the context of your overall business?
Goderich mine is the largest underground salt mine in the world, and it has the capacity to produce up to 8 million t/y. We access the reserve via a vertical shaft, and we are mining about 1,800 feet below the surface under Lake Huron. The salt deposit has enough reserves to sustain production for the next 60 to 80 years, and we employ around 600 people in the Goderich area.

What actions has Compass Minerals taken to boost profitability and margins at Goderich mine?
A few years ago, we transitioned away from the underground drill and blast method into mechanized mining, where we are using very large Komatsu continuous miners. These machines are very advanced and can capture a lot of data in a manner where the machine learns the right way to cut the salt face. I would characterize that technology as one of the big breakthroughs that has occurred at the Goderich mine over the past decade.

The data capture from these sensors also allows us to predict failures, so we can service machinery ahead of time. We are making money when those cutter bits are cutting salt, and whenever they are not, our productivity drops.

What steps is Compass Minerals taking to diversify and develop more reliable revenue sources?
Our financial results are highly correlated to weather, more specifically snow, within our primary served market covering the Great Lakes region in Southern Canada and the Northern US Rust Belt states. If we get big winters, then we will have big years from a financial perspective. It is a good business when the winters are cold and brutal, but in a soft winter, it's helpful if there is an anti-cyclical opportunity to offset that revenue lost. Our Plant Nutrition segment serves that role to some degree, because it is more of a summer business than a winter business. We are also excited about the potential for our emerging lithium and fire-retardant businesses to serve as counter-seasonal businesses to our core Salt segment.

What are the biggest differences between salt mining and processing, and lithium mining and processing?
There are some very distinct similarities and some very distinct differences. When you start with our footprint in Utah, you can think of it effectively as mining the Great Salt Lake. We are taking the brine from the Great Salt Lake and extracting minerals from it. We precipitate sulfate of potash, and we precipitate salt, and magnesium. At Ogden, we are simply plucking one more ion out, which happens to be a lithium ion, and we are making it a different product. Over the years, we've known the ambient concentration of the Great Salt Lake contains lithium, and we trap this brine in our evaporation ponds. With the recent advancement of lithium extraction technologies now available and market demand expected to grow, we decided to capture that lithium ion via a different process and market it as a battery-grade product. But how you turn lithium chloride into lithium carbonate, and then into lithium hydroxide is where we are getting into a new competency. ■

Tim Hill

CEO
IMPALA CANADA

Can you provide an overview of the history of Impala Canada?
The Lac des Iles mine has been operating since 1993. It started as an open pit operation, and then transitioned to an underground mine in the 2000s. We have just under 900 employees plus a few hundred contractors who currently operate an open pit and underground mine, as well as a mill.

There has been a significant level of investment in Lac des Iles and our business over the last five years, which includes the acquisition of the asset in December 2019 by Implats.

Lac des Iles is Implats' first acquisition outside of the African continent. Being part of the Implats Group has enabled us to increase investment in the asset. Impala Canada contributes 20% of the group's palladium and about 8% of all PGEs. We have significantly expanded the underground operation, increasing underground production by approximately 65%.

What efforts is Impala Canada making to further explore the property?
While we have a full exploration portfolio, we are focusing on brownfield exploration at the moment. We are also drilling a deposit we call the Camp Lake block, which is the lower part of the current existing deposit at Lac des Iles.

Do you have a final message for GBR's audience?
As we come to the end of a five-year investment cycle, and we achieve underground production rates of 12,000-plus t/d, we will turn our minds to optimization, sustainability and growing our business. Along with that comes the importance of the right cost structure, which is how we refine and optimize our business. Achieving our desired level of production, then getting to a steady state, positions us well to ensure we have a strong and robust business that can contribute to a better future. ■

Steven Dunlop

General Manager - Canada
KGHM INTERNATIONAL

What is the importance of Ontario and Canada in general to KGHM's overall portfolio?
KGHM is a global mining company headquartered in Poland, and we are among the top copper and silver producers in the world. For KGHM Canada, we see the opportunity to be a key stakeholder in the critical minerals transition. Canada is a key component to KGHM's overall international strategy.

Can you provide a breakdown of progress made on KGHM's Canadian assets in 2022?
We have been able to extend the life of mine of our assets through exploration and innovative programs to reduce costs and expand our mineral resources. We have also strengthened our relationships with adjacent stakeholders, particularly with other larger mining companies in Sudbury. We are now seeing the benefits of win-win opportunities for both parties and we have been able to attract very talented mining professionals and retain the majority of our personnel.

What makes Victoria a compelling asset?
Victoria is a multi-element ore body with high-grade copper, nickel, cobalt and a host of precious metals. Victoria is ideally located with immediate access to services, transportation, personnel, contractors, safety services and in close proximity to Sudbury. KGHM is envisioning a lower energy intensity project through green initiatives such as "BEV" and having the ability to explore some of the newest technologies available on today's market.

What are some important catalysts on the horizon for KGHM?
We want to continue to advance the Victoria project, and we also are looking forward to continued exploration. KGHM has a company-wide ethos which is to "always have copper." It translates into our sustainability model so that by always having copper, we will bring economic drive, stability, and security for our people and the communities we work in. ■

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in getting us there." The company will also leverage access to new technologies they gain exposure to by being in close proximity to the Sudbury technology ecosystem. "Sudbury is now an established global mining hub, and we are fortunate to have these breakthrough technologies available to KGHM within an arm's reach," Dunlop commented.

Perhaps one of the silver linings of Victoria's dormant period was that management was able to better plan out the mine and strengthen partnerships with area First Nations. These are all welcome benefits, because there is a large capital spend on the horizon and every effort to mitigate unexpected costs is beneficial. "KGHM has been able to leverage its international arm to help fund and work towards its vision for sustainable growth. Additionally, KGHM has worked closely with our Indigenous communities, Vale, DMC Mining Services, the City of Sudbury and a host of others to move this project forward," Dunlop said.

» Magino is a low cost, long life gold mine with potential to further expand the +4 million ounces resource base both through open pit and underground exploration. Mill optimization could create a pathway to a top 10 gold producer in Canada.

Richard Young, President & CEO, Argonaut Gold

«

Passing Salt

Further displaying the diversity of minerals being produced in Ontario is Compass Minerals' Goderich Salt mine, which began operating in 1959 after oil exploration efforts inadvertently led to the discovery of a huge salt formation. Today, the Goderich mine is the largest underground salt mine in the world, and it has the capacity to produce up to 8 million t/y, with most of that salt used for de-icing snow and ice conditions.

Remarkably, the salt deposit has enough reserves to sustain production for the next 60 to 80 years, but the company's financial results are highly correlated to snowfall in the Great Lakes region in Southern Canada and the Northern US Rust Belt states. In order to diversify, Compass has an emerging lithium and fire-retardant businesses to serve as counter-seasonal businesses to its core salt segment. The lithium business has garnered particular attention after Koch Minerals & Trading, a subsidiary of Koch Industries, agreed to make a US$252 million investment in Compass Minerals. "Our goal is to build out an overall business that is more steady throughout the year with these counterbalancing, seasonally anticyclical businesses we are moving into," Compass Minerals president and CEO Kevin Crutchfield stated. ■

Development Spotlight

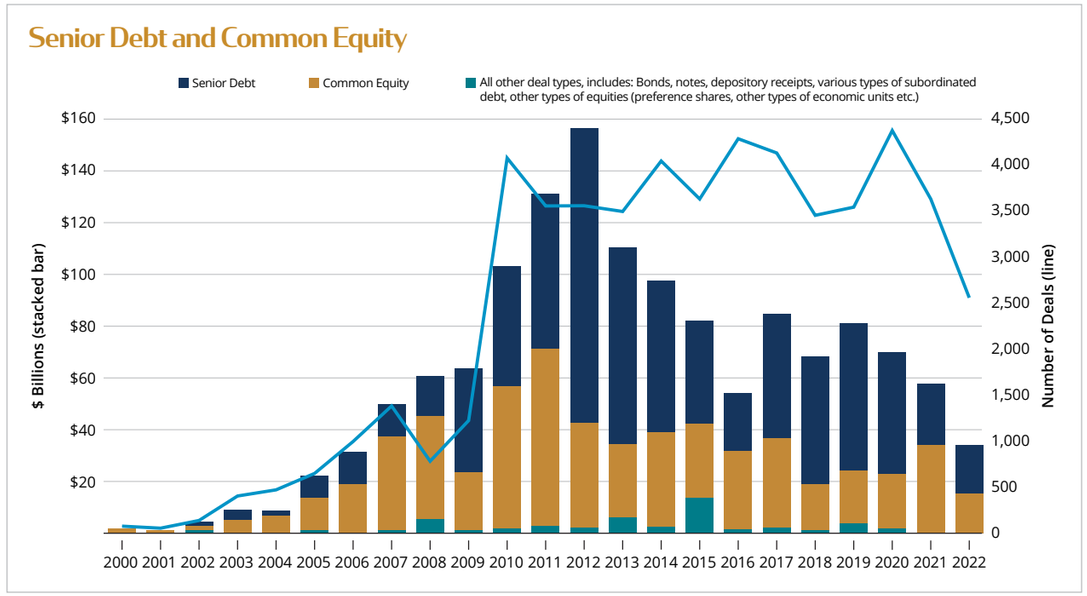
Inflation challenges cost and schedule management

Image courtesy of Marathon Gold

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, but all of this comes after significant dilution to investors. Despite the cost overruns and challenges that needed to be overcome, Argonaut's new management team, led by president and CEO, Richard Young, underscored that the company is still scheduled to produce first gold in Q3 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 the company has four operating mines in Mexico and the US, and produces 200- 230,000 oz/y (2022 guidance). The Magino project will not only bring on Argonaut's fifth operating mine but it will nearly double their overall production. "As Magino is completed the Company is pivoting from an investing phase to a free cash flow generating phase, which means that we should be able to operate and grow the business without further dilution," Young affirmed.

Building in Newfoundland

Another key development in 2022 was Toronto-based Marathon Gold's decision 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 and CEO of Marathon Gold commented.



Source: Bloomberg and company data and Resource Capital Funds Analysis

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 those 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. ■

Marathon has a compelling geological property in that the other gold plays in Newfoundland are structurally hosted, high-grade narrow veins. This is a big bulk tonnage deposit.

Matthew Manson

President and CEO
MARATHON GOLD

What factors encouraged Marathon to greenlight construction of the Valentine gold project?

This decision reflects the progress Marathon has made on its Valentine project, which is a greenfield open pit gold mine that has gone through a full federal and provincial environmental assessment. This is a relatively rare thing, because many larger mines in Canada are brownfield sites on top of historical mining districts.

Following the completion of the environmental assessment 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.

We spent the last couple of years drilling and doing exploration, discovering what is going to be a third pit called Berry, and we are going to be reflecting that in an updated feasibility study.

What is driving inflationary pressure for mining companies today?

The biggest issue is labor. The mining industry went into covid with a chronic labor and skill shortage, and the pandemic compounded the issue. If you are building a new mine, you are inevitably hiring and if you want employees to move you must incentivize them. Salaries are up markedly, and to be competitive in this tight labor market you must offer compelling benefits and rotations, which impacts headcount. Marathon's burden rate on our people is 45%, whereas 10 years ago, it would have been 25%. Moreover, labor is reflected in every cost, every contractor bid you get and logistics cost.

What is the size of the resource at Valentine?

Marathon has a compelling geological property in that the other gold plays in Newfoundland are structurally hosted, high grade narrow veins. This is a big bulk tonnage deposit. It has a different deformational style, different host rock, and it is at a different scale. We are 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 because we see the potential for our deposit style to continue the whole way through the project. We also believe there is an underground future.

What are the most critical factors in achieving successful mine development?

In the process of building a mine, the most important thing is schedule. If you are behind schedule, you will be over budget. And if you want to be on budget, you have got to be on schedule.

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. However, the narrative is always based on company stock price and gold prices. Miners must look beyond that.

What agreements does Marathon have in place to establish license to operate?

There are six communities that we consider to be in our social and economic area of influence. We have cooperation agreements with all six, and they deal principally with employment contracting. We also signed a benefits agreement with the province that commits Marathon to 85% provincial hiring during the build and 90% during operations. We are meeting those targets now. Our relationship with communities is very much based upon the economic potential of the project and long mine life, which will lead to long-term compensation.

What milestones would you like to achieve over the next 12 months?

Marathon is currently in project financing mode. We have a good cash balance, debt arranged, and equipment leasing arranged. This helps de-risk the build. We would like to finish the year fully completed in early works, and fully mobilized at site. There is also significant exploration occurring, so continuing to tell our story about resource growth during the build is a big priority for us. We are going to be replacing ounces, adding new discoveries, telling stories about future pits and future underground mines. Newfoundland is a very richly endowed metallogenic province. While it has been prospected of a lot over the years, it has not been explored in a very systematic way. ■

JL

KK

Jamie Levy & Kerry Knoll

JL: President and CEO
KK: Chairman
GENERATION MINING

Can you provide an overview of Generation Mining's (GENM) efforts to advance its Marathon project in 2022?
KK: Generation Mining had four main initiatives over the past year. First, we have been navigating our environmental assessment process for the past several years, and in 2022 we had our public hearings. We now expect a decision which should enable us to proceed with permitting before the end of 2022. This will give us the federal and provincial approval to proceed with mine construction, subject to individual permits. The second initiative was to secure financing. At the end of 2021 we announced that we had a C$240 million stream with Wheaton Precious Metals to help fund the project, and we followed this up by announcing that we had a consortium of banks looking to fund up to C$500 million. We are now looking at additional financing strategies to bring in the balance required. Once that funding package is secure, we will be in a position to start construction. The third vector of progress is related to our relationships and agreements with surrounding indigenous communities. As a result of progress made, we hope to have a benefit agreement in place with our nearest First Nations group by the end of 2022. The last area to highlight is the build out of our team. We now believe we have the staff and expertise in place to execute through to production. We will hire up to 1,100 workers during Marathon's construction phase.

What efforts is Generation Mining taking to mitigate risks associated with project construction?
JL: Our plan is to get 75% of our detailed engineering complete before we start construction. As a single asset company, we are maniacally focused on our Marathon project, so we will not get distracted. We also feel that the inflationary environment is shifting, and if that is the case, we will benefit substantially.

Can you outline the medium-term supply-demand dynamics you see for palladium and copper?
KK: Marathon's primary commodity is palladium, and it is 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. Although we have been mitigating car exhaust in North America for the past 45 years, some countries have not even started yet. Hybrid cars are also getting more popular, and they need more palladium than a typical vehicle.

The bear case for palladium is one in which electric cars begin to dominate the market. They do not use any palladium. However, they do use a substantial amount of copper. There is an immense amount of copper demand, so fortunately our secondary product is copper. This provides Generation Mining with a built-in hedge.

Can you speak of the carbon footprint associated with the Marathon project? How does this compare to other PGM projects throughout the world?
JL: The two main sources of platinum group metals in the world are Russia and South Africa. Russia's production is powered 55% by carbon intensive fuels. South Africa is over 90% powered by coal. In contrast, our Marathon project is on the Ontario grid making it 96% carbon free. End users like Tesla and GM are now required to go down their entire supply chain to figure out how much carbon was produced in the making of an EV battery. Fortunately, we will be producing some of the cleanest palladium in the world, and, at some point, we believe that is going to command a premium price in the market.

Are there any advantages Generation Mining is able to leverage given it is attempting to take two critical minerals into production?
KK: One example in which being a critical mineral producer has provided an advantage was when the Export Development Corporation of Canada expanded their indicated interest in their share of the debt financing from C$100 million to C$200 million. ■

Richard Young

President and CEO
ARGONAUT GOLD

What motivated you to take on the role of CEO at Argonaut?
Magino was the main attraction. Magino is a low cost, long-life gold mine with potential to further expand the +4 million oz resource base both through open pit and underground exploration. Mill optimization could create a pathway to a top 10 gold producer in Canada.

With my first visit to site in December, what I saw was a team nearing completion of their scope of work outside of the fence, with the focus now turning to Ausenco to complete their work inside the fence, namely the mill. Commissioning is expected to begin in the second quarter followed by commercial production in the third quarter of this year.

What is the status of relations with the Indigenous communities surrounding Magino?
Our relationship with our Indigenous Partners is going along well as we continue to engage and implement our agreements. There are always opportunities to strengthen our relationships in trying to be the best in class within in ESG.

What technologies does Argonaut intend to make use of to maximize efficiency at Magino?
There are two key aspects to the Magino project to maximize production and profitability. The first is strong grade control procedures and the second is optimization of the mill to increase throughput. Strong grade control procedures start with a reliable geologic model followed by solid mine plans, very good grade control procedures, and most importantly, good people who are well trained. On the process front, the objective will be to continue to debottleneck the mill and increase throughput without materially reducing recovery rates.

How should investors think about the potential upside in Argonaut's shares?
As Magino is completed the Company is pivoting from an investing phase to a free cash flow generating phase. ■

Greg Smith

President and CEO
EQUINOX GOLD

How has Equinox Gold evolved over the past few years through mergers and acquisitions?
Since 2017, Equinox Gold has undergone rapid growth through M&A, the development of our assets, and the spin out of our royalty, and copper businesses as well as a Nevada-based gold business. We acquired the Mesquite gold mine in 2018, Leagold Mining in 2020 and Premier Gold in 2021, and production has grown from zero to 540,000 oz/y, with the ability to add another 600,000 oz/y through organic growth. As a company, we remain focused on getting to scale, and we have a good portfolio of long-life, high-quality assets to help us build the foundation for long-term success.

How will Greenstone coming online impact Equinox Gold's production profile?
The deposit has over 5 million oz in reserves for a 14-year mine life in the main open pit. It has a life of mine grade of 1.27 g/t and is going to produce more than 400,000 oz/y for the first five years, making it one of the largest, highest-grade open pit mines in Canada. We currently own 60% of the project, so Greenstone will add close to 250,000 oz/y of low-cost gold production to our portfolio. The mine sits on a Greenstone trend that moves from the mine to the west, and there are a significant number of open pit targets along that trend that could eventually feed into the Greenstone mine. The most interesting upside is another 4.5 plus million oz in all categories of underground potential.

From a corporate perspective, would you like to increase your 60% stake in Greenstone?
We would love to have 100% ownership of Greenstone in the future, and if our JV partner Orion Mine Finance ever wants to sell their interest, we have a right of first refusal. ■

MINING FINANCE AND INVESTMENT

"Close to 50% of companies on the TSX started out on the TSXV, and approximately 20% of those companies that graduated have gone on to be included in the S&P/ TSX Composite Index."

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

GBR SERIES • MINING IN ONTARIO AND TORONTO'S GLOBAL REACH 2023

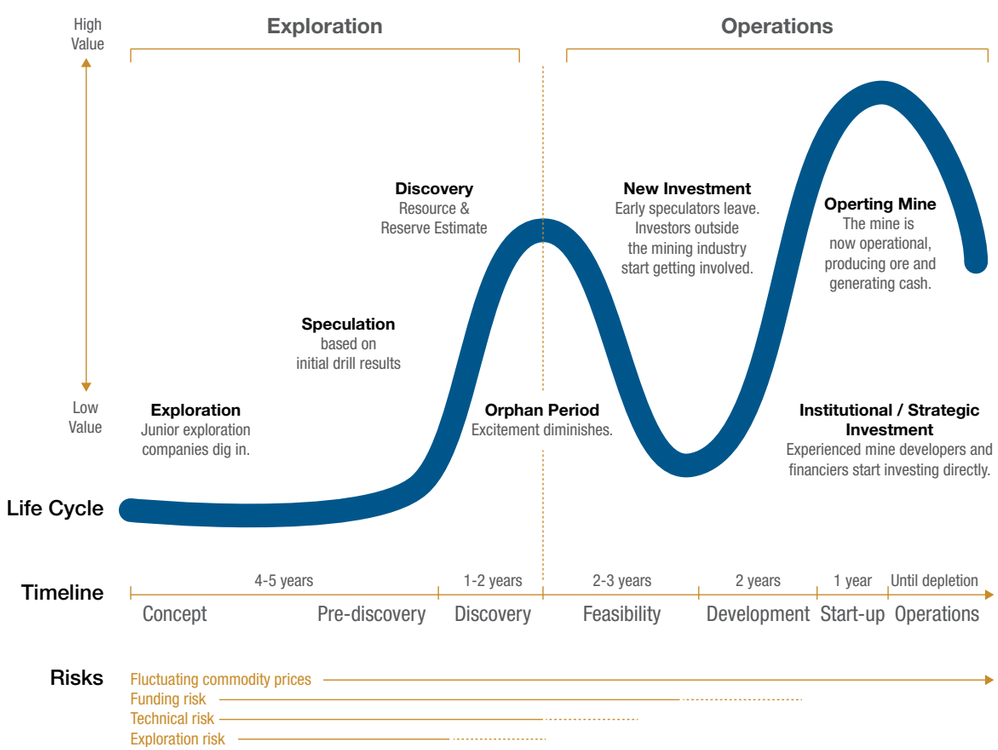
Image courtesy of f11photo through Adobe Stock

Mining Finance and Investment

Toronto remains the epicenter for mining capital

Take a cursory glance at the Lassonde Curve and it is clear that bringing a mine from exploration into production is a remarkably treacherous ride. Although the Lassonde 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 increasingly 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 recently been hindered 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.

Lassonde Curve



> We have a world-class mining ecosystem built on the fact that Canada is a mining country.

Dean McPherson

Head, Business Development - Global Mining
TORONTO STOCK EXCHANGE AND TSX VENTURE EXCHANGE

What makes Toronto Stock Exchange the preferred exchange for junior mining companies?

Over the past five years, 35% of equity financing for mining went through our marketplace, and 42% of equity financing occurred through our markets. The ability to raise capital is of paramount importance to junior mining companies.

The other key consideration is our location. There is an element of stability that Canada provides from a financial, economic and regulatory standpoint when you consider the ability to endure global economic and geopolitical shocks. A final factor is the ecosystem that we have built in Canada over the past 170 years; it is one that is significantly important for mining companies that are trying to get their stories not only seen but also correctly understood. We have over 250 global analysts covering companies that are listed with us, in addition to the many bankers and technical professionals involved in and supporting our sector. We have a world class mining ecosystem built on the fact that Canada is a mining country.

To what extent do TSX and TSXV serve the needs of the full spectrum of mining companies?

Between the TSX and TSX Venture Exchange we have a place for most companies regardless of stage. What is great and different about our two-tier system is as companies grow and gain scale, they may choose to seamlessly move up or graduate to the senior market. 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. Our innovative growth accelerator program helps our prospective and existing companies prepare for the changing demands of global investors and stakeholders, with teaching/coaching modules on ESG reporting; effective investor relations strategies; disclosure requirements; etc. We partner with our clients before they even get listed, preparing them to be a successful public company.

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. If the project is attractive and the management is right, capital will follow. An old perspective but still true today.

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. Mining is ahead of most other sectors in modernizing its interaction with its stakeholders. That interaction has evolved beyond just pacifying stakeholders, while rewarding shareholders. 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. This partnership approach with stakeholders embraces ESG, but extends into a broader responsible approach to mining - realizing generational benefits through skills and wealth creation. It certainly will enable more people to relate to the contribution of mining to society. The world's eye is now so far reaching that this strategy has to be implemented for all groups at all corners of the globe.

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, another notable event was Gold Fields. 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. ■

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 shun the sector. 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 progressing toward production. BMO has helped finance several notable projects in Ontario, including Argonaut Gold's Magino gold project, where it 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 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.

As a company situated in close proximity to a multitude of pivotal deals within the province, BMO's bullish perspective on the industry is a telling sign of its belief in the industry's exceptional potential for superior performance vis-à-vis other sectors. Ilan 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.

> Mining might have traditionally been a focus for speculative risk-taking capital, but it is far more diluted today because of greater choice. Despite this, I think mainstream awareness of the role mining plays in the energy transition will bring a lot more generalist capital back to the industry over the next few years.
>
> **James McClements, Co-Founder and Managing Partner, Resource Capital Funds**

James McClements, co-founder and managing partner of Resource Capital Funds, one of the industry's most prolific private equity investors, echoes Bahar's sentiment that the current setup is advantageous for mining investors. "The thematics around what is driving our industry right now are as strong as I have seen in a long time," McClements said, reflecting that the Chinese economic advancement drove demand during the previous bull cycle. Today, in addition to the burgeoning Chinese middle class acting as a tailwind for demand, there are additional relevant factors driving markets: "There are still billions of people that are on that same journey, lagging China, be it Indonesia, India or Africa. And, clearly global decarbonization will have a large impact on demand for critical metals and minerals needed for electric vehicles, wind, solar," he added.

That said, McClements' view is that there are times when influences beyond the sector itself come to bear. "Rising interest rates and geopolitical concerns have dampened the overall market. In this regard, it is absolutely a good opportunity to invest because valuations are better than they were last year. I do not think this is reflective of what we think the next five to 10 years for the industry will be. I think this is a temporary pullback for our sector," McClements explained.

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

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> We feel more optimistic today about the macro trends for metals and mining than at any time since the 2005 to 2007 period.

Ilan Bahar

Managing Director and Co-Head, Global Metals & Mining
BMO CAPITAL MARKETS

What are some of the key equity financings BMO has led in Ontario's mining sector over the past year?
BMO has helped finance several projects in Ontario, one of which is Argonaut Gold's Magino gold project. We were the sole bookrunner on a C$52 million offering that the company completed in March 2022, and we were the top left bookrunner on a C$195 million offering that closed in July. We also worked with a couple of companies with future facing commodities—Frontier Lithium completed a C$10 million offering in November 2021, where we were joint bookrunner on a financing to support exploration activities on their PAK lithium project in Ontario. For Electra Battery Materials, we acted as sole agent on a C$10 million equity offering the company completed as part of a larger US$45 million financing package for a hydrometallurgical refinery the company is building in Ontario.

What forms of financing are proving most resilient in today's market?
The most resilient form of financing in a relatively more uncertain environment like the one we find ourselves in currently tends to come from commercial banks and private debt providers, including for corporate revolvers. Revolvers in particular are usually intended for large established companies that have a history of cash flow, and the bank market tends to support extensions of established revolvers even in times of uncertainty. Conversely, the least resilient financing markets tend to be the equity market and the high yield debt market. When companies say that it has been difficult to raise capital to build projects in this environment, what they really mean is it has been most challenging to find the equity portion of the funding package. Generally, companies can find project or private debt, even if expensive, and capital from royalty and streaming companies also continues to be readily available for high quality projects.

Does BMO remain bullish on long term supply—demand dynamics for battery metals?
Near term, rising interest rates and concerns about potential recession in many places could create a shaky environment for forecasts. However, in our business 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 electric vehicles, and all on the same timeline, implying that metal demand will be extraordinary. I think we can all agree this creates a supply / demand imbalance and it should drive strong price performance of a number of these commodities.

What are the most pressing concerns for mining companies today, and in Ontario specifically?
The concern for companies and investors is that governments may look to increase taxes or royalties as a means of reducing government debt levels going forward. Permitting timelines, everywhere in the world but also including Canada, remains a focus. The result of rigorous permitting and often appropriate permitting processes can be that desirable returns on equity are more difficult to achieve for investors. In Ontario specifically, the two concerns we hear most from our clients are availability of experienced labour and inflation.

Is there a playbook mining companies should consider following when it comes to efficient capital management in a downturn?
It definitely depends on the type of company. A large senior company with cash flowing assets will be thinking about managing their debt maturities and very carefully considering their dividend policy, thinking about staging projects in their pipeline, and defining a more defensive strategy to apply around capital allocation overall. More aggressive companies will look at a downturn as an opportunity to pursue either organic or inorganic growth.

For companies that do not generate cash flow, they might consider curtailing and / or delaying spending on their exploration / development projects or on G&A, and raising capital in the most non-dilutive way possible to get to the next catalyst, such as the next resource estimate or economic study. ■

> We want to be capable of investing across the mining development lifecycle, from exploration all the way through to operating assets, but also through the capital stack.

James McClements

Co-Founder and Managing Partner
RESOURCE CAPITAL FUNDS

Can you provide an overview of RCF and its different investment strategies?
Currently, we have three live strategies (Private Equity, Opportunities, Jolimont) and a fourth strategy focused on credit and transition metals in development.

Our core business is private equity, so we look for businesses in the prefeasibility stage that we can take an influential or controlling stake in. We are an active investor, so we expect board representation and involvement in technical decisions. We also have ESG standards that we want to see imposed, and a lot of what we do is focused on human resources, where we help our portfolio companies identify the right board and management team. The other aspect about the mandate for private equity is that we pay more attention to timelines to achieve outcomes. We must have a high degree of confidence that the company we are investing in has a pathway to become permitted, construct the mine and ultimately move into production. The essence of private equity is around de-risking an asset from its late-stage study through to a cashflow outcome.

Can you elaborate on RCF's move to diversify into different strategies including Opportunities, Innovation and Credit?
In addition to private equity, we have the RCF Opportunities strategy, which takes more technical risk and more top-down macro calls. It does not focus on influence or control positions, and it is a smaller, more nimble fund, with an average hold period of three years instead of five plus. While it can "go-anywhere" it's focused on juniors and mid-cap mining companies and is built for real-time decision-making to maximize exit realizations and planned for liquidity. The next mandate that is live is RCF Jolimont strategy, which is our mining innovation fund. For Jolimont, we are looking to invest in established businesses in the mining equipment, technology, and services, or METS, space that have a product or service that is already in use in the industry. They are generally privately owned, but do not have the capacity to grow either the capital or the organizational people. We come in and generally seek to scale these businesses and accelerate their growth over a period of time. The final mandate that we are in the process of developing is a credit offering with a large focus on transition metals. From our point of view, we want to be capable of investing across the mining development lifecycle, from exploration all the way through to operating assets, but also through the capital stack. Our goal is to be able to support equity all the way through to senior credit.

Do you believe the passing of the Inflation Reduction Act will materially benefit the exploration and funding environment for US-based critical mineral projects?
Like many, RCF views the passage of the Inflation Reduction Act and associated critical minerals legislation as a net positive for our sector. Specifically, elements of the Inflation Reduction Act will support exploration and funding for mining projects, such as the earth & satellite mapping support that the US Department of Energy (DoE) has backed. However, the larger driver will be development of clean energy value chains and midstream infrastructure that will accelerate the demand for metals & mineral products. Ultimately, the commitment that the US has shown towards funding decarbonization and energy transition projects will influence commodity investment strategy, along with jurisdictional choices that align with the global trends RCF continues to follow closely.

What kinds of projects do you see currently getting funding, and where are the biggest funding gaps?
The US DoE has only deployed less than 1% of the capital that recent legislation has granted to the loans office. Additionally, there is the 5x to 10x multiplier which will come from private capital following those projects chosen by the DoE as worthy of support. So, there is literally trillions coming behind the US$369 billion that the DoE will deploy over the next five years or so. From that perspective, it is far too early to call where the funding gaps may be. From a RCF perspective, what is clear is that China, the EU and now the US are fully committed to transitioning from a fuels-based to minerals-based energy system. Quite simply, the energy transition begins and ends with metals & mining investment.. ■

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advancing assets and providing capital that only gets repaid when the mine does well. Unlike debt, which can be a costly 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. This is because royalty financiers are generally able to sidestep the issue of excessive dilution, as they are insulated from the cost inflation that is commonly encountered by junior mining companies.

Franco-Nevada is a royalty and streaming company that pioneered this model under its founders Pierre Lassonde and Seymour Schulich in the 1980s and 1990s The business was subsequently involved in a three-way merger between Newmont, Normandy, and Franco-Nevada, but since Newmont decided to spin the business out at the end of 2007, Franco-Nevada has traded as its own entity. Franco-Nevada president and CEO Paul Brink explained that what changed in the ensuing period was the concept of streaming. The biggest streaming deals have all been on big copper mines, where there is a precious metal by-product. "The arbitrage in providing that sort of capital is very material and streaming has grown to be a mainstream way of financing any project that has got a precious metal component," Brink said.

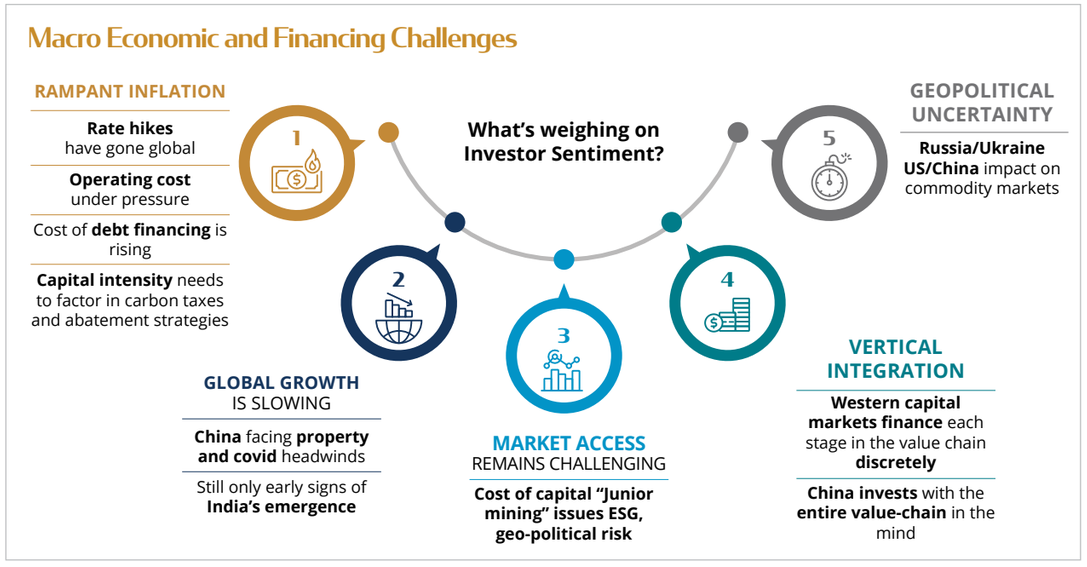
Brink highlighted that the current market is presenting royalty and streaming companies with a plethora of attractive opportunities driven by a high inflationary environment, tight equity markets and dwindling capital available from mining focused institutional investors. "A number of opportunities that we are currently working on are situations where companies have had cost overruns, they need incremental capital, and it is extremely hard to get that in the equity market at this stage. Royalty and streaming companies are well placed to provide that incremental capital," Brink affirmed.

Newcomers Make Their Mark

A more recent entrant into the streaming and royalty business is Triple Flag Precious Metals, which had its IPO on the NYSE in 2022 after listing on the TSX one year prior. The company has achieved a 26% compound annual growth rate in GEOs over the past five years, and today, founder and CEO Shaun Usmar highlights that Triple Flag is seeing its busiest pipeline since inception. The group is also responsible for one of the marquee transactions in 2022 when it agreed to offer US$606 million to acquire emerging gold royalty and streaming peer Maverix Metals. "It is a sensible opportunity to create greater scale, diversification, critical mass, and unlock meaningful annual synergies, resulting in an accretive transaction that continues our growth trend," Usmar commented.

The combined entity will mean Triple Flag now oversees 228 assets in its portfolio, 93% of which being gold and silver focused by value. Of those assets, 29 are producing, and 82% lie in favorable jurisdictions like Canada, Australia, the USA and Latin America.

Despite much hype around energy transition metals, one of the hallmarks of Triple Flag's strategy is its disciplined focus on the precious metals streaming and royalty model and commodity exposure. This is in part because Usmar sees an advantage in avoiding competition over the primary products of the companies Triple Flag finances. Fortunately, a very high proportion of ore bodies are polymetallic, and there often exists a precious metals byproduct, that is



Source: Wood Mackenzie

more valuable to Triple Flag investors than to the miners targeting battery or base metal exposure. "If Triple Flag is not streaming or doing a royalty on the primary product, and instead we are taking a byproduct that the mining company and its shareholders care less about, then we can provide them with a more competitive cost of funding, unlock value not otherwise realized, and help share the risk on new mine developments or acquisitions, for example. That can be highly symbiotic and unlock additional value for all stakeholders," he concluded.

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 typically 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.

> A royalty and streaming company is the ultimate long-term investor. Only by looking at mines as a long-term commitment — and not just as a quarter-to-quarter return — you can make money. Looking back at our investments over the years, we outlived not just the management teams of those projects, but usually also the operating companies of those projects.
>
> **David Awram,**
> **Co-founder,**
> **Sandstorm Gold Royalties**

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

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> We are fortunate in that streams and royalties are top line interests. This means we are not directly impacted by capital cost overruns.

Paul Brink

President and CEO
FRANCO-NEVADA

Can you provide background of Franco-Nevada's business model?
One of the main differences of streaming from royalties is that you are financing an operator putting up a large amount of capital, most often to build new mines. The biggest streaming deals have all been on big copper mines where there is a precious metal by-product. The arbitrage in providing that sort of capital is very material and streaming has grown to be a mainstream way of financing any project that has got a precious metal component. Franco-Nevada's business today is a combination: We have a very deep portfolio of royalties that have been acquired over 35 years, and we are very active in the streaming market. Royalties on gold projects have tremendous optionality. Gold projects typically have a shorter life at the outset, but more of the orebody is revealed over time. Additionally, we benefit from streaming precious metals from long-life copper deposits that have a tendency to be expanded over time.

What criteria does Franco-Nevada consider when making an investment decision?
When investing in resource projects, you never know how things will play out over time. When we make investments, the most fundamental thing is that we want to have certainty that the worst thing that happens is we will get our money back. Operating projects are the lowest risk but don't typically need much capital. The big capital we spend is often on construction projects, when a feasibility is in place and we can get a good grip on the economic parameters.

What are the keys to avoiding inflationary cost overruns in project construction?
We are fortunate in that streams and royalties are top line interests. This means we are not directly impacted by capital cost overruns. In this market, where controlling capital costs is difficult, it is bringing us some opportunities. A number of opportunities that we are currently working on are situations where companies have had cost overruns, they need incremental capital, and it is extremely hard to get that in the equity market at this stage. Royalty and streaming companies are well placed to provide that incremental capital.

You mention having a patient approach to investing in cyclical markets. What is your perspective on where we are in the cycle today?
It is a good time to invest capital in the gold market, because there is a shortage of capital. Our view is that you want to be aggressive when capital is scarce. When you get to a stage in the market where everybody is putting capital in, that is the point where you want to pull back. Franco-Nevada has such a deep portfolio that when there is a lot of capital available, we benefit from organic growth. Companies expand the mines in which we already have interests, move our development properties into operation, and they explore on our exploration properties.

Can you outline the exploration potential in the Ring of Fire?
We already have royalties that cover a lot of the prospective property in the Ring of Fire. It is a region where there was very limited exploration more than a decade ago. They very quickly made some major discoveries, but it was expensive as everything was helicopter supported. For there to be real activity in the region, you need roads to be built. With the Eagle's Nest nickel deposit and the chromite discoveries a road is justified. The Government of Ontario is working with First Nations on permitting. Following that, they will hopefully provide financing to get it built. Once that is done the real exploration will begin. I believe we have only seen the tip of the iceberg in terms of mineralization in the Ring of Fire.

Can investors' desire for dividend payouts hinder much needed investments in growth?
The best time to build a mine is at the bottom of the cycle, when other people do not have capital and when you are not competing for labor and materials. If you have the support of your shareholders to do that, you have the best chance of keeping control on your capital costs, and you have the best chance of bringing your mine into production exactly when prices start to run up. ■

> Conventional financing tends to be inconsistent or unreliable at various points of the cycle, and mines need to be built on their own unique schedules. This requires more patient, long-term knowledgeable capital.

Shaun Usmar

Founder and CEO
TRIPLE FLAG PRECIOUS METALS CORP.

How has Triple Flag navigated 2022, and what is the state of the business today?
A year ago, if we were having this conversation, I do not think any of us could have forecast 2022 to be the year it has been. The evolution of the pandemic, Russia-Ukraine war and China zero-Covid policy have led to geopolitical instability, ongoing supply-chain disruptions and hyperinflation, which have all been compounding factors in a complicated environment. Having said that, I think it has shone a light on the role gold plays as a store of value in uncertain times, the resiliency of our business model and, specifically, Triple Flag's business. We had numerous corporate milestones as a business despite only having listed in Toronto in May of 2021. Amongst those accomplishments were the announcement of our largest transaction in our history, namely the acquisition of Maverix Metals; our sixth consecutive annual sales record; and listing on the NYSE, which was an enjoyable moment to celebrate.

We have also continued to maintain the carbon neutrality of our portfolio and investing activities, including scope 1, 2 and 3 emissions. We were pleased that our efforts were captured in our inaugural Sustainalytics rating, where we came fourth out of the 120 precious metals companies globally in their coverage universe, and in the top 1% of all the companies in any sector around the world.

The acquisition of Maverix Metals takes us to 228 assets in our portfolio, 93% of which will be gold and silver focused by value. We have 29 producing assets, and 82% are located in favourable jurisdictions like Canada, Australia, the USA and Latin America. We also pay the highest dividend yield in the sector.

Do you believe M&A will play a key role in bringing back generalist investors?
The sector needs more consolidation, more relevance and more scale. If you are going to appeal to generalist audiences beyond the index trackers and specialized investors, you need to continue to do the right things with capital allocation and portfolio management. M&A is surely part of that, otherwise the sector risks being simply too niche.

What makes Triple Flag's form of financing suitable given the cyclicality of the mining business?
There is an important role for sophisticated, competitive, customizable, long-term capital to enable the funding needs of the mining sector through the commodity cycle. Conventional financing often tends to be inconsistent or unreliable at various points of the cycle, and mines need to be built on their own unique schedules. This requires longer dated, more patient, long-term knowledgeable capital. We found a consistent opportunity set to deploy despite the cyclicality of the business. Today, large, diversified mining companies have got strong balance sheets, ample liquidity, and have demonstrated greater discipline in allocating capital and the funding of their strategic priorities than some prior cycles. They have the ability for self-help. Single asset businesses, developers, explorers, juniors and intermediates tend to be in far less advantageous positions.

There are also heightened risks present at this time. Several majors have highlighted the challenges of lower volume, supply chain disruptions, higher costs, and materially higher capital outlooks in a way that has weakened sentiment. If you look at intermediates and juniors, with these inflationary forces, higher borrowing costs and less liquidity, they are facing an even more challenging situation. The pressure relief valve for big companies when they get it wrong is their ability to tap into their available liquidity sources and ongoing cash generation. For those less fortunate, smaller companies, whereas beforehand they would go and do an equity raise, that is a lot harder today, and if they can raise equity or debt it is a far more expensive alternative in this market. Triple Flag is seeing a plethora of opportunities from companies who need capital. That includes producers who are engaging with us at a higher rate than we have seen in a couple of years, but the pre-production and development stage is where we tend to consistently see the most opportunities.

At a moment when the sector needs capital and opportunities abound, you want to have capital to deploy. If you can have both cash generation and access to funding, it is foundational to creating value over time. ■

> My advice to any company planning to raise capital is to do it on a basis that minimizes the extent to which the company will then be dependent on ups and downs in the markets.

Denis Frawley

Partner
ORMSTON LIST FRAWLEY LLP

How have macro events impacted the evolution of junior miners operating in Ontario today?
Financings are lower than they were in 2021, but 2021 was unusually strong on a historical basis. The Ukraine war and global inflation has had a strong negative influence on investor sentiment in 2022. However, in Ontario there is still a widespread understanding of the need for critical minerals to support the energy transition. 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.

How does the nature of your work change when there are not as many financings occurring?
There is more strategic positioning going on. For example, clients are looking at how they can use their capital in smart ways, they are considering structures or relationships that can be put in place to make it possible to continue advancing the exploration or development of projects, and they are evaluating their spending priorities. We see our clients working hard to find the right partners to help spread the risk on those projects.

Do you anticipate more M&A opportunities will arise as we progress through this phase of interest rate increases?
The companies that weather this period and continue to have capital are going to have the leverage to acquire projects they want to bolt onto their portfolios. I believe that companies know that if they hold multiple projects that are well aligned with the needs of the energy transition, they will enjoy a huge advantage.

What advice can you offer to juniors looking to IPO or raise capital in this market?
An IPO is not a great idea for a private company. My advice to any company planning to raise capital is to do it on a basis that that minimizes the extent to which the company will then be dependent on ups and downs in the markets. A company can execute on its exploration plan and show great results, but for juniors it's never certain that markets will react when you need or want them to react. As much as possible, a company should take a longer-term view.

Where do you hope to see progress on the policy front with respect to mining?
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. A second policy priority would be for the government to do all it can to facilitate discussions and alignment between the ultimate end-users of the commodities or minerals being targeted in exploration, and the exploration companies conducting that exploration. If there is alignment between OEMs/manufacturers and exploration companies, and if the users make commitments to purchasing production early on or offer funding, it sends a strong signal to investors. It also sends a signal to nearby communities that successful exploration will result in longer-term benefits. If the requisite investments are not made towards building a battery material supply chain in Canada, these commodities will be sourced somewhere else, the manufacturing activity will embed itself in a different market, and once implanted in another country Ontario and Canada will never get those industries back.

What do you see as OLF's value proposition for juniors?
Our value proposition for our existing and future clients is that we are smaller firm that is cost competitive while being able to draw on close to 20 years of experience in the sector. Exploration companies almost always have very lean management teams and, when executing transactions, whether they are financings, strategic arrangements or acquisitions, they need deep support. We have always provided that support to our clients. We do it at a cost where the people from our firm providing that support have, and are drawing upon, years of experience, as compared to our larger competitors where a company is likely to be working with less experienced advisors at a cost that is generally higher than what we charge. ■

Alex Pernin

CEO
STAR ROYALTIES

What have been the most significant developments for Star Royalties over the past year?
We took Star Royalties public in early 2021, originally with a precious metals focus. However, our company evolved as we identified more opportunities in the carbon offset business. Consequently, we founded Green Star Royalties, which was created to capitalize on the numerous opportunities, limited competition, and more attractive returns associated with carbon credit royalties. We were also fortunate to structure Green Star as a joint venture between Star Royalties and Agnico Eagle Mines.

What is the appeal of carbon offsets for a mining company?
We provide capital to premium North American environmental projects so they can begin to generate carbon offsets. This means that without our capital, these projects would not be enabled to realize their carbon revenue potential. We believe that for a forward-thinking company, the aspect of origination is much more attractive because it is the better environmental thing to do. Also, by funding a carbon offsetting opportunity, it allows us to generate a better return with a lower risk profile relative to buying an existing stream of carbon offsets. ■

Spencer Cole

Chief Investment Officer
VOX ROYALTY CORP.

Can you provide an overview of Vox Royalty?
Vox was created as a platform to give generalist investors exposure to the best parts of the commodity industry without the major pitfalls of the junior mining sector. From the beginning, the company's mission was to generate sector-leading returns by investing in quality mining royalties while avoiding the excessive dilution and cost inflation commonly experienced by junior miners. The idea was to focus on overlooked royalty opportunities with exploration upside, production expansion potential, commodity price leverage, and inflation hedge capability. Since 2014, we have deployed C$50 million to create a C$130 million market cap mining royalty company that is dual listed on the NASDAQ and TSX Venture and is paying one of the highest dividend yields in the mining royalty sector.

What is Vox's methodology for acquiring existing mining royalties?
Our methodology focuses on finding and acquiring existing mining royalties that cover high quality mining assets but are below the radar of our competitors. The overlooked royalties that we identify and acquire are often 20 - 40 years old and held by the original exploration prospector, but they are often attached to some of the world's best mining assets. ■

David LeClaire

President & Founder
OBERON CAPITAL

What is Oberon Capital's role in the mining finance segment?
Oberon has been in business for 13 years and has originated about C$1.5 billion in exploration risk capital through 350+ charity flow-through financings with over 250 unique issuers. Oberon has been a big part of developing charity flow-through financing as the most advantageous and effective way for Canadian and offshore companies to raise and deploy exploration risk capital in Canada.

Oberon's Charity Flow-Through Financing model is the linkage between Canadian taxpayers and investors globally. The largest impact has been to expand the available supply of exploration risk capital from a domestic to a global pool.

Will the government's push for critical minerals exploration result in more flow-through financings for juniors?
Government has sent a powerful signal by increasing the federal tax credit from 15% to 30% for critical mineral projects that qualify. We are already seeing companies use the Charity Financing Format to take advantage of the greater value available from the enhanced credit to attract capital, which will be important given the recent loss of appetite from institutional investors globally for junior mineral exploration projects. It is starting bounce back, but many investors are still hesitant to participate in such a volatile market. ■

Lisa Davis

CEO
PEARTREE SECURITIES

Can you give an overview of PearTree Securities?
Since Covid started, PearTree has increased our financing capacity by approximately 75%, and we have grown from C$300 million of flow-through financings annually to about C$500 million plus. Things have slowed down to an extent in recent times, but our results are still very strong. 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. The draft legislation that has been released has already resulted in explorers and producers of critical minerals getting premium pricing for their flow-through share issuances. In the short period of time since the budget announcement, we have already financed over C$50 million of flow-through share offerings for critical minerals. I believe that this is really going to be a big driver of new exploration and discoveries in Canada in the coming years.

To what extent can you measure the benefit that flow-through and charity tax credits provide to society and the mining community?
The mining community needs significant capital, and the benefit of being able to raise capital is the creation of economic opportunity and jobs, particularly in the far north of Canada where the mining industry is the largest employer of members of indigenous communities. 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. By having the government authorities embrace the donation arrangement in particular, it allows us to put together different tax incentives. ■

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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.

Oberon Capital has also played an important role in developing Charity Flow-Through Financing as an advantageous way for Canadian and offshore companies to raise and deploy exploration risk capital in Canada. Oberon's Charity Flow-Through Financing model acts as the nexus between Canadian taxpayers and investors globally, and the largest impact has been to globalize the supply of exploration risk capital. According to David LeClaire, president and founder of Oberon Capital: "Oberon connects its Canadian client's interest in flow-through tax benefits with investors globally whose interest is to own the underlying company. These investors include large producers taking strategic positions to secure future reserves, metals and mining funds deploying capital, and sovereign investors seeking long-term supplies of critical minerals."

In addition to the impact it has on boosting fundraising for Canadian charities, this form of financing also benefits remote communities and is well aligned with the economic objectives related to Northern development. "No one is drilling for gold in downtown Toronto, Montreal or Vancouver," LeClaire proclaimed. "Charity Flow Through Financing brings more money for employment and greater resources for management to accomplish their goals in remote parts of Canada."

ESG

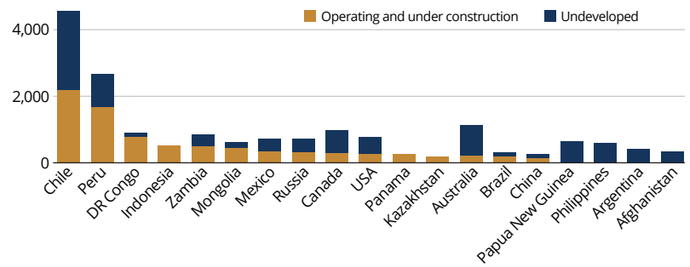
The shift to electric vehicles and renewable power is utterly reliant on metals such as lithium, nickel and cobalt. So as China reopens and Joe Biden's bumper green spending package boosts EV demand in the US, the boom in metal prices should be a win-win for sustainable investors. Nevertheless, mining supply chains are still riddled with environmental, social and governance risks that new disclosure frameworks are seeking to quantify. One of the inescapable realties for mining companies is that ESG performance and compliance are now inextricably linked with access 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.

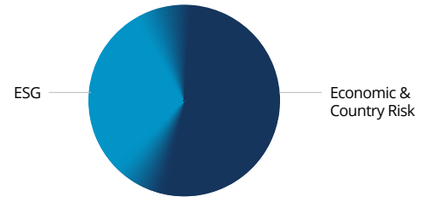
Another component of failure on the ESG front is that in down markets, governance issues can leave companies vulnerable to activist investors who seek to challenge a management teams' strategy and dictate an outcome that might be counter to the company's long-term interests. Kingsdale Advisors is a strategic 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. ■

Current Status of Projects in 2012 Pipeline, '000 t/y



What is the Main Reason Projects did not Materialize?



Source: CRU

EY's top 10 business risks and opportunities for mining firms in 2023

2023 Rank	Risks & Opportunities	Index Score
1	ESG	—
2	Geopolitics	↑ 4
3	Climate change	↓ 2
4	License to operate	↓ 3
5	Costs and productivity	↑ 10
6	Supply chain disruption	★
7	Workforce	↑ 8
8	Capital	↓ 5
9	Digital and innovation	↓ 7
10	New business models	↓ 9

↑ Up from 2022 ↓ Down from 2022 — Same as 2022 ★ New entry

Source: EY

How ESG Technology De-Risks Investment Decisions and Drives Capital Investment

Expert Opinion Article by
Laurie Clark, Founder and CEO, Onyen Corporation

The structural change that is underway in the investment management industry is being led with technological advancements such as machine learning and data science. In fact, it's revolutionized the capital markets industry.

With this increased ability to aggregate and automate data by leveraging artificial intelligence, the investment management industry now relies on computerized systems to interpret trends, assess risks, forecast business strength, apply its investment criteria, and monitor a company's operations. In fact, leading asset management companies are investing in technologies that promise to speed up and expand their data science capabilities.

As this trend becomes widespread and mainstream, it puts more pressure on public companies to disclose more of their performance data with increased frequency, so that capital providers are more capable of defining, analysing, and pricing capital risks.

We've also come to understand that environmental, social and governance (ESG) factors also have material financial implications, and therefore, these disclosures are becoming just as important and frequent as financial statements filings.

Investors continue to look for easily automated formats of key disclosure and audited information from public issuers. Being able to quickly find and analyze performance data, and seamlessly integrate that data into valuation models to make intelligent investment decisions remains a key focus for most money managers.

One such example of a technology initiative driving consistent and transparent information gathering, is the EU's Corporate Sustainability Reporting Directive (CSRD) which now requires that more than 50,000 public issuers disclose their sustainability performance. However, not only are they required to disclose their ESG information, they must also digitally tag the reported information so it is machine readable and can thus be fed into the European single access point envisaged in the capital markets union action plan.

Algorithms have always acted as a wide-angle lens performing predictive modeling of climate related impacts, scrutinizing greenwashing tactics, measuring reports against the ever-growing list of global sustainability standards, and even identifying lesser-known companies worthy of being added to portfolios.

The investment advisor's role continues to expand, not only for portfolio construction, but also in connecting investors with appropriate investment products that fit not only their requirements, but also their values; and are based on data filters and rankings. It is now in the best interest of all publicly listed companies to offer the most accurate and complete public disclosure in order to be part of the assessment process. But not only is being part of the assessment process critical, advanced technology - one can almost call it 'Star-Wars-like' technology - such as satellite imaging systems that can identify what is really occurring in a company's own backyard, along with real-time data streaming, creates the background for finding gaps between the company's corporate statements and the company's reality. The alignment of the company's stakeholder priorities in conjunction with its corporate strategy is only successful if all relevant ESG factors are disclosed and compared.

Along with the ease of data gathering and gap analysis, technology also assists with due diligence assessments. Conclusions, however, are only as accurate as the information disclosed, thus putting pressure on the reliability and accuracy of the data collected at the source. Ensuring internal technology and other "metered" systems are aligned with reporting requirements in an easily readable format not only optimizes the reporting cycle, but ensures key risk factors are proactively monitored so the company can manage the resultant outcomes. Centralising and organising the collected data also allows decision makers to better allocate resources, resulting in better management of capital costs.

In today's digital world, automated solutions such as the Onyen ESG Reporting system bring not only operational efficiencies but also reduced costs. Created specifically for the customers' reporting needs, Oyen centralizes ESG data and automates reporting for junior and mid-tier resource companies. Onyen Corporation recognized the need for an affordable and AI driven ESG reporting solution to overcome the complexities currently being experienced by many companies. The system aggregates disparate data sets; organizes the information and tracks changes; generates ESG scorecards and sustainability reports for multiple stakeholders; offers tools for monitoring performance against targets; and equips Boards and executives with the tools they need to make informed decisions.

Technological advancements such as Onyen's will continue to drive efficiencies throughout the supply chain for many products and services, resulting not only in mitigating business risks, but in driving capital investment. And this technology benefits society at large by facilitating progress towards the ultimate goal: a more sustainable future. ■

Musings on Mining Markets

On Raising Capital:

"When companies say that it has been difficult to raise capital to build projects in this environment, what they really mean is it has been most challenging to find the equity portion of the funding package. Generally, companies can find project or private debt, even if expensive, and capital from royalty and streaming companies also continues to be readily available for high quality projects."

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

On Weathering Volatile Markets:

"In the current environment, you want to look for companies that are cognizant of their cash burn rate. You do not want them to turn things off. However, you want to see the companies give themselves enough runway so that when markets turn up again, they can finance at a less dilutive entry point."

Michael Durose, President and CEO, Lavras Gold Corp.

On Concentration over Diversification:

"The market is not attributing much value to our wide stable of mineral properties, because it is difficult for them to understand a diversified play. It is easy for them to appreciate a one trick pony, where they know the project and the prospects. That is why we are looking for a flagship from within or outside our portfolio."

Rajesh Sharma, President and CEO, Fancamp Exploration

On M&A:

"The sector needs more consolidation, more relevance and more scale. If you are going to appeal to generalist audiences beyond the index trackers and specialized investors, you need to continue to do the right things with capital allocation and portfolio management. M&A is surely part of that, otherwise the sector risks being simply too niche."

Shaun Usmar, Founder and CEO, Triple Flag Precious Metals Corp.

"Stepping out into this market and doing M&A has proved to be very problematic. It is hard to make reasonable deals, and even when you do, it is not necessarily well received by the market. Until the market is sending us very strong signals that they are going to encourage M&A and that they are going to welcome good quality deals, we are going to focus on organic growth."

John McCluskey, President and CEO, Alamos Gold

"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

"I think we are in an environment where you will see transactions. For companies with stronger balance sheets, the downturn creates an awful lot of opportunity where there are cheap stock companies. The question for the bigger mining companies is how much are they prepared to bite off versus focus on exploring the assets they already have."

Paul Wood, CEO, BTU Metals

CANADIAN EXPLORATION

"The perception that Canada is a mature gold producer is being challenged by new discoveries hosted in unconventional rocks. We have established a high-powered exploration team dedicated to discovering new potential Tier One and Tier Two opportunities in prospective Canadian belts."

Mark Bristow,
President and CEO,
Barrick Gold

GBR SERIES • MINING IN ONTARIO AND TORONTO'S GLOBAL REACH 2023

Image courtesy of Auteco Minerals

Canadian Exploration

Juniors eye long-term payoff

Image courtesy of First Class Metals

The prevailing storm in capital markets has been a challenge to navigate over the past year. This is particularly true for junior gold explorers who faced an exceedingly tight funding environment in 2022. Capital markets have been convulsed with uncertainty over the extent of interest rate hikes and a rapidly strengthening dollar, and free cash flow became increasingly in vogue. The subsequent downturn clouded the path for emerging gold juniors who faced depressed valuations. Nevertheless, the gold price managed to end the year north of US$1,800/oz, ensuring profitability for any decent mining operation globally. The World Gold Council reported record-high demand for gold, driven by central bank purchases that underscore gold's enduring appeal as a safe-haven asset during times of geopolitical upheaval. As a result, producers will be empowered to reinvest their profits into exploration and M&A, and with Ontario's longstanding tradition of historic discoveries, the region is well-positioned to remain a hotbed of activity in the gold industry.

Timmins

Timmins has a long history of gold mining, with some of the first gold discoveries made in the early 1900s. The Timmins mining camp has produced over 70 million ounces of gold since its discovery, making it one of the richest gold mining regions in the world. Today, exploration continues with companies like Galleon Gold, which is located next door to Pan American Silver's Timmins West gold complex. Other notable companies, such as Moneta Gold, Mayfair Gold, and McEwen Mining, are also present in the Timmins area.

The area is also well known for its prowess in base metals, and Glencore's Kidd Mine is the world's deepest base-metal mine below sea level, operating at 9,800 feet. Given the infrastructure and know-how that is already present in Timmins, it is no surprise that it is distinctly well positioned for exploration and commissioning of mines that will fuel the energy transition.

Vance White, president and CEO, of Noble Mineral Exploration Inc. has made Timmins a cornerstone of his company's strategy for many years. The company has generated multiple successful projects, which were later sold for a premium. Most recently, the company spun out Canada Nickel to Noble shareholders. Canada Nickel has its flagship Crawford nickel-cobalt mine development in the Timmins mining camp, and has attracted interest from majors, with Anglo American taking a 9.9% minority interest in the company.

North of Canada Nickel's Crawford Project is Noble's Nagagami Project near Hurst, which the Company feels is most de-risked and ripe for acquisition today. "With the additional sampling of the core in Nagagami Project hole NG-22-02 wherein we have identified a 61.0 meter long mineralized zone that has an average grade of 0.554% Total Rare Earth Oxide (TREO) and 0.098% Nd2O3. It is a new discovery and at current market prices for commodities would be the equivalent of 5.2 g/t of gold," White commented.

Red Lake

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. Thereafter, Barrick raised its exposure to the area, which puts BTU in a favorable 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.

East of Red Lake lies the historic Pickle Crow mine, which is now under the ownership of Auteco Minerals. Over the past two years, Auteco has rapidly increased its resource from approximately 800,000 oz to 2.2 million oz at 7.8 g/t Au, and is now in the process of updating its resource. "There are two ways in which we plan to move forward. One revolves around the 2.2-million-oz resource we already have. It is still open, and we are going to continue to grow that, but we are also moving towards working out how to get underground to infill drill that resource. This will be a key focus for us in the next six to 12 months," Auteco Minerals CEO, Darren Cooke said.

The other aspect of Auteco's strategy, as Cooke puts it, is to aggressively explore regional ground to find other deposits in Auteco's landholding. "We believe that we are sitting on a whole mineral district, not just the single Pickle Crow deposit," Cooke added. As for its startup costs, Auteco is poised to benefit from a small mill located on-site, giving the company with a low capex option.

Wawa

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. Manitou Gold's Goudreau project is bookended by the Island Gold and Magino mines on the west, and by Barrick Gold's past producing Renabie mine on the east. With its 366 km2 land package that was consolidated over the course of nine distinct transactions, Manitou is the largest landowner in this greenstone belt, and received investment from Alamos Gold and O3 Mining for its potential to make a significant discovery. "I think Wawa and the Michipicoten Archean Greenstone belt is quickly emerging as one of the most important gold belts in Ontario and Canada," Richard Murphy, President and CEO of Manitou Gold stated.

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 38,000 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 to 6 km in strike length. Management anticipates this will result in a substantial increase in the potential value of assets on the property. 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.

Hemlo

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 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." ■

After the discovery of Hemlo, there was frenetic exploration in the area, but it was quite polarized into small projects with very little district sized systematic focus.

Marc Sale

CEO
FIRST CLASS METALS

What were the key events that lead First Class Metals toward an IPO in 2022?

First Class Metals (FCM) holds 100% ownership of 7 claim blocks in the Hemlo-Schreiber-Harte greenstone terrain. We started as a cottage industry, with a few claims, and ultimately reached a critical mass that needed technical input. Then Power Metals Resources PLC, initiated discussions and we agreed to combine their claims with First Class' in exchange for a 30% stake in the company. Palladium One, our neighbors at North Hemlo, subsequently approached us to do an earn-in joint venture at our West Pickle Lake property. This coincided with our grant of C$200k from the Ontario Junior Explorers Programme (OJEP). That money coupled with Palladium One being prepared to spend C$325K meant we raised over C$500K exploration budget without spending a cent. The listing process was torturous. IPOs were being canceled, suspended, and forgotten about all around us. However, FCM ultimately got across the line and became one of very few new London listings in 2022. Moreover, we submitted our document when the London Stock Exchange changed the listing rules for main listed companies from a market cap of less than £1M to £30M. This means we are now small fish in a big pond.

What did you find compelling about the geology First Class Metals claims possess?

There are several compelling attributes. For example, Palladium One's Tyko Project, which includes the ultra-high grade nickel discovery Smoke Lake near us. Looking at the vectors on the western side of North Hemlo, at Panther Metals' Dotted Lake project, those trends continue onto our property. In addition, there is a distinct lack of (systematic) exploration of our properties. After the discovery of Hemlo, there was a frenetic explosion of exploration in the area. The First-Class claims have not had much drilling done, there has not been cohesive sampling done, nor has there been blanket geophysics. We are now seeing some very encouraging results including the recent assays from the first drill reported from the Pickle Lake project we share with Palladium One. The first hole reported 4.8% Nickel, and 3.7% Copper (6.8% Nickel Equivalent) over 1.8 meters from massive nickel-copper sulfides. These results have carried through to several other high-grade holes, some of which have double-digit nickel equivalent percentages. In total, more than 30 holes have been drilled for over 6,000m, for instance, hole TK22-76 is more than 2km west of WPL. We have recently reported multiple multi-gram including 'double digit' gold values from our Dead Otter trend along a broader 3km structure. The goal of FCM is to develop our claims to a point where in five years' time a mid-tier or major would make an offer to take North Hemlo into production.

How would you characterize your approach to exploration?

Currently, FCM is undertaking a methodical, systematic reconnaissance of the property, because this has not been the focus in the past. There is no point in having an exploration permit to do drilling, trenching, and stripping if we have not vectored in on the highest priority targets. Therefore, in the meantime, we will use classical systematic exploration methods with geologists on the ground walking alongside contemporary state-of-the-art methodology, including airborne geophysics and perhaps using remote sensing. Thus far, we have done a structural interpretation of the Hemlo area covering our claim blocks, and we have completed high-resolution magnetics over North Hemlo.

Why is now a good time for potential investors to acquire shares of First-Class Metals?

We did a lot of work pre-IPO. We hit the ground running with significant de-risking, and we did this by doing the work needed on the properties, by the identification of potential by the OJEP Grant, and by gaining Power Metals Resources and Palladium One's involvement. Since listing, we have had geological teams out in the field and in the air from May 2022 onward, with multiple results coming in. The first of these results have evidenced a new gold occurrence on the Enable Property and more importantly a 3km+ trend of gold and moly on the North Hemlo property which sits on the North Limb of Hemlo syncline just 20km above the iconic Barrick Hemlo gold mine.

The acquisition of the historical high-grade past-producing Sunbeam Gold Mine, along with the recently announced drilling results from West Pickle Lake, put the spotlight on our company. We also have our exploration permits in progress, leading up hopefully to a maiden drill campaign in 2023. Finally, as a postscript, we believe we are close to inking an agreement on a hard rock lithium prospect in NW Ontario. ■

Vance White

President and CEO
NOBLE MINERAL EXPLORATION

Consistent with the company's project generator model, Noble has been specializing in identifying under-explored or unexplored areas, focusing on battery-related critical minerals.

What were the highlights of 2022 for Noble Mineral Exploration?
During 2022, Noble was active in nine projects in areas of Northern Ontario (five properties), as well as more recently acquired sites in Québec (three) and Newfoundland (one), and successfully spun out Canada Nickel to the Noble shareholders.

The most recent projects include the niobium and rare earths Nagagami Carbonatite Complex, our Kidd Creek North VMS project in Kidd and Carnegie Townships, and the copper and PGM Boulder project near Hearst, Ontario. The Nagagami project resulted in a new rare earths discovery. The Kidd Creek North project is a follow up on new theories related to the Kidd Creek mine. The Boulder project is a follow up on the discovery of a boulder that analyzed greater than 70% copper per ton.

In Québec, the company has expanded its reach with the Buckingham graphite project, Cere-Veillebon and Laverlochere nickel projects, and copper and PGM properties.

Where are you finding the biggest opportunities for value creation today, and how has Noble gone about deciding between acquiring more properties versus further developing the ones it currently owns?
Consistent with the company's project generator model, Noble has been specializing in identifying under-explored or unexplored areas, focusing on battery related critical minerals. These minerals are very much in demand especially in areas with reliable supply chains and in politically safe jurisdictions.

Which of Noble's projects do you feel are most de-risked and ripe for acquisition today?
We feel that with the additional sampling of the core in the Nagagami project hole NG-22-02, wherein we have identified a 61.0 m long mineralized zone that has an average grade of 0.554% Total Rare Earth Oxide (TREO) and 0.098% Nd2O3, may be the most de-risked. It is a new discovery and at current market prices for commodities (www.kitco.com) would be the equivalent of 5.2 g/t of gold.

To what extent have policy developments in North America helped encourage investment in critical minerals?
Global, federal and provincial policy developments have made the search for battery and critical minerals larger than we have ever seen. We believe that with global developments related to Russia/Ukraine and China/Taiwan, the West has come to realize that it cannot be dependent on governments hostile to the North American way of life to fill its mineral needs.

What makes Ontario and Timmins in particular an advantageous region to explore and develop a mine?
Ontario, and Timmins in particular, is a mining friendly jurisdiction with road, rail, high-tension power, ample water, a skilled labor force and a depth of technical expertise. The equivalent in the real estate business as location, location, location.

To what extent are new exploration technologies and AI helping to unlock new areas of exploration?
AI and new exploration models are opening up new areas to exploration that have not seen intensive past exploration. Increases in metal prices and supply chain problems have also increased demand for most metals

What are some of the key lessons you have learned over the years in developing Noble's business model? Why is this model well suited for the current market conditions?
If you were to review the spin out from Noble of Canada Nickel to the Noble shareholders, wherein the shareholders will benefit directly as Canada Nickel advances the Crawford Ni/Co/PGM deposit, you would note how the project generator model has worked. The Crawford project is currently in the feasibility phase due out in Q2, 2023.

I feel the generator model works as it takes out the early stage risk through data collection and compilation combined with airborne or ground surveys to identify follow up drill targets that have the potential to bring in partners. ■

Darren Cooke

CEO
AUTECO MINERALS

What are some of the milestones achieved at the Pickle Crow project, and what is Auteco's growth stratrgy moving forward?
Auteco has rapidly increased its resource from approximately 800,000 to 2.2 million oz at 7.8 g/t Au. We have 500 square kilometers of ground, and we are starting to find more gold further away from the main deposit.

The 2.2-million-ounce resource we already have is still open, and we are going to continue to grow that, but we are also working out how to get underground to infill drill that resource. The other side of the strategy is to aggressively explore that regional ground to find any other deposits that are in our landholding.

The Pickle Crow deposit has clean ore as there is low sulphide content in the quartz veins and very high gravity recovery. We are also fortunate to already have a small mill on site.

How would you characterize relations with surrounding First Nations?
We were left with many legacy issues at Pickle Crow, but have done significant work on rehabilitation and monitoring, and we will leave it in a much better condition than what it was when we arrived. Auteco has recently signed an agreement with the Mishkeegogamang Ojibway First Nation, which takes us through both exploration and advanced exploration phases. ■

Quentin Yarie

President and CEO
RED PINE EXPLORATION

What progress has Red Pine made on its Wawa gold project in 2022?
We have been drilling continuously for all of 2022, to complete approximately 38,000 m of exploration drilling on the property. We showed that mineralization now extends over 6 km in strike length. This is a substantial increase in the potential value of our assets on the property. We also pushed down to depth. Our historic resources were limited to depths of 300 m, but we have now intersected significant results at depths of over 600 meters vertical.

How will higher interest rates impact the broader junior mining community?
It is always challenging for juniors to raise money, but with increased interest rates, and lower risk appetites, capital is flowing into safer investments. We anticipate it is going to be difficult to attract people to invest their money in junior miners, because it is an asset class with highly uncertain near-term fundamentals.

Do you feel ESG reporting provides a transparency advantage for Red Pine?
Investors want to ensure that companies are environmentally conscious and have good relationships with their First Nations neighbors. In this way, ESG becomes a de-risking mechanism for shareholders and an opportunity for junior explorers. ■

Terry Harbort

President and CEO
TALISKER RESOURCES

Can you provide an overview of Talisker's flagship Bralorne asset?
Even though the mine has not been in commercial scale production since the early 70s, it still holds a position as Western Canada's largest gold producer. It produced 4.2 million oz. The second factor was the style of mineralization. Bralorne has veins that are continuous along strike for up to 2.5 km, and have been proven down to depth at 2 km and beyond. It was one of the highest-grade deposits in Western Canada, and the historic production average was 17.7 g/t.

We felt that there was strong potential that Bralorne could still be economic, because the asset was only shallowly mined, and there were ownership gaps between the historic mines. We just got the whole belt consolidated recently.

What is your long-term vision for Bralorne, and how will this asset differentiate Talisker?
We want to transition the asset into a production scenario. We have one big advantage in that we are fully permitted, and if we are able to use an offsite processing mechanism, then it is a relatively inexpensive transition into that phase. This allows us to get into cash flow fairly quickly, and I think that is something that is very important in the difficult markets we are in. We have a stockpile at surface that we can quickly process. ■

"When we took our maiden reserve at Media Luna, we were getting checks and boxes on ESG matrices, but the reality of that decision means that Torex will now make generational change in an area of the world that needs economic development the most."

Jody Kuzenko,
President and CEO,
Torex Gold Resources

TORONTO'S GLOBAL REACH

GBR SERIES • MINING IN ONTARIO AND TORONTO'S GLOBAL REACH 2023

Image courtesy of Torex Gold Resources

Toronto's Global Reach

Headquartered in Toronto, mined abroad

Image courtesy of Largo

The mining industry operates on a global scale, but has a limited number of centers where most publicly traded companies are based. Toronto, like Vancouver and Perth, is a major hub for the mining industry, encompassing both large producers and smaller junior companies, as well as engineering firms. It is a key location for conducting deals and orchestrating projects.

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 unparalleled access to capital. This, in addition to the abundance of expertise that resides in Toronto, is why companies with projects in jurisdictions all around the world 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 ensuing 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 vale of US$60 million.

Michael Meding, vice president and 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.

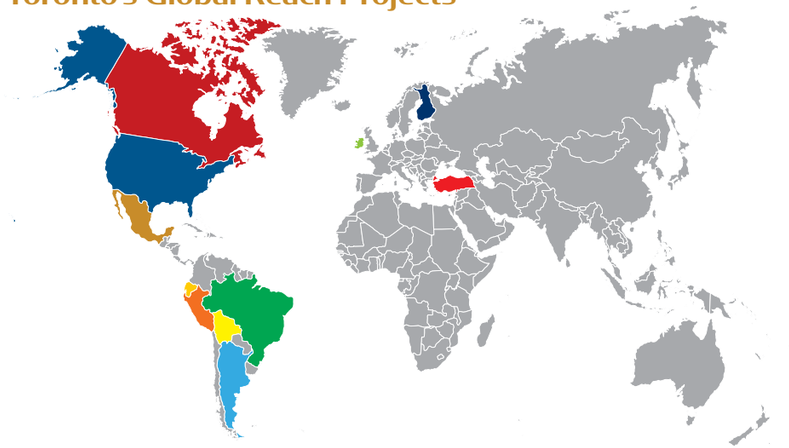
McEwen spoke of the advantages of Los Azules compared to similar projects in the province, including the fact that it sits at a lower altitude that is closer to infrastructure. He also noted that the published estimated copper resources and grade are 2-3 times higher than two other copper projects, Filo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

In Brazil's Bahia State, Largo has its Maracás Menchen mine, which is the world's largest primary producer of vanadium. It is also one of the highest-grade vanadium assets, and its cost of production is comparatively low. The company is now developing a titanium business, which is an optimization of its Maracás Menchen asset. Largo ex-

Toronto's Global Reach Projects



* This infograph represents projects of the companies featured in the Global Reach section, some of which with operations in and outside of Ontario.

» 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 Copper, McEwen Mining

«

pects to produce titanium from the same ore the vanadium is produced from to provide a new revenue stream and so that operational costs will be optimized. Expectations are that the mine will produce about two thirds of Brazilian demand for titanium pigment once the project reaches full capacity. "According to our latest filed NI 43-101 technical report, we have outlined a plan to expand our titanium pigment plant capacity to produce 60,000 t/y, with a subsequent expansion plan to 120,000 t/y TiO2," Daniel Tellechea, Interim CEO of Largo said.

The other pillar Largo's business centers around is the emerging vanadium battery business, based in Massachusetts. While Largo is well positioned as the preferred vanadium supplier for the aerospace market, there is potentially a much larger market stemming from the application of vanadium for batteries related to the energy transition. Tellechea highlighted market forecasts that vanadium battery demand should result in consumption of 4,000 t/y V2O5 in 2022, 10,000 t/y in 2023, and 20,000 t/y in 2024. Given the rapid growth in demand, Tellechea is determined to ensure Largo is able to capitalize on the growing market, and consequently acquired a vanadium redox flow battery technology. Tellechea described his reasoning: "We wanted to create more value for our high-grade vanadium, and our theory was that it is perfect to be deployed into batteries for energy storage. We identified VionX as having the best VRFB technology, because the energy density is about five times greater than any of the VRFB alternatives. By having more energy, the number of components per kilowatt hour is lower, and that effectively means one can lower costs with fewer components needed."

Mined in USA

Mining is embedded into the history of Idaho, and 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 Revival 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 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 7.7 g/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 pretermitting, resulting in a slowdown in the processing of

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» **Our primary goal is to keep our eye on the ball in terms of delivering Media Luna on time, on schedule and on budget. However, we also want to diversify away from single asset risk.** «

Jody Kuzenko

President and CEO
TOREX GOLD RESOURCES

Can you provide an update on Torex Gold's most significant achievements over the past year?

We are about to close off another record year on production, delivering on the high end of our guidance range. With prudent cost management also in place despite inflationary challenges, we are poised to achieve our fourth consecutive year delivering on operational guidance.

Beyond our success on the operating front, we continue to deliver on our strategy, which was articulated in 2021 under six key pillars, which are: (1) Optimize and Extend ELG: This is comprised of our El Limón Guajes producing assets, which include open pit and underground mine deposits on the north side of the Balsas River. (2) De-risk and Advance Media Luna: an underground mining project that represents our future in Guerrero. (3) Grow Reserves and Resources: Our property is 29,000 hectares, 75% of which remains unexplored. (4) Prudent Capital Allocation: As of the end of Q3 2022, Torex is sitting on C$340 million in cash, no debt, operating cash flow from ELG, and a credit facility pinned for C$250 million.

The two other areas of strategic focus for us are continued excellence on ESG, and lastly, we continue to embrace innovation.

What is the significance of Media Luna to Torex's future growth plans?

Every company is founded on a flagship asset, and the combination of ELG and Media Luna on our Morelos Property represents the future from which we will grow. When we released our feasibility study, we took our maiden reserve on Media Luna and it revealed 3.3 million oz au eq at about 4.5 g/t. The interesting thing about Media Luna is that 30% of the value of that ore body sits in copper. As a result, Torex will be transitioning from being a gold producer with some copper byproduct to being a true gold-copper producer. Media Luna is going to be a big underground mine, producing 7,500 t/d at peak capacity. It will be one of the largest gold underground operating mines in Mexico, and a generator of value for us.

Media Luna extends our mine life out to 2033; and with the magnetic anomaly that hosts the Media Luna deposit only about a third drilled off, we believe we will be mining in Guerrero for decades to come.

Do you see opportunities for accretive M&A deals in the current environment?

Our primary goal is to keep our eye on the ball in terms of delivering Media Luna on time, on schedule and on budget. However, we also want to diversify away from single asset risk. When valuations are depressed, it is an opportune time to look at other companies that have quality assets, and whose share prices are in similar situations to ours. In these instances, it could be appropriate to do some kind of merger of equals to get to scale and diversify away from single asset risk. Given the strength of our balance sheet, we can be patient, prudent, and opportunistic when it comes to M&A and make the right deal at the right time that will accrue value to our shareholders. That is our strategy, and it is playing out positively for us.

Does the market use ESG as an effective mechanism to weigh investment risks and opportunities?

The problems with ESG come when the market reduces it to a carbon conversation. It needs to be a holistic conversation that is bred into the DNA of a company. The other area the market gets wrong is that for the most part only the quantitative components of ESG are considered. The important parts of ESG are much more qualitative. For example, when we took our maiden reserve at Media Luna, we were getting checks and boxes on ESG matrices, but the reality of that decision means that Torex will now make generational change in an area of the world that needs economic development the most. Parents who envision their children with options for education, well-paying jobs, or the permanent establishment of a wage economy in support of eradication of poverty are positive community impacts that should be recognized in an ESG framework. ■

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.

Minera Alamos recently announced a PEA on its second mine, Cerro de Oro, that it plans to build in Zacatecas, Mexico, and 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 also continues to deliver positive news coming out of Mexico. It topped guidance with record production in 2022, and continues to report positive operational results at its 100% owned Morelos property. In 2023 it will 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. “Every company is founded on a flagship asset, and the combination of ELG and Media Luna on our Morelos property represents the future from which we will grow,” Torex Gold president and CEO Jody Kuzenko said.

Kuzenko is also open to M&A discussions given a strong balance sheet with C$340 million in cash and a desire to diversify away from single asset risk. She shared: “When valuations are depressed, it is an opportune time to look at other companies that have quality assets, and whose share prices are in similar situations to ours. In these instances, it could be appropriate to do some kind of merger of equals to get to scale and diversify away from single asset risk. This will improve the valuation of our company and deliver value to shareholders.”

Ecuador

Nestled between the rugged peaks of the Peruvian Andes and the lush valleys of Colombia, Ecuador is a land of untapped mining potential. While its neighbors boast well-established mining industries, Ecuador's mining sector is just starting to take shape after years of opposition from indigenous communities and adverse court rulings. With rich mineral deposits waiting to be uncovered and a government accepting of foreign investment, the country is poised to become a more relevant player in the mining world. Ecuador’s mines and energy ministry expects to generate over US$4 billion in annual mining exports by 2025. According to the latest Fraser Institute survey, Ecuador was the only Latin American country that improved its score on the Policy Perception Index.

Adventus Mining is a Toronto-based company that took a chance on Ecuador's young-mining industry. After raising US$263 million in January 2022, and signing the investment protection agreement with the government of Ecuador, Adventus hopes that its El Domo copper asset is next in line for approval. "This is only the third time ever that a mining company has signed such an agreement with the government of Ecuador. The other two times were with Lundin Gold's Fruta Del Norte, and EcuaCorriente’s Mirador mine, which were each in the order of a billion dollars in foreign direct capital investment," explained Christian Kargl-Simard CEO of Adventus Mining.

The agreement not only grants Adventus tax breaks, but it also protects investments made in the country under strict terms. Kargl-Simard pointed out that they expect to produce 25,000 t/y of copper equivalent. “El Domo is a rare breed, because there are a lack of copper VMS deposits in development, and the ones that are being developed have grades that are half to a third of what Adventus has,” he added.

> We produce approximately 7% of the global vanadium supply, and on the titanium side, we are expected to produce about two thirds of the Brazilian demand for titanium pigment once the project reaches full capacity.

Daniel Tellechea

Interim CEO
LARGO INC.

Can provide an introduction to Largo Inc.?
Largo has a two-pillar business strategy that includes being a tier one vanadium supplier with an emerging vanadium battery business. We are the world's largest and one of the highest-grade primary producers of vanadium, with one of the lowest costs of production from our Maracás Menchen mine in Brazil. At the same time, we are developing a titanium business, which is an optimization of our mining asset in Brazil. We expect to produce the titanium from the same ore that we produce our vanadium from.

We produce approximately 7% of the global vanadium supply, and on the titanium side, we are expected to produce about two thirds of the Brazilian demand for titanium pigment once the project reaches full capacity. We are not only going to sell the ilmenite titanium mineral, but we will also produce white pigment, which is the next step in the titanium production chain. In trying to add more value to our vanadium, and meet the needs of the energy transition, we developed our business based on the vanadium redox flow battery (VRFB). After acquiring certain VRFB technology patents in December 2020, we established Largo Clean Energy, and are in the process of developing the best solution for long duration energy storage.

Can you elaborate on Largo's future titanium production plans at Maracás Menchen?
Our Ilmenite plant is already in progress, and it will start producing in Q2 2023. We expect a six-month ramp up before reaching production levels of 145,000 t/y of ilmenite. We are also in the process of implementing the first phase of our titanium pigment plant with a capacity of 30,000 t/y of TiO2. According to our latest filed NI 43-101 technical report, we have outlined a plan to expand our titanium pigment plant capacity to produce 60,000 t/y, with a subsequent expansion plan to 120,000 t/y of TiO2.

What applications will drive the future growth in demand for vanadium?
As it stands today, vanadium is an important strategic metal for the steel industry, because steel is strengthened with very small amounts of vanadium. This represents about 90% of the demand for vanadium. Another 4% goes to aerospace, 4% to chemicals, and about 1% goes to the VRFB.

The application of vanadium for batteries related to the energy transition should result in consumption of 4,000 t of V2O5 in 2022, 10,000 t in 2023, and 20,000 t in 2024. It is expected that in about 10 years, the energy transition will demand the entire amount of vanadium that is being produced today.

What was the rationale behind Largo's strategic pivot from primary vanadium miner to a fully integrated vanadium redox flow battery technology company?
We wanted to create more value for our high-grade vanadium. We identified VionX as having the best VRFB technology, because the energy density is about five times greater than any of the VRFB alternatives. We bought the technology in 2020, with the goal being to develop the best product for long duration energy storage. It is our belief that VRFB technology is more competitive than lithium-ion because it is safe, and it has the power unit separated from the energy unit. With a VRFB, you do not need to increase the power unit for long duration applications (8 to 10 hours for example), you just need to increase the volume of the vanadium electrolyte. We use a vanadium electrolyte on both the anode and cathode side, which means there is no cross contamination, and the vanadium electrolyte does not degrade.

Our battery life is expected to be about 25 years due to the unique characteristics of vanadium. Vanadium is inherently unique when used as electrolyte because it never degrades. That is very sustainable, and it will allow us to establish a very important business strategy for the electrolyte. Vanadium represents about 40% of the cost of a battery. This compelled Largo to launch Largo Physical Vanadium (VAND:TSX.V), which is a company that purchases and owns a portfolio of vanadium products to give investors exposure to vanadium price. ■

Bolivia
Along with Ecuador, Bolivia has a checkered history when it comes to mining. Nevertheless, President Luis Arce, the former finance minister for the Morales' government, has made it clear that he wants to attract foreign investment. At the same time, he expects full involvement with Bolivians. Eloro Resources has been operating in-country since acquiring its Iska Iska project in 2020, and the management team senses enormous latent potential in country. Eloro EVP of exploration Bill Pearson's observed: "If you look at a map of Peru, you see a plethora of mines, but then you come down to Bolivia, and suddenly the number of mines drops off considerably. That certainly has nothing to do with the geology."

Thus far, Eloro's experience in country has gone smoothly, instilling even stronger conviction in the jurisdiction from Pearson: "You cannot judge the politics in Latin America based off what happened 10 or 15 years ago," he said.

Eloro began drilling in September of 2020, and had a big breakthrough when it drilled to the southwest and hit 180 m of mineralized breccia. One of the big achievements of 2022 was the recognition that Iska Iska's major mineralized zone spans the entire Caldera. After a little over two years, the company has completed 85,000 m and 122 holes. "We have not missed in one hole, and furthermore, we have not defined the limits of the mineralized zone yet," said Pearson.

The company's next big benchmark will be its inaugural mineral resource estimate on Santa Barbara, but as the company explained, it is more of a progress report. "We are finding magnificent core, which is remarkably consistent, continuous, and high grade at 90 g/t silver equivalent. Santa Barbara is essentially the cherry on top of what we feel is a giant likely tin porphyry." Pearson added.

Eloro continues to add to its land package with the acquisition of Mina Casiterita, which is important, because it ties onto the southwest side to Iska Iska. The impetus of the acquisition: "In Casiterita we are down in the valley off the mountain, so we think this is very likely a tin porphyry. All of a sudden, instead of having to drill 1,500 m holes under Iska Iska to see if it is there, we can actually explore this near surface'

Finland
Rupert Resources' Rupert Lapland project and its Ikkari discovery are located in a part of Finland that had seen limited commercial exploration, despite hosting Agnico Eagle's Kittila gold mine, which is one of Europe's largest mines. The first drill hole went into Ikkari in March 2020, and months after Agnico Eagle made a strategic investment into Rupert. This catalyzed investor enthusiasm, bolstering Rupert's balance sheet. "This discovery stands out as being unique in terms of gold discoveries today, and the market caught onto it quickly. They realized that when you have huge intercepts with 137 m of continuous mineralization, at 1.8 g/t, there was little doubt in people's minds that this was going to grow into a significant deposit," noted James Withall, CEO of Rupert Resources.

The success continued as more exploration was conducted, and at the end of November 2022, the company published its PEA. Since then, Rupert has graduated to the TSX mainboard from the TSXV.

Perhaps the most appealing attribute of the Ikkari is the high margins it is expected to generate. The main driver of the low cost base at Ikkari is the morphology of the deposit. As an analogy: Imagine you are looking at a city block. "A lot of gold deposits occur as a narrow line down the middle of the road - the vein or structure where the gold occurs. Ikkari is like mining the whole city block, because the intercepts are up to 150 m wide. You are not just taking the street, you are taking the buildings on either side, and it is all mineralized," Withall proclaimed.

This ultimately enables the net present value of every ounce mined at Ikkari to be almost twice the average seen in other projects. Withall added: "Ikkari will produce 200,000-220,000 oz/y, but it produces far more annualized cash flow than many much larger producers." ■

> We are working with the authorities so they can make a very informed, defensible decision about permitting the Ikkari project. From that perspective, Finland is a very good place to work. We are looking at a two to three year permitting process.

James Withall

CEO
RUPERT RESOURCES

What is attracting investors to Rupert Resources' story?
We set out back in 2018 to be an exploration company focused in a part of Finland that had seen limited commercial exploration but was host to Europe's largest gold mines; Agnico Eagle's Kittila gold mine. We acquired a large land package with the Pahtavaara acquisition and took a very systematic approach to exploring it. We made a number of discoveries in the first couple of years doing regional exploration, but the discovery that has driven all the value has been our Ikkari discovery. This discovery stands out as being unique in terms of gold discoveries today, and the market caught onto it quickly.

A year later, we announced the first resource of just under 4 million oz at 2.5 g/t. To be able to move at that pace all comes down to the geology, and the style of this deposit. That drove people's expectations, and allowed us to access the capital markets again in the summer of 2021. This set the company up well to do our PEA, and first engineering study, and we announced that at the end of November 2022. Since then, we have graduated to the TSX mainboard from the TSXV.

What are the reasons you expect such high margins at Ikkari?
The main driver of the low cost base at Ikkari is the morphology of the deposit. As an analogy: Imagine you are looking at a city block. A lot of gold deposits occur as a narrow line down the middle of the road. Ikkari is like mining the whole city block, because the intercepts are up to 150 m wide. That means the amount of waste you have to move is a lot lower, plus it also occurs very near to the surface. Most importantly, the waste products it generates are not complicated, so waste management costs and long-term environmental impacts look to be low. It is one of these unique deposits whereby everything lines up. Overall, being simple drives the cost base to be lower.

What makes Finland an advantageous jurisdiction to explore and develop a mine?
Finland has a very established predetermined process of going about getting your permits, and Rupert Resources is taking a proactive approach in terms of working with the authorities. The challenge for the industry is that the broader public perception of permitting mining deposits is typically negative. Companies can do a much better job in terms of understanding the environmental impacts of their projects. We are very fortunate to be located in an area with potentially low power costs, and zero emission power. We are working with the authorities to make sure they have the information they need to make a very informed, defensible decision about permitting the project. From that perspective, Finland is a very good place to work. Rupert Resources is looking at a two to three year permitting process. If someone wants to make an appeal against a license granted, there is a well-regulated path to move through in the courts. In Finland ultimately the gold in the ground belongs to the state, so it must be developed in a manner that generates a net benefit to the country. Deposits like Ikkari, which have high margins, can be a significant contributor to the country.

Will Rupert Resources' graduation to the TSX help in accessing new institutional capital?
If the opportunity is compelling enough, investment institutions will find you if their fund policies allow. That said, over the last 15 or 20 years, the fund management industry has become a lot more highly regulated, so a lot of funds are restricted on where they can allocate capital. For us, graduating to the TSX will open up doors to other funds that were not able to hold TSXV shares. And also, by completing the PEA, funds that cannot invest in exploration companies can now consider Rupert as the potential economics have been outlined Moving to the TSX removes yet another hurdle for potential investors. ■


TL


BP

Tom Larsen & Bill Pearson

TL: CEO
BP: Executive Vice President of Exploration
ELORO RESOURCES

What initially captivated you about Eloro's land package in Bolivia?
BP: The whole thing starts off with Dr. Osvaldo Arce who was fascinated with the geological potential of Bolivia. If you look at a map of Peru, you see a plethora of mines, but then you come down to Bolivia, and suddenly the number of mines drops off considerably. That certainly has nothing to do with the geology. Osvaldo came up with Iska Iska in 2019, and we put in some money to do due diligence work there. He then went in and did a channel sampling program, and we realized very quickly that there was a very large alteration zone. We negotiated a deal and announced the acquisition in January of 2020, but due to Covid we did not start drilling until September. We were able to drill from underground at Huayra Kasa, and on holes three and four, we hit a breccia pipe. This was a revelation, and geologically it was significant, because breccia pipes rarely occur in isolation. Our big breakthrough occurred when we drilled to the southwest and hit 180 m of mineralized breccia. In January of 2021, we announced the discovery hole DHK-15, and we have not looked back since.

What progress has Eloro made since its initial Iska Iska discovery?
BP: One of the big achievements of 2022 was the recognition that our major mineralized zone spans the entire Caldera. In the last half of 2022, we stepped out our drilling to the southeast, and we continually got excellent intersections. The breccia pipes were our big focus initially, but as we move across the valley is there is a huge dacitic porphyry sitting in the middle of the caldera. This is what is likely driving the massive porphyry-epithermal mineralized system and which appears to have overprinted a deeper and earlier tin porphyry system.

After a little over two years of drilling, we have done 85,000 m and 122 holes. We have not missed in one hole, and furthermore, we have not defined the limits of the mineralized zone yet. Our next big benchmark will be our inaugural mineral resource estimate. But it is more like a progress report. We are finding magnificent core, which is remarkably consistent, continuous, and high grade at 90 g/t silver equivalent and greater. Santa Barbara is essentially the cherry on top of what we feel is a giant likely tin porphyry.

What are some of the key catalysts for 2023?
BP: First is the mineral resource estimate, which we are focused on getting done by the end of Q1. That will be on Santa Barbara. The number two trigger will be to go after targets at Mina Casiterita with the hope of defining the tin porphyry aspect. We have a remarkable opportunity at Iska Iska to outline two world-class deposits.

How do you view Bolivia as a jurisdiction?
BP: President Luis Arce was the finance minister during the Morales' government, and he has made it very clear that he wants to attract foreign investment. At the same time, they want full involvement with Bolivians. If you go to our site, you will see our managers are Bolivian, we have a group of about 28 geologists, all of whom are our Bolivian, our drill contractor is Bolivian. That is the kind of investment Bolivia is looking for, and our experience in Bolivia has been nothing but positive. Bolivia, to me is a jewel in South America. The potential is tremendous, and we have had nothing but great cooperation from the communities.

What could lead to a rerating in the value of Eloro's stock in 2023?
TL: Given how quickly things are evolving, we have been very careful on the share capitalization structure of Eloro to capture the value added from what is taking place on site. We are trying to contain the share cap fully diluted to 100 million shares outstanding, so once you see the quantitative parameters of what will take place in the MRE, we will capture the value per tonne of rock in relation to the amount of shares outstanding. I believe this will contribute to a dramatic rerating of the company. ■

CRITICAL MINERALS

"80% of refining today is occurring within China [...] With the adoption of the IRA, there is now a huge imperative for battery makers and their OEM clients to stop buying out of China. This will require an increasing content of North American or free trade country percentage of production within a vehicle."

Trent Mell,
CEO,
Electra Battery Materials

GBR SERIES • MINING IN ONTARIO AND TORONTO'S GLOBAL REACH 2023

Image courtesy of Avalon Advanced Materials

Critical Minerals

North America moves toward a more secure supply chain

Image courtesy of Green Technology Metals

When BHP and Andrew Forrest's Wyloo Metals engaged in a bidding war to acquire Noront Recources' 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 Ontario's position as a geopolitically stable jurisdiction with a relatively low-carbon electrical grid, which makes it a place that can be relied upon to produce, and 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 to see precipitous increases in demand as electrification becomes more widespread and supply chains more local. In spite of coming up short on its acquisition of Noront, BHP's dedication to identifying promising copper and nickel exploration prospects in Ontario is evident through its establishment of a presence in the region. The relocation of the company's metals exploration team to its Toronto office in 2021 further underscores this commitment towards identifying long-term opportunities related to copper and nickel. "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.

Looking to capitalize on favorable market conditions for nickel, 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 t, 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 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."

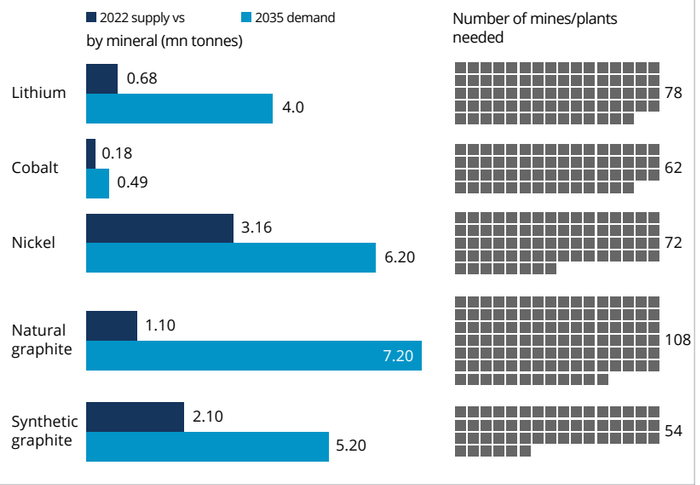
A final factor that can differentiate a company working with an OEM concerned with carbon footprint is having a low-carbon cost associated with the mining operation. Although most markets are not yet bifurcated based off of carbon metrics, Samson anticipates the market will shift toward greater differentiation 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.

Sudbury-based Magna Mining is adding to the momentum around nickel with its completion of a feasibility study on its Shakespeare project, and its acquisition of Lonmin Canada, whose Crean Hill project is a nickel mine in the same jurisdiction as Shakespeare. In explaining his strategy behind the deal, Jason Jessup, CEO of Magna Mining said: "We think that we have positioned ourselves uniquely in the nickel space given our presence in a tier one jurisdiction, with two advanced nickel assets, and permits to build our own mill. Our vision is to become a hub and spoke producer over the next few years."

Hedging Commodity Risk

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

The Critical Minerals Needed to Meet Global Battery Demand by 2025



Source: Benchmark Mineral Intelligence

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.

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 lb Cu, a typical electric car uses 180 lb Cu, and every EV charging station requires an additional 40-50 lb Cu. "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/lb," Generation Mining executive chairman Kerry Knoll proclaimed.

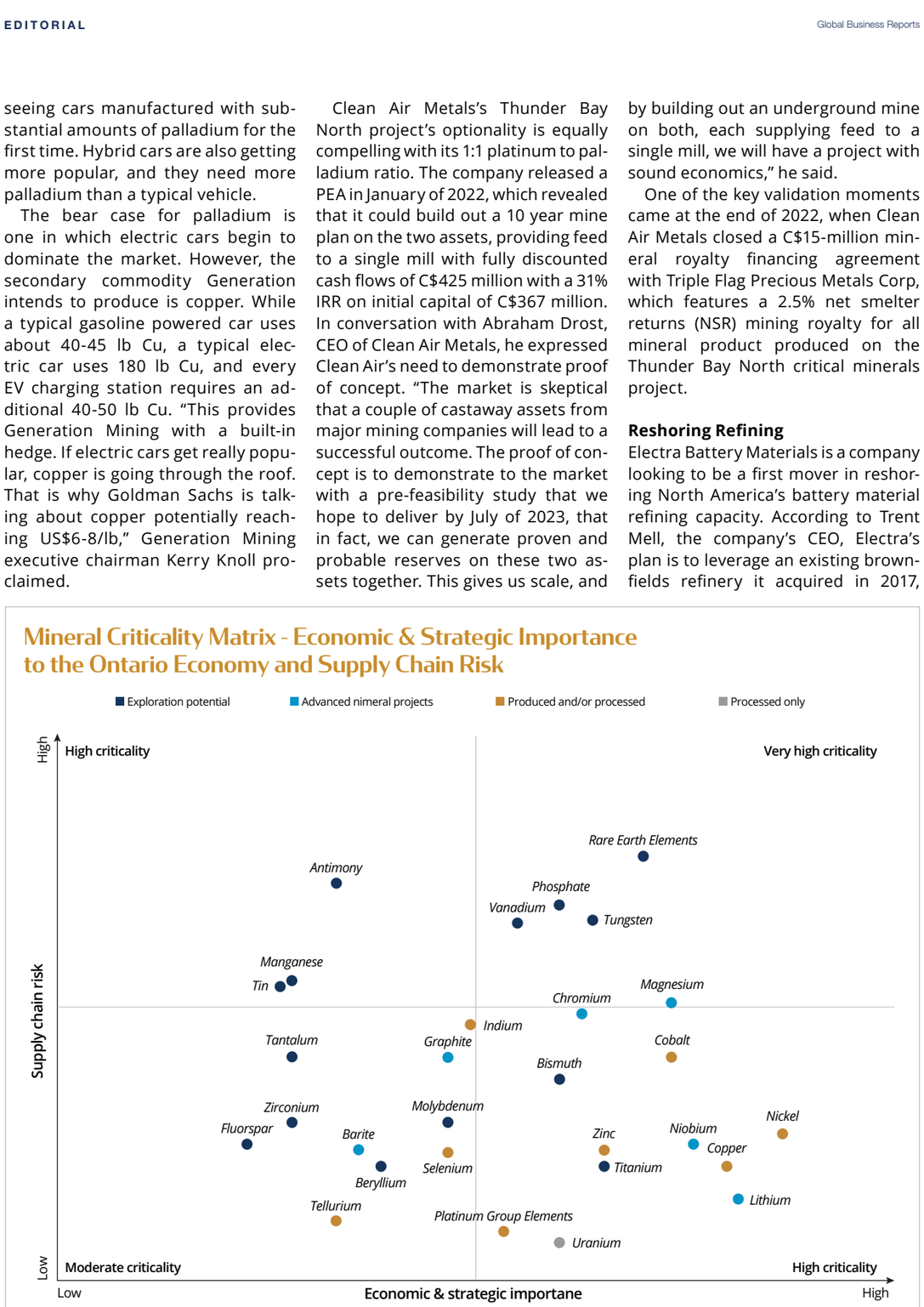
Clean Air Metals's Thunder Bay North project's optionality is equally compelling with its 1:1 platinum to palladium ratio. The company released a PEA in January of 2022, which revealed that it could build out a 10 year mine plan on the two assets, providing feed to a single mill with fully discounted cash flows of C$425 million with a 31% IRR on initial capital of C$367 million. In conversation with Abraham Drost, CEO of Clean Air Metals, he expressed Clean Air's need to demonstrate proof of concept. "The market is skeptical that a couple of castaway assets from major mining companies will lead to a successful outcome. The proof of concept is to demonstrate to the market with a pre-feasibility study that we hope to deliver by July of 2023, that in fact, we can generate proven and probable reserves on these two assets together. This gives us scale, and by building out an underground mine on both, each supplying feed to a single mill, we will have a project with sound economics," he said.

One of the key validation moments came at the end of 2022, when Clean Air Metals closed a C$15-million mineral royalty financing agreement with Triple Flag Precious Metals Corp, which features a 2.5% net smelter returns (NSR) mining royalty for all mineral product produced on the Thunder Bay North critical minerals project.

Reshoring Refining

Electra Battery Materials is a company looking to be a first mover in reshoring North America's battery material refining capacity. According to Trent Mell, the company's CEO, Electra's plan is to leverage an existing brownfields refinery it acquired in 2017,

Mineral Criticality Matrix - Economic & Strategic Importance to the Ontario Economy and Supply Chain Risk



Source: Analysis based on Natural Resources Canada, Statistics Canada, USGS and EU data. Note: Due to data limitation, celsium is not included.

which has permits in place, to commence its journey with cobalt refining. Electra's cobalt-sulfate refinery is scheduled to be commissioned in mid 2023, and thereafter, the company will take a multipronged approach. This includes processing black mass, and then after that looking at introducing both nickel refining and ultimately manganese refining. All of that will support precursor manufacturing, which is the next step of battery manufacturing in North America.

A significant accelerant encouraging Electra's development was the adoption of the Inflation Reduction Act (IRA), which Mell calls "transformational" for the company and for Ontario's critical material supply chain. "We were already on a path where, by 2025, we would see a notable uptick in domestic manufacturing of batteries and EV plants, so we were gearing up early for that transition. However, with the adoption of the IRA, there is now a huge imperative for battery makers and their OEM clients to stop buying out of China," said Mell.

The reasoning for the urgency is twofold: First, more raw materials in EV's will be required to come from North American or free trade countries. Second, if an OEM buys any critical minerals from a country of concern, for example Russia or China, the US$7,500 vehicle credit drops to zero. In response, LG Energy Solution signed a strategic relationship with Electra. "This put us on the radar with anybody looking to onshore in North America, because there is a dearth of opportunities to onshore the refining part of the supply chain," Mell added.

Lithium

Due to its lightweight properties, lithium plays a crucial role in electric vehicle batteries. As the adoption of electric vehicles continues to gain momentum in the next decade, demand for lithium is expected to significantly escalate. In order to satisfy the decarbonization and electric vehicle goals of national governments, an additional 60 lithium mines will be required by 2030, according to IEA figures. Nevertheless, financing a lithium mine can be considered a heavy lift. There are currently zero producing lithium mines in Ontario, and many investors bear scars from the bankruptcy of Nemaska Lithium in Québec in late 2019, which came after spending C$411.4 million on the C$1.27 billion Whabouchi lithium project. Subsequently, there has been a marked appreciation in lithium prices, with a roughly 1,000% increase observed. Simultaneously, the federal and provincial governments have expressed a heightened willingness to invest in remote infrastructure and promote the establishment of mid-stream processing in Ontario.

As Frontier Lithium president and CEO Trevor Walker puts it: "The urgency of climate change, transition to low GHG sources of energy production and storage, advancement of technology to allow for electrification of transportation, and geo-political conflict highlighting East Asian dominance in supply chains are all accelerating changes here at home."

Consequently, the province has recognized Frontier Lithium as a leader in this space due to the significance of its PAK lithium project, which an updated resource estimate revealed to have about 42 million t measured, indicated, and inferred with a grade of just over 1.5% lithium oxide. That represents the highest-grade resource for lithium in North America. "When fully in production the lithium chemicals supplied by Frontier Lithium for EV battery use will help displace approximately 500,000 internal combustion vehicles," Walker affirmed.

Partnerships Pave the Way

Another lithium explorer gaining momentum in Ontario is Green Technology Metals (GT1). The company made its IPO on the ASX in 2021, and is now moving to build a vertically integrated lithium business in Ontario with the help of Lithium Americas Corp who came on as a strategic investor in 2022, in an effort to add portfolio exposure to hard rock spodumene in Canada. "They chose to partner with us because we have a very strong board of directors and strong backing from companies like Primero, one of the most advanced businesses in the world spearheading innovation technology and building lithium processing plants, and AMCI, a strategic partner to assist with financial backing to make sure we get into production," said GT1 CEO Luke Cox.

Cox elaborated that the ultimate vision is a costly but worthy one, the plan being to create a concentrate around

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Luca Giacovazzi

CEO
WYLOO METALS

What was the evolution of Wyloo's pursuit of Nickel assets, and ultimately, the impetus for its acquisition of Ring of Fire Metals (formerly Noront Resources) this past April?
We started with the premise that nickel is going to be important, but not all nickel is equal. The product you make from a laterite differs greatly from that of a sulfide. We ultimately decided to focus on sulfides, because we think sulfides will have substantial cost advantages relative to laterites.

We screened opportunities in nickel sulfide, looking at grade and size, Eagle's Nest came at the top of our list every time. We then asked why is it not being developed? That is what prompted us to look at Noront. What attracted us the most was that we liked what the team was doing from a First Nations perspective.

What is the current status of road development?
This process is still going on, and it is 100% funded by the province of Ontario with a multi-million dollar commitment. That means that the roads will get built, with the communities taking the lead. Wyloo's role is to support them in the execution of that. Eagle's Nest is groundbreaking, because it is one of the largest undeveloped, high-grade nickel-copper-platinum-palladium deposits in the world.

What is Wyloo's vision for the Ring of Fire and its presence in Ontario and Canada moving forward?
We are motivated to see progress on three fronts: Eagle's Nest's infrastructure development, the battery metals processing plant in Ontario, and in our exploration in Canada. ■

Jason Jessup

CEO
MAGNA MINING

Can you provide an overview of the past year for Magna Mining?
In 2022, we completed a feasibility study on our Shakespeare project, and we acquired Lonmin Canada, which was a transformational acquisition for us. Their Crean Hill project is a nickel mine in the same jurisdiction as Shakespeare, so we are confident this deal will help us leverage the many synergies between the two projects. We announced a significant resource at Crean Hill, and we think that we have positioned ourselves uniquely in the nickel space given our presence in a tier one jurisdiction, with two advanced nickel assets, and permits to build our own mill. Our vision is to become a hub and spoke producer over the next few years.

Over 20 million t of ore have been mined out of Crean Hill, and we just announced an indicated resource of 31 million t. We believe that there is still significant exploration upside for new footwall deposits and extensions to the contact nickel-copper deposits.

What is Magna's strategy to progress its portfolio of assets?
In January of 2022, we announced an MOU with Mitsui, which outlined Mitsui acquiring a 10% to 12.5% interest at the asset level for Shakespeare, with a goal of them acquiring up to 25% interest to become a minority JV partner. That is one option, and it could help us build the mill. For Crean Hill, our first step is to complete a PEA based off the resource that we just announced, and we intend to use that to demonstrate the potential economics of the project, as well as to demonstrate the synergies with our Shakespeare project. Based off that, we will most likely do some bulk sample mining to better firm up our understanding of some of the areas of the deposit. ■

> The proof of concept is to demonstrate to the market with a pre-feasibility study, that we hope to deliver by July of 2023, that we can generate proven and probable reserves on these two assets together.

Abraham Drost

President and CEO
CLEAN AIR METALS

What have been some of the key milestones in 2022 for Clean Air Metals?
Our number one milestone was the publication of the PEA in January of 2022, and it confirmed that we could build out a 10 year mine plan on the two assets, providing feed to a single mill with fully discounted cash flows of C$425 million with a 31% IRR on initial capital of C$367 million. On a full after tax basis, we are running about C$300 million NAV with a 25% IRR, which is still robust, so we are confident we have a project here. The next milestones ahead are to do pre-feasibility level engineering, and raise non-equity based strategic investment.

What is your strategy to raise the capital Clean Air Metals requires while minimizing dilution?
The market is waiting for Clean Air Metals to demonstrate proof of concept. The proof of concept is to demonstrate to the market with a pre-feasibility study, that we hope to deliver by July of 2023, that we can generate proven and probable reserves on these two assets together. This gives us scale, and by building out an underground mine on both, each supplying feed to a single mill, we will have a project with sound economics. There are various ways to provide validation moments and that includes strategic investment by a third party. The markets are in such a tough state right now driven by macroeconomic trends, that it is not the time for us to be raising equity financing because it would do irreparable harm to our balance sheet. If we can leverage the asset now for a strategic financing, that is step number one. Step number two is to have a great asset with a team that can build it. The third aspect to this would be showing visibility on production financing, because as a C$25 million dollar junior, with a C$350 million project that it owns 100% of, we need to establish partnerships. A joint venture with a strategic investor that can provide visibility to the market on project financing will ultimately enable us to reach production without potentially having to issue another share.

Can you speak to the basket of minerals you are mining at Thunder Bay North?
Platinum, palladium and copper together generate just over 90% of our revenues, with nickel contributing the remainder. Palladium is used in 85% of internal combustion engines for pollution control. Platinum has multiple industrial uses, and it has also been used as a catalytic conversion metal in industrial and internal combustion engines, particularly in diesel. It had a significant price downdraft post the Volkswagen scandal, but the interesting thing is that as we move into the clean energy transition, battery electric vehicles will be brought to bear to accomplish the carbon free transition. The other technology is hydrogen hybrid vehicles powered by hydrogen fuel cells. BMW now highlights that they have a hydrogen fuel cell about the size of a diesel engine that produces 600 horsepower. They are incredibly excited about that, because the benefit of producing electricity onboard in a hydrogen fuel cell to charge a much smaller battery and electric motors on the wheels is that you have a much lower vehicle weight. You do not need a large battery to run around town or across country. You also reduce your range anxiety because you can fill a tank with hydrogen. That is exciting because for us because there is a direct linkage both in the production of green hydrogen and the use of hydrogen fuel cells with platinum. Platinum, ruthenium and osmium, three of the six platinum group metals, are the only metals that can be used efficiently to produce green hydrogen, or in turn, convert hydrogen and oxygen to water plus an electron to a battery in a fuel cell. As hydrogen fuel cells start to scale, it is expected to create a supply-demand imbalance. This is why some analysts forecast the price of platinum could go from the present price level of US$1,000/oz to well over US$2,000/oz by 2030 driven by the green hydrogen transition. ■

Trent Mell

CEO
ELECTRA BATTERY MATERIALS

Can you provide an overview of Electra Battery Materials' multi-prong strategy?
Our vision is to be a leading refiner of battery grade materials in North America. The way we plan to execute on that is to leverage an existing brownfield refinery that we acquired in 2017, which has permits in place, and to commence our journey with cobalt sulfate refining. To that end, the cobalt-sulfate refinery is scheduled to be commissioned in spring 2023. Thereafter, our multipronged approach would include processing black mass, and then after that looking at introducing both the nickel sulfate refining and ultimately manganese sulfate refining. All of that will support precursor manufacturing, which is the next step of battery manufacturing in North America.

Electra, views itself as being a bridge between mining in North America and the battery manufacturing process. With the expertise that we have already developed pre-commissioning, we were invited to look at building a second cobalt sulfate refinery, in Bécancour, Québec, which is quickly emerging as a second vital battery materials park in North American. 2023 is going to be momentous for us, because this is the year that we will achieve first cashflow.

Why is Electra's refinery a fist of its kind in North America?
With the adoption of the IRA, there is now a huge imperative for battery makers and their OEM clients to stop buying out of China. This will require an increasing content of North American or free trade country percentage of production within a vehicle. The other less discussed factor is the reality that if you use any critical minerals from a country of concern, for example Russia or China, the US$7,500 vehicle credit drops to zero. That is huge, because 80% of refining today is occurring within China. ■

Dirk Harbecke

CEO
ROCK TECH LITHIUM

What are the trends driving Rock Tech Lithium's business?
Rock Tech Lithium has been developing a lithium mining project, over the past five years, and at the end of 2018, we made the decision to not only work on the upstream but to also go downstream. This means we take material out of the ground, and concentrate it into a 6% lithium concentrate. We plan to do this in Canada, at our mining site near Thunder Bay, and then we will produce in Europe with our first lithium hydroxide converter. This is the first of its kind on the European continent that will produce a lithium hydroxide product out of spodumene concentrate. When the North American market is ready, we will build a second conversion plant in Canada next to our mining site.

What is Rock Tech's path forward, and what are the capex requirements associated with your mining assets in Canada and converter in Germany?
We are aiming to produce our downstream final product lithium hydroxide in late 2025. In November 2022, we published a bankable feasibility study on our converter in Germany, while at the same time doing a pre-feasibility study on our mining asset in Georgia Lake. The capex for development of the mining asset is approximately C$240 million, and the expected capex requirement to develop the German converter projects is approximately 700 million euros. Financing for these projects is expected to come from a combination of bank debt, including support from European development banks such as the European Investment Bank and the German Development Bank KfW. Furthermore, we expect financing to come from German government subsidies, own equity and potentially also from strategic partnerships. In Europe and in North America, we see a significant willingness of large firms to support Rock Tech. ■

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2025. GT1 will look to take the concentrate offsite and convert it into lithium hydroxide. “To create lithium hydroxide would complete the lithium supply chain from mine to electric vehicle and it will all be made in Ontario,” he added.

Even more than financing a mine, the construction of a lithium hydroxide facility is a costly endeavor, with estimates ranging from half a billion to three-quarters of a billion US dollars. Such a significant financial undertaking presents a formidable challenge for both junior and major mining companies, rendering it imperative that they form strategic partnerships in order to bring projects to fruition. For this reason, Avalon Advanced Materials has chosen to pursue development of a mid-stream battery material processing facility in Thunder Bay. “We now have LGES as an interested party to commit to the offtake and potentially partner with us. That is what we need to be able to access the capital because it is by far the most expensive part of the lithium battery materials supply chain,” said Don Bubar, president and CEO of Avalon Advanced Materials.

Bubar added that since conducting a PEA in 2016, he realized that to create a mid-stream processing capacity, it must be in a central location so that it is not just serving one mining operation. Rather, it should be able to serve the needs of other new lithium mineral producers in Northwest Ontario. This would be instrumental in lowering barriers to entry for smaller projects that are often overlooked. “If Avalon gets the processing capacity established, that should inspire more new producers of lithium concentrates. I am trying to encourage more First Nations to take advantage of this opportunity, because you do not have to try to scale production in the same way traditional mining does. There is not the same need to develop big and high-grade operations. You can develop a bunch of small quarries that do not create the same environmental impacts but can create a significant supply,” Bubar concluded.

Regional Supply Chains Lower Carbon Footprint

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.

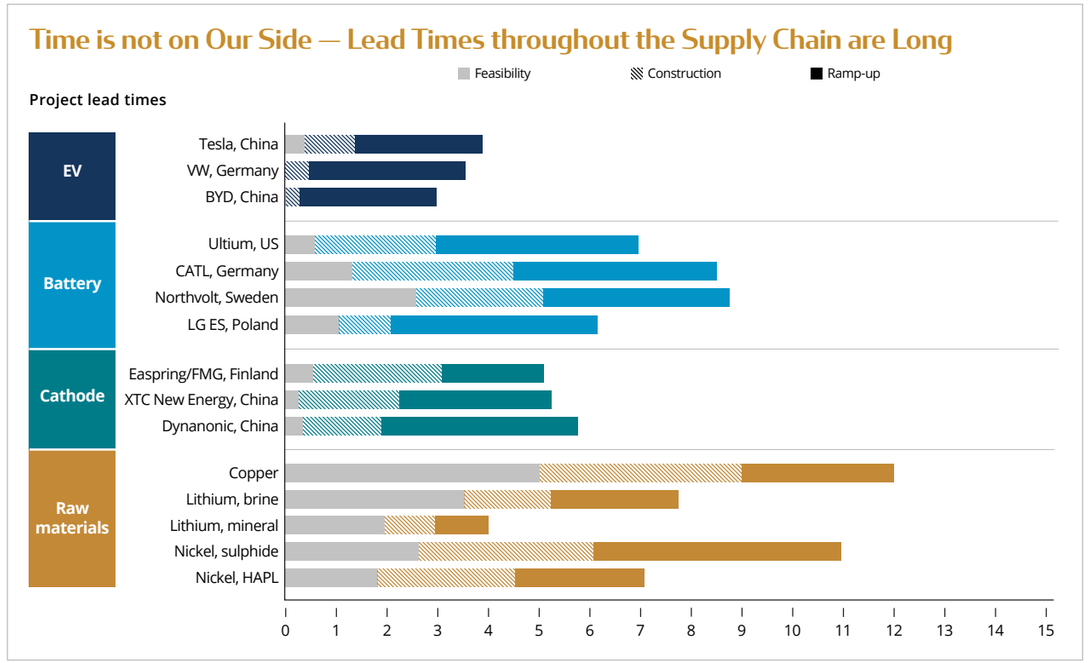
Ion CEO Ali Haji points out that, if you look at consumption today, China uses over 50% of mined lithium to produce batteries for the world. Most of this lithium is extracted in the lithium triangle in the Andes Mountains, alongside assets in Australia, but people are not accounting for the fact that 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 close to 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”.

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 this has become common. General Motors announced 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.

Case in point, in 2022, Rock Tech Lithium announced a partnership with Mercedes Benz who will be its offtake partner for 40% of its lithium hydroxide production from 2026 onward. According to Rock Tech’s CEO Dirk Harbecke, the company will take material out of the ground, and concentrate it into a 6% lithium concentrate in Canada at its Georgia Lake mining site near Thunder Bay. Rock Tech will then produce the material in Europe with its lithium hydroxide converter. This is the first of its kind on the European continent that will produce a lithium hydroxide product out of spodumene concentrate. “The car makers and power utilities are the strongest financially, and in terms of



Source: Wood Mackenzie

brand name and reputation, they are the strongest partners in the supply chain. They also need the products, so they are supporting us in lobbying on the political side to help politicians understand how challenging it is to create a completely new supply chain. The politicians are telling them that they also must invest directly, so all parties can get things done together. This is already happening, but we see much more of this coming," Harbecke affirmed.

J.C. St-Amour, president of Imagine Lithium, whose Jackpot lithium project neighbors the Georgia Lake project and whose pegmatites were most likely created by the same event, shares a similar view to Harbecke, noting that favorable supply-demand dynamics are driving opportunities to finance lithium exploration. "In general, market conditions are tough for exploration companies. For lithium, I think it is much easier."

He also points out that Ontario's flow-through regime is influencing capital flows for critical mineral exploration in the province. "For lithium in particular, the tax incentive is greater than it is for other types of projects. This generally means that more funds are available for lithium projects and allows companies to raise funds at a greater premium in the market."

» The best comparison to our Jackpot Lithium project would be our neighbor Rock Tech Lithium's Georgia Lake project. Our pegmatites were most likely created by the same event, so metallurgically and chemically we believe we have very similar deposits.

J.C. St-Amour,
President,
Imagine Lithium

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Graphite

When a battery is charged, lithium ions flow from the cathode to the anode through an electrolyte buffer separating the two electrodes. This process is then reversed as the battery discharges energy. While various materials can be used for the cathode, graphite is the go-to material for most anodes, thanks to its abundance, low cost, and long cycle life.

China plays a significant role in the production of a battery's anode, and according to the International Energy Agency, China is responsible for mining 65% of the world's graphite, processing 85% of it, and is home to the six largest producers of anode materials. The only graphite producer in North America is Northern Graphite, whose sole asset in the past was its Bisset Creek project in Ontario. In the past year, however, the company purchased two Imerys assets: Lac des Iles in Québec and the Okoruso/Okanjande mines located in Namibia, which they anticipate to be back in operation next year. Through these acquisitions, Northern Graphite will become the third largest producer of graphite outside of China, with the intention to develop capacity from 50,000 t/y of production to 300,000 t/y.

In examining why Northern Graphite's Lac des Iles mine is the only producing graphite mine in North America today, Northern Graphite Corp. CEO, Hugues Jacquemin, indicated that the scarcity of mines has little to do with a scarcity of deposits in North America. "Canada is actually very rich in graphite. The issue is that, until now, the volume of demand for graphite in its traditional industrial markets was relatively small," he said.

Because China had most of the production, whenever they had a surplus of graphite capacity, they would sell that capacity into North America and into Europe at very low prices, which created a vicious cycle, where people trying to develop capital intensive graphite mines could never

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» **We are the first movers in-country in the lithium space. Nobody else has yet gone after brine in Mongolia.** «

Ali Haji

CEO
ION ENERGY

Can you provide an update on ION's progress over the past year, in particular at Baavhai Uul?

Our 100%-owned flagship site represents the largest exploration license ever granted in Mongolia at +81,000 hectares: Baavhai Uul is five times the size of Vancouver, 60 km wide and as long as 20 km in some areas. Throughout the pandemic, we were able to conduct a fair bit of drilling, and made an exciting new discovery: the White Wolf lithium discovery with lithium anomalies up to 1,502 ppm. We also made a new copper and nickel discovery, leading to a promising strategic alliance for reciprocal mining rights with Aranjin Resources, an emerging copper explorer in Mongolia. Whatever base metals we find on our assets, ION gets a 20% free carry. When I finally had a chance to conduct a technical site visit to Mongolia this year, we visited our sites to kick off the next phase of our fully-funded exploration programs, and conducted over 100 km of TEM surveys at Ugrakh Naran. We have advanced this project significantly based on the low resistivity area we see today that shows a volume of 22.7 billion m3 at a very conservative cut off of 6.5 ohm.

Our exploration program continues to progress rapidly, and we are now drilling diamond holes. We are also drilling nested wells, allowing us to collect brine samples at depth that are encapsulated and not contaminated. 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.

To what extent can ION's proximity to OEM manufacturers in Asia disrupt the lithium supply chain?

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, 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 close with the Chinese border would significantly lower the carbon footprint of the battery manufacturing supply chain. We are not net zero yet, but there is the capacity to get there.

What is the strategy underlying ION's negotiations with potential strategic partners at this stage?

We are speaking with strategic partners to come in with a farm-in approach, where we would sell 4.99% of ION at a premium to the last raise with no warrants attached. Such a strategic agreement will signal to the market that ION Energy has the world-class assets that we believe we have, and will ultimately validate the work that we have already done on our projects.

How would you explain the valuation discrepancy between ION and its peers in Latin America?

We are the first movers in-country in the lithium space. Nobody else has yet gone after brine in Mongolia. We went public in August 2020, with no access to Mongolia, and unlike other mature lithium jurisdictions, Mongolia lacked the exploration skillset necessary to advance our assets, leaving us with an 18-24 month lag relative to peers. In Latam, you can see proximity plays that have allowed companies that have done little to no work on their licenses to grow their market caps to 10x that of ION's; a result of being beside or close to a more advanced asset.

Mongolia is still a relatively unknown, undervalued and largely misunderstood investment jurisdiction. Therefore, a Mongolian discount exists, though we continue to make strides in increasing global awareness in how much government modernization has taken place to make Mongolia an investment-friendly jurisdiction. Rio Tinto recently announced that it wants to buy Turquoise Hill's equity index investment in Oyu Tolgoi. That accounts for about US$8 billion going back into Mongolia. That is validation for a jurisdiction that every major should be paying attention to right now. ■

We are taking the lead in trying to get our mid-stream battery material processing facility established in Ontario.

Don Bubar

President and CEO
AVALON ADVANCED MATERIALS

Are there any key lessons that encouraged you to pursue a sustainable approach early in the life of the company?
One of the things I learned was that if you are going to produce materials for clean technology, the end users often audit their supply chains back to the source to make sure their materials are produced in sustainable ways. That is what inspired Avalon to start implementing basic principles of sustainability as part of our overall business model. We have been producing an annual GRI compliant sustainability report for over 10 years now.

Why has Avalon chosen to pursue development of a mid-stream processing facility in Thunder Bay?
We are taking the lead in trying to get our mid-stream battery material processing facility established in Ontario. We now have LGES as an interested party to commit to the offtake and potentially partner with us. That is what we need to be able to access the capital because it is by far the most expensive part of the lithium battery materials supply chain.

Our mineralogy at Separation Rapids is different from most of the lithium resources that are spodumene pegmatites, in that this pegmatite contains petalite and lepidolite, a lithium mica. We can recover lithium and produce lithium battery materials from either one. Thunder Bay is the perfect location for it because it is the transportation hub of the Northwest, and it has good proximity to all kinds of lithium pegmatites. If new producers find a resource that is not that big, then they can develop it as a small quarry, use new processing technologies like dense media separation or sensor-based ore sorting to concentrate it, sell it and make a lot of money while not doing any damage to the environment.

What are the implications for First Nations communities that may have pegmatites on their land?
If Avalon gets the processing capacity established, that should inspire more new producers of lithium concentrates. I am trying to encourage more First Nations to take advantage of this opportunity, because you do not have to try to scale production in the same way traditional mining does. There is not the same need to develop big and high-grade operations. You can develop a bunch of small quarries that do not create the same environmental impacts but can create a significant supply.

What more can government do to improve the chances of developing a viable battery material supply chain in Ontario?
This is quite a different business from traditional mining of exchange traded commodities in that it is more like a manufacturing business. It is all about how you process the material to meet the needs of the end users' specifications. It is time for the regulations to get updated to recognize some of these fundamental differences. It is not about tons of grade, it is about designing a process and product, and then you scale your operation based on market demand, not the size of the resource.

I would also encourage policymakers to consider that mine wastes at closed mine sites now be looked at as an opportunity for companies to extract value from the waste while remediating the environmental liability. There are many examples of resources that were developed to mine one traditional commodity where the resource contained many other elements that had no value then but do today. You do not have to mine them, just re-process the waste and clean up the mess while you do it. It is taking a while to get the regulators educated on that, as they only see closed mine sites as no-go zones that are too risky to re-activate.

Why is petalite such an important material for manufacturers?
There is now a global shortage of petalite that many glass ceramic manufacturers want to secure supplies of. This is happening because China took control of the traditional sources of supply in Zimbabwe, and now Avalon's resource is the only significant petalite resource in the world that China does not control. Consequently, we have all kinds of demand for the product from manufacturers. ■

I believe you will see a battery manufacturing hub develop with a carbon footprint near zero - this would be a massive win for Thunder Bay.

Luke Cox

CEO
GREEN TECHNOLOGY METALS

What progress has Green Technology Metals (GT1) made since its IPO one year ago?
Straight after our IPO we moved our team to Thunder Bay, Canada to setup the offices and started to expand the team in-country because we wanted to start drilling our Seymour project immediately, and knew we would need an early exploration agreement and an exploration permit to allow us to drill. Our team went straight up to Whitesand First Nation, introduced themselves. The drilling was approved, and our early exploration agreement was signed straight away. A week later we began our maiden drilling program and shortly after we built a 30-man exploration camp. The drilling was a success with the first drill hole on the property intersected high grade lithium with very thick intercepts.

In March we went back to our JV partner and increased our ownership of the assets from 51% to 80% and then raised A$55 million where we picked up a strategic investor, Lithium Americas Corp. LAC already had lithium brines in South America and Thacker Pass, a clay deposit in North America, but they wanted to break into hard rock spodumene in Canada.

We have kicked off drilling at our second project called Root, straight away hitting high-grade lithium. We now have two high-grade deposits that we are developing at the same time, but plan to bring our flagship Seymour project into production first.

What does GT1's production timeline look like and what is the end product you are hoping to create?
To get into production we need a PEA which is already in progress and nearing completion. Our plan is to create a concentrate around 2025, which we will be looking at taking offsite, converting it into lithium hydroxide.

Why are partnerships essential in order to build a cohesive battery material supply chain?
If a small exploration company thinks they are going to become an all singing, all dancing, downstream producer, they have got a lot of work to do. That is why you must partner with downstream players. To build a lithium hydroxide facility, you are talking between US$500 million to US$750 million. Junior and even major mining companies are going to find it hard to invest that money.

What makes Thunder Bay well suited to become a battery materials hub? How does this contrast with the battery supply chain you previously worked in, from Australia to China?
I used to be the mine manager on one of the biggest lithium operations in the world, and at the time, we would crush the lithium down to sub 40 mil, put it on road trains, take it 300 km up to the port, upload it onto the sea bulk carriers, who would then then ship it to China. After being unloaded at the port in China, it would go onto barges, up the river to the converters. All that time we were burning diesel and bunker fuel. To top that off, a lot of these converters are powered by coal fired power stations. It is an oxymoron, because it felt like we were doing the right thing, but in the process of manufacturing that battery, we created an enormous carbon footprint. That is why I love Thunder Bay. The mine is a stone's throw away, and the whole area is powered by Hydro One, so all of the power is green. Moreover, rather than traveling 30,000 km, I'm traveling ~300 km from the mine to the converter facility. And in the future, I believe you will see a battery manufacturing hub develop with a carbon footprint near zero - this would be a massive win for Thunder Bay.

The battery and car manufacturers that have already built their plants have a carbon footprint that is pretty much not changeable. Therefore, if we can lower the carbon footprint for the raw materials and chemicals that go into a battery, it will potentially receive a premium in the market. If the supply chain gets built, Thunder Bay will be producing some of the most premium low carbon lithium in the world, because it is not traveling large distances and created using green energy. ■

> **Recently we outlined a phased approach for future development that will include initial production of lithium concentrates as phase one, followed up by chemical production as a part of a later phase two.**

Trevor Walker

President and CEO
FRONTIER LITHIUM

Can you provide us with an update on some of the key events of the past year for Frontier Lithium?
We updated our resource in spring of 2022, so we have now made four discoveries, two of which are deposits outcropped at surface. They make up about 42 million t under measured, indicated and inferred, with a grade of just over 1.5% lithium oxide. That represents the highest-grade resource for lithium in North America. Up until 2022, we drilled roughly 15,000 m, and this year alone we more than doubled the amount of meters drilled. Of that 42 million t, about 60% is still categorized as inferred, so it is necessary to complete a pre-feasibility study, and we will be delivering that in the spring of 2023. Working in parallel, we are continuing exploration on the property and conducting baseline environmental data collection to enable future permitting work. Recently we outlined a phased approach for future development that will include initial production of lithium concentrates as phase one, followed up by chemical production as a part of a later phase two.

Why is Frontier Lithium's high grade such an important advantage for the company?
Whether it is precious metals or industrial minerals, grade remains king. Generally, the higher the grade, the lower the costs are. This in turn provides for longer project life and a more sustainable project. The PAK lithium project contains a North American leading grade of 1.54% Li2O which, coupled with its large size and low stripping ratio provides competitiveness over its global peers.

The combination of Frontier Lithium's PAK and Spark deposits have been compared to the famed Greenbushes in Australia. What are some of the key similarities and differences?

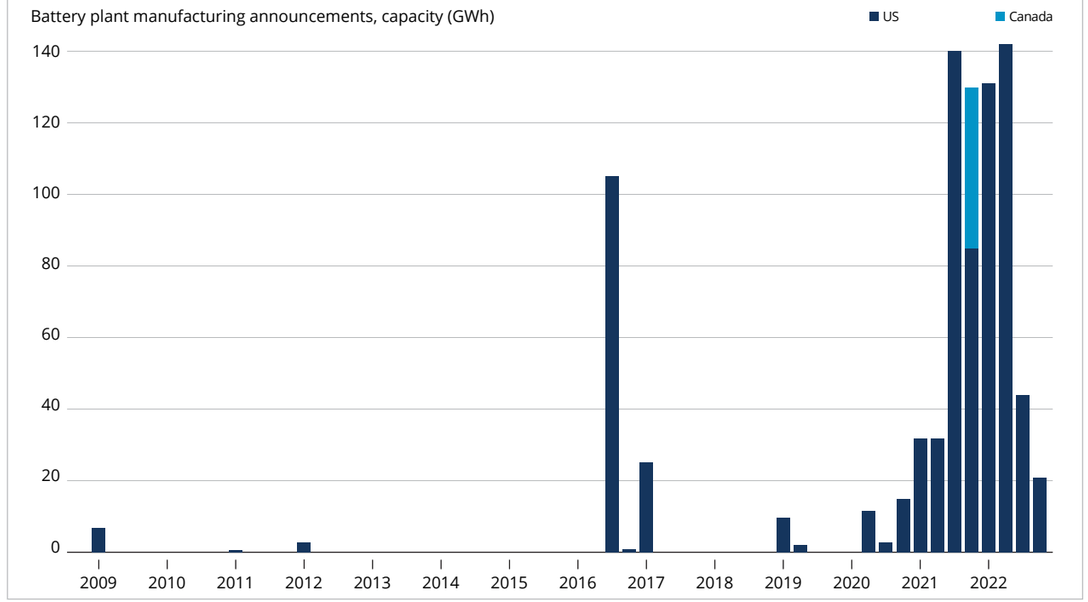
The PAK lithium is in a new emerging district, whereas Greenbushes was established originally as a tin mine in the late 1800s.

Our deposit grade is comparable to Greenbushes. Greenbushes references a "core zone" in their resource that contains really low iron levels, which enable concentrates with less than .15% iron oxide. Frontier Lithium is similar in that we have classified our PAK deposit as a technical grade deposit. We have roughly 9 million t of low iron spodumene. This low iron characteristic is rare and is very similar to Greenbushes, which supplies roughly 30% of the world's lithium demands though that output is coming to an end within a decade.

The Greenbushes resource is approximately 300 million t, and Frontier has an exploration target of 100 million t in its mining lease area alone.

To what extent does Frontier Lithium need to continue to see surrounding infrastructure built out in order to realize its vision?
To date, we have utilized a winter road of about 140 kilometers. This has served us well during the exploration stage of the project and we are fortunate that it has seen upgraded as part of the Wataynikaneyap (Wataay) Power Project that is currently under construction. The Wataay Power Project is multi-billion dollar project electrifying 17 northern Indigenous communities, including those proximate to our project. This winter the lines will be strung, and we expect that by early 2023, that lines will be energized bringing much needed power into the area. It is exciting that our project is viewed as a possible first industrial consumer for the excess capacity that has been built into that line. Our initial phase, producing premium concentrate, can use existing winter road infrastructure allowing us to supply premium low-iron bearing concentrates for chemical production or premium glassmakers in both North America and Europe. Using this market strategy, we can lessen permitting risk, lower the initial capital requirements and be more fiscally responsible. This will also allow us to leverage the resource for northern communities, enable all-season road construction to the project and to feed a downstream chemical plant. From a timeline perspective, these things are all working in parallel, and we think we are in good shape so that when we are ready, the road will be in. This will enable us to supply the much needed lithium chemicals in the region before the end of this decade. ■

The North American Battery Boom



Source: S&P Global Commodity Insights

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raise enough money to do it. Whenever the cycle was at the top, China would dump graphite onto the market, and suddenly prices would crash and North American business models would no longer make sense.

Jacquemin posits that this time is different thanks to skyrocketing demand for lithium-ion batteries. "These batteries did not exist in cars until 2010, but once electric vehicles started to be manufactured, the amount of graphite required by the market started to grow exponentially. What we see now is that, as these batteries grow, you need between 800 to 1,200 t of graphite per gigawatt hour of battery capacity," he added.

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

> Graphite is key to any battery supply chain as it represents almost 50% by weight of the materials needs, no matter what the chemistry of the battery.

Hugues Jacquemin

CEO
NORTHERN GRAPHITE

Northern Graphite acquired the Okanjande graphite deposit together with the Okorusu processing plant in Namibia in April 2022. What has attracted the company to these assets?
When I was working as the CEO of Imerys Graphite and Carbon, we started scouting for a graphite deposit that could help us develop the European market. We came across Okanjande, a mine that was developed back in the 1990s by Rio Tinto. Just 22km away from the mine, Okorusu was an old fluorspar plant owned by Solvay. The brownfield facility presented us with the opportunity to convert it to a graphite processing plant and reduce capital costs. In 2016, Imerys acquired both the mine and plant and began mining that same year. Two years later though, as graphite markets were highly depressed, Imerys put the plant on care and maintenance. After thorough due diligence, Northern Graphite acquired these two assets earlier this year. Our goal is to start production in the next 1-2 years.

Based on the recent PEA, the estimated CAPEX to restart the operation is US$15 million. At this stage, we have 48 people on site, we ordered all long-lead items, and we are evaluating a few options, including dismantling the Okorusu facility and relocating it closer to the Okanjande site. At a basic level, our operating costs would come down since we wouldn't have to transport concentrates from the mine to the plant.

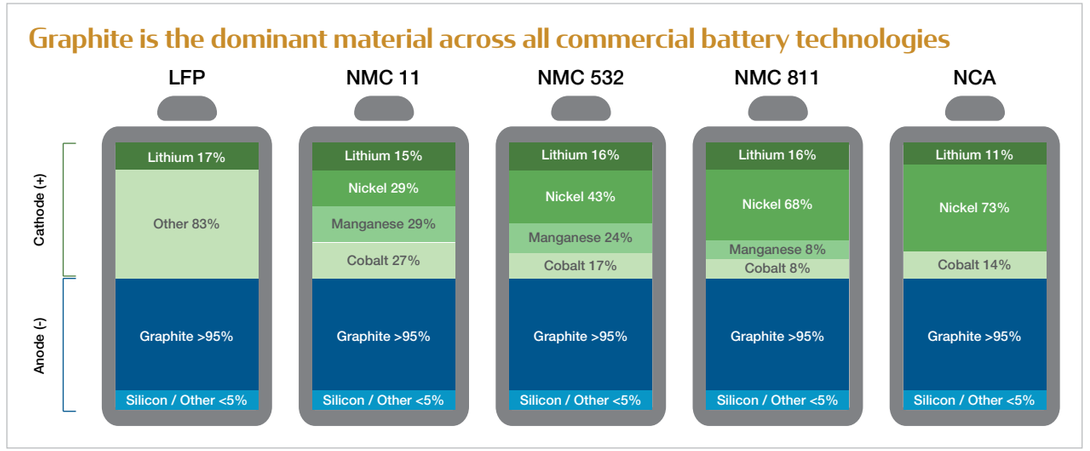
Okanjande is a large deposit amenable to an operation of 150,000 t/y with the right investments. With a new plant, we could produce 40,000 t/y instead of 30,000 t/y (the capacity afforded by Okorusu). From there, it would be a lot easier and quicker to expand through bolt-on investments because the tailings dam, electricity, water, and other infrastructure elements would be already there. The time is also on our side, as most of the big giga-factories in North America and Europe will start in 2025, giving us a window to make the right decisions. The relocation would only take about six months longer than our current plan, pushing first production to early 2024.

Can you help our audience understand better the importance of graphite for electric batteries?
Whatever the battery chemistry – be it nickel, manganese, cobalt, LFP, or other – graphite represents 48% of the battery's weight. That means that every GW of power requires between 800 and 1,200 tons of graphite, depending on the design of the battery. Today, most graphite is produced and processed in China, which has been continuously increasing capacity over the past decade. For the first time, however, China began importing graphite. Market specialists expect to see a shortage of 40,000 tons of graphite in 2023, a deficit expected to increase further in the coming years. At current forecasts, more than 10 mines will need to be developed to meet growing demand.

Graphite prices are yet to react to the supply-demand imbalance. Why is that?
The pricing of graphite has undergone repeated cycles, affected primarily by China's irregular supply into European and North American markets. Because graphite pricing is quite opaque, lacking sufficient market data to inform investors and developers, the financing of graphite projects becomes challenging. With a bit of patience, I believe we will see this change. There is a lot of appetite for investment in graphite that will eventually create visibility on pricing.

What makes Namibia a favourable mining jurisdiction?
As someone who has been travelling to Namibia frequently for the past six years, I can say Namibia is a business-friendly jurisdiction with a history of uranium mining and talented people with an abundance of mining expertise. The country has a relatively stable currency, pegged to the South African Rand. The proximity to South Africa also gives us the advantage of being able to pull in local engineering talent. Okanjande is only five hours' drive away from the deep-water port of Walvis Bay, which provides perfect shipping connectivity into Europe and North America. Moreover, state agencies and institutions like the World Bank are looking at Namibia very favorably and we believe we will be able to apply for public funding to support our projects.

Do you have a final message?
Northern Graphite found in Namibia a permitted project that can easily expand into a world-class operation. Using our experience as the only graphite producers in Canada, we want to get there first, be the quickest to reach the market and capture the high growth in graphite prices. Some call the graphite problem to be 10 times the lithium problem. The graphite sector must work together, consolidate, and create opportunities of scale to respond to the growing appetite of cell manufacturers and OEMs. ■



Source: Pallinghurst-Traxys battery analysis. %s represent the proportions of cathode and anode in each battery respectively/ NCA batteries contain 2% aluminium (not shown)

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 and 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.

Image courtesy of Purepoint Uranium

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 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 a 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 a portfolio of the most prospective projects," said Frostad. ■

EQUIPMENT AND INNOVATION

GBR SERIES • MINING IN ONTARIO AND TORONTO'S GLOBAL REACH 2023

Image courtesy of NORCAT

"The green transition can be killed in two ways: either through producing an insufficient supply of the energy metals needed for electrification, or by producing those metals at such a high price that they fail to drive carbon out of the economy. If we produce more expensive copper, nobody can afford to buy an electric car, and no country can afford to upgrade their electrical grid."

Doug Morrison,
President and CEO,
Centre for Excellence in Mining Innovation (CEMI)

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, startup 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 across the globe. This chapter illustrates the wide range of technologies Ontario-based companies are developing and delivering to the world.

Organizations Incentivize Innovation and Adoption

Mining is a long-term game, where every dollar invested takes its own sweet time to yield returns, making companies less willing to take risks on untested technologies. Nevertheless, the mining industry is constantly exploring new ways to improve efficiency, safety and sustainability, and the future looks bright for those who can find a way to innovate.

Organizations like the Centre for Excellence in Mining Innovation (CEMI) and NORCAT exist to lower the barriers to entry for mining startups and technology providers while also demonstrating to potential buyers the efficacy of new technologies. Over the past year, CEMI initiated a new Mining Innovation Commercialization Accelerator (MICA), which creates a network of SMEs, and helps accelerate them and their products into the marketplace. CEMI's president and CEO Doug Morrison's view is that, although Sudbury is a dynamic environment, it is difficult for any small company to build itself up into a much larger company solely relying on the Canadian market. "Mining companies in Canada are very slow adopters of new technology and many other jurisdictions are more dynamic, adopting new solutions much more quickly - especially in Chile and Peru," Morrison said.

One option Ontario-based technology developers have to demonstrate their technology is the NORCAT Underground Centre in Sudbury. The organization recently hosted its Mining Transformed event which brought together over 50 tech companies of different sizes from all over the world, with installations at the NORCAT Underground Centre. According to NORCAT CEO Don Duval, this event confirmed their hypothesis that being able to have demonstrable technology in an operating environment does indeed expedite potential procurement, adoption and deployment of these technologies. When asked why so many startups find it difficult to gain traction in mining, Duval commented: "If they cannot solve the first customer problem, especially for tech selling into legacy industries, many of these start-ups will run out of cash before they can get to market."

In this context, NORCAT plays an essential role in acting as a first reference customer to provide a platform on which a company can build a track record and narrative to expedite the process of winning over a production-scale customer.

One technology company that leveraged its NORCAT experience to validate and iterate its technology was Sofvie, whose mission is to develop a software solution that ensures all workers on a mine site go home safely. The company's CIO, Gus Minor, conveyed that Sofvie sensed a need in the market, because mining conversations were often undocumented or unmanaged, resulting in slow and inefficient transfer of information. By the time information got to the decisionmaker it was often no longer relevant or factual, thereby creating safety and productivity risks. "Sofvie resolved this problem by developing a web and mobile application dedicated to maximizing insights and communication between managers, fieldworkers and their supervisors," Minor said.

This past year, Sofvie partnered with the R&D department at Cambrian College and a local provider to integrate Sofvie's software with an Internet of Things device to act as an "off switch" to prevent unqualified workers from using specific equipment. With all of the traction, partnerships and growth Sofvie has experienced since its inception, Minor is not shy about crediting Sudbury's role in creating a propitious environment for success. "In deciding where to locate Sofvie, part of our decision was influenced by the fact that we needed direct feedback from customers using our software. In Sudbury, there are many companies and mines located just down the street. We also have a lot of the Sudbury workforce that travel and work around the world after getting their start here. It is a great way to network and get feedback from what others have witnessed in other parts of the world in their mining journey," Minor added. ■

Don Duval

CEO
NORCAT

Can you provide an overview of NORCAT's business model?
At NORCAT, we aspire to be the global leader in skilled labour training and development. Concurrent to that goal, through our innovation services and assets at the NORCAT Underground Centre, we act as the global one-stop-shop for all that is the future of mining technology and innovation. For example, an entry level skilled labor worker looking for a career in the mining industry can come to NORCAT for classroom-based training or online training that incorporates virtual reality learning opportunities for a number of skills, including scaling, hoisting and rigging and equipment pre-op checks. Additionally, they will have the opportunity to utilize the NORCAT Simulation Training Centre, where they can operate machinery with the same specs and operational requirements as the equipment found in a mine.

What was the idea behind Mining Transformed?
The goal of Mining Transformed was to bring together the buyers of innovation – mining companies - with the builders of innovation – mining tech companies - to connect and conduct business in an operating mine environment. Our hypothesis was that mining executives considering procuring, adopting and deploying emerging technologies will be more apt to act if they are able to interact with the technology in an actual operating environment.

What are the biggest challenges startups face in trying to gain traction in the mining industry?
The role of the NORCAT UG Centre is to provide that all important first reference customer to provide a platform on which that company can build a track record and narrative to expedite getting their second - and more important - production-scale customer. Simply stated, we have validated that, if you cannot solve the first customer problem, especially for tech selling into legacy industries, many of these start-ups will run out of cash before they can get to market. ■

Doug Morrison

President and CEO
CENTRE FOR EXCELLENCE IN MINING INNOVATION (CEMI)

Can you provide an update on some of the key developments that occurred at CEMI over the past year?
We initiated our new Mining Innovation Commercialization Accelerator (MICA), which creates a network of SMEs, and helps accelerate them and their products into the marketplace. We also have membership levels for mining companies who want to be able to see all the opportunities that are out there to follow within the MICA Network. The purpose of the Network is to help SMEs identify the key players in the mining innovation space. In addition, we try to bring in cross-sector innovators to work with mining SMEs.

What are the primary reasons technology companies fail to effectively commercialize and scale technology for mining?
Often, companies are underfinanced, which is why CEMI is working on project funding, but also, small companies do not have all the skillsets they need to make the successful leap into a commercially viable product themselves. So, in addition to the project funding that we offer, we also provide an assessment of the skills gaps that exist within an organization, and we try to find the consultants they need.

Where do you see investment flowing and where are the critical gaps at the moment?
When it comes to capital allocation, investors still prefer an investment in a product or service that has relatively low risk. We are no longer in a low-risk environment, however, and the greater risk is to fail to accomplish the transition to a low carbon economy and suffer the enormous economic consequences.

The green transition can be killed in two ways: either through producing an insufficient supply of the energy metals needed for electrification, or by producing those metals at such a high price that they fail to drive carbon out of the economy. ■

» When digital tools are too difficult to use, they end up being abandoned, so we developed Sofvie directly with the workforce to make sure that it is user-friendly. «

Gus Minor

Chief Innovation Officer
SOFVIE

What inspired the founding of Sofvie?
We created Sofvie to enhance the workplace and make sure that mining workers return home safely. Prior to Sofvie, mining conversations were often undocumented and/or unmanaged, therefore, information was transferred slowly and inefficiently. By the time information gets to the decisionmaker it is often no longer relevant or factual, thereby placing safety and productivity risks. Sofvie resolved this problem by developing a web and mobile application dedicated to maximizing insights and communication between managers, fieldworkers and their supervisors. This collaborative software solution provides timely information to and from the field in order to make consistent and accurate decisions. At the click of a button, the information is accessible by everyone along with managers, which in turn lowers the risk to life and increases productivity all while supporting a positive environment to work in.

How is Sofvie's software helping companies acknowledge talent and worker performance?
We are seeing that after adopting our software, entire organizations are much more informed in a real time fashion. This catalyzes a cultural transformation. We have a positive recognition module built into our software. During any standardized process or audit, they have the opportunity to acknowledge work that is performed to a very high standard.

What were the shortcomings of health and safety software offerings before Sofvie was introduced?
There are a lot of generic tools on the market, but we built our software specifically for the mining sector. Before developing Sofvie, we conducted market research to find out what was out there. We found that existing software was overly engineered in the sense that workers needed training, or the onboarding process was too steep. When digital tools are too difficult to use, they end up being abandoned, so we developed Sofvie directly with the workforce to make sure that it is user-friendly. Sofvie has been well received, and workforce adoption rates are very high for our software.

Could you elaborate on Sofvie's work with Cambrian College and the integration of wearable devices?
We are working with the R&D department at Cambrian College, and a local provider to integrate Sofvie's software with an Internet of Things device to act as an "off switch" to prevent unqualified workers from using specific equipment. If the training records do not match and the worker does not have the authorization to run a piece of equipment, it will not turn on.

We are also trying to integrate wearable devices into Sofvie. We know that for the data to be rich, predictive and prescriptive, we need more information. We need to analyze the pictures and biometrics to obtain a clear scope of possibilities. Because of underground environmental conditions such as pressure and temperature, devices last an average of two weeks before they are no longer functional. Our idea is that miners can be well taken care of and depend on solutions that will endure the harsh environments, we developed a prototype resistant to extreme conditions.

How is Sofvie leveraging partnerships and funding opportunities from the Government of Ontario?
Sofvie has been leveraging Cambrian College's network of funds and funding from the Government of Ontario through the Ontario Centre of Innovation's (OCI) Voucher for Innovation and Productivity (VIP) program. The Northern Ontario Heritage Fund (NOHFC) has also agreed to contribute to our data sciences and development for predictive and prescriptive analytics.
We are also working to build internship opportunities so people can have direct experience right out of school. If we want access to talent in the future, we must help to develop it now.

How has being a part of the Sudbury mining ecosystem helped Sofvie grow?
In deciding where to locate Sofvie, part of our decision was influenced by the fact that we needed as much direct feedback from customers using our software. This would be very difficult to do from larger centers which are greatly removed from the workplace, but in Sudbury, there are many companies and mines located just down the street. We also have a lot of the Sudbury workforce that travel and work around the world after getting their start here. It is a great way to network and get feedback from what others have witnessed in other parts of the world in their mining journey. ■

Geophysics and Geological Modelling

Maximizing discovery in a mature jurisdiction

Image courtesy of MPX Geophysics

Innovation in the Air

Traditionally there has been a certain mystique that goes with a classical boots on the ground reconnaissance of a property. However, in an era where there is pressure to make discoveries faster, and 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 defy this. 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: "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 and 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 are ill-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 advances 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.

While there is undoubtedly a strong push toward identifying deeper targets, Mandy Long, general manager of SkyTEM Canada Inc., points out that over the past few years there has been something of a trend in Ontario with clients seeking a clear picture of their near surface geology. "Traditionally, groups were all looking at depth, and the philosophy was to go as deep as you can and find as much as you can. We have now seen a shift back towards understanding what is going on in the near surface in Ontario," Long commented.

M&A Drives Product Improvements

In reckoning with the build versus buy dilemma, in 2021 Xcalibur Multiphysics, formerly a leading player in magnetics and radiometrics and typically specialized in doing larger scale country mapping programs in Africa, decided to diversify and expand its business with the acquisition of CGG Multiphysics. This added CGG's expertise in gravity gradiometry and electromagnetics, and instantly helped Xcalibur grow its market presence in the Americas, Australia and Asia.

A manifestation of this merger will occur in 2023, when Xcalibur's XMAG system is introduced into the Canadian market. XMAG is a magnetic and radiometric system that utilizes a fixed-wing aircraft to deliver ultra-high resolution data, with a quick turnaround time. In fact, it is flown on a crop-dusting aircraft designed specifically to fly at ultra-low levels. "In Africa, we are flying low level surveys with very tight line spacing, which gives customers an extremely detailed, data rich solution. We are going to be exporting that technology around the world, and Canada is a key place to receive it," noted Davin Allen, managing director – Canada at Xcalibur.

With the acquisition of CGG, Xcalibur will now offer an existing technology that was formerly part of CGG called TEMPEST, which is a fixed-wing time-domain system that originated in Australia. "Prior to the sale, CGG did not want to invest heavily in capital expenditure on this offering. However, now that we have been integrated into Xcalibur, the board have been very forward thinking, and they are investing a significant amount of money, time and energy to focus on broadening our solutions," Allen elaborated.

The sense of urgency from top management comes as a result of the pressing need to meet exponentially rising mineral demand while mitigating environmental disturbance. Xcalibur's CEO, Andrés Blanco, underscored this dilemma, explaining that Xcalibur's vision is to support the fast mapping of energy transition minerals in Ontario. Consequently, the company is investing US$40 million in R&D for acquisition technologies, as well as technologies that apply machine learning techniques in the interpretation of the data. "These technologies are important because, when there is compelling evidence of mineralization, exploration efforts can focus more precisely on defined areas. This maximizes the probability that drill campaigns will succeed and minimizes environmental disturbance," Blanco affirmed.

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.

New Technology Increases Conviction

Technoimaging is a University of Utah spinout that has developed a system that integrates all kinds of geophysical data to create a 3D imaging solution. It transforms datasets into geologically meaningful models via 3D images, which are referred to as Glass Earth models. This technology allows the company to deliver a transparent model of the subsurface, where a geologist can see the earth's internal structure expressed in different physical properties like conductivity, density, seismic velocity, and magnetic properties.

TechnoImaging founder and CEO, Michael Zhdanov, highlights that the industry's use of historical geophysical maps is often called 'bump hunting'. For example, people look at magnetic maps, see some anomalies, and go after them. "Very often, however, there are 'bumps' on the map, but they have nothing to do with real discovery in the ground. With our technology, we transform these maps into very high-resolution 3D images of the different physical properties of the rocks underground. Then, by integrating different properties, we can conclude with higher confidence whether there is a mineral deposit or not," Zhdanov said.

New Hardware and Deep Learning Enables Improved Models

Sudbury-based Clickmox Solutions began to develop its current suite of LiDAR products after working with a 3D laser mobile mapping system at Rio Tinto's Grasberg mine in Indonesia. However, 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."

Another founder-led technology company hoping to help mining companies maximize production is StratumAI, which leverages deep learning to create more accurate resource models using the data a mine already has generated. Traditionally, mines drill out long cores of rock for analysis, then assay each sample to determine the content. This is done repeatedly using a predetermined spacing/orientation decided by each company. Geologists use that drill data, their experience, and industry-standard geostatistics to fill in the blanks between the drill holes to create a 3D map of the mineral content in the ground. Stratum uses that same data to create a more comprehensive 3D map that better represents the mineral content in the ground, and it does that by applying its own algorithms. "Even though data is sparse, it implicitly carries the geological patterns of the system and, therefore, can be used as is to extract the geological patterns of the system. It just requires a lot of work on the machine learning side to be able to ingest the data and extract something logical. From there, the next challenge was to deliver an outcome that is much more accurate than the best resource model created by the mining operation," said Farzi Yusufali, co-founder of StratumAI.

Freed from the Mundane

After winning the Disrupt Mining competition in 2017, KORE Geosystems Inc. received a C$1 million investment from Goldcorp, giving it the capital it needed to develop its technology specialized in extracting value from data to solve specific industry problems. KORE's flagship SPECTOR system started when one of its first data scientists was granted access to a dataset from a gold mining company, and his team proved that the technology could predict the rock type from the imagery using deep learning models. The company's choice to focus primarily on the core logging process may seem mundane. However, almost every single exploration and mining site drills core, and there are labor-intensive tasks associated with this process that can be automated. "It is a big market, and a lot of the major mining companies are drilling hundreds of thousands of meters a year at a single mine site. Because the drilling volume is large, there is a lot of labor-intensive work required. We felt there was a market to make things more consistent, faster, and efficient," said Vince Gerrie, president of KORE Geosystems Inc. ■

Elisabeth Ronacher & Jenna McKenzie

ER: Co-founder and Principal Geologist
JM: Co-founder and Principal Geophysicist
RONACHER MCKENZIE GEOSCIENCE

Can you describe your business model, and the services you provide within the mining value chain?

JM: We provide a full range of services from helping a client determine where to stake to the point where a company is ready to estimate a resource. We provide a range of different services from exploration planning and fieldwork to geophysics and property assessments.

What are the biggest pain points for explorers in Ontario?

JM: The long time it takes from targeting to mining is a huge issue, and we want to help in terms of the efficient targeting portion. We cannot help with the permitting or governmental aspects, but we can bring all the data together to make sure a company is going after the right targets.

ER: The other pain point is that investors have a very short attention span. Consequently, companies are driven to publish news constantly without taking the time to reflect and maximize the value of each data set they collect.

Do you believe algorithms are capable of generating ideas that geologists miss?

JM: We developed an algorithm that allows us to know what factors are influencing a target at any point on the target generator map. That is powerful, because there are many variables that we are inputting such as different varieties of geophysics, geology and geochemical data. As a human, you cannot cross correlate all of these in your head. As a result, the algorithm may come up with ideas that geologists may not have previously considered. Machine learning is helpful in removing bias in how we look at our data. ■

Revolutionizing Mining

Geophysics Drives Discovery

"We have been using geophysics, and in particular drone magnetics, which has been revolutionary in giving us the resolution to map the subsurface architecture, particularly around the banded iron minerals which are strongly magnetic."

Darren Cooke, CEO, Auteco Minerals

"We have done a lot of borehole IP, and the Iska Iska deposit is remarkably conductive. It is not a conductor in the way that most people think however. This is an amazing net-like textured stockwork of veins and vein breccia's that is electrically continuous. We end up with very extensive conductive zones that are running through there. The geophysical signature here has been remarkably useful."

Bill Pearson, Executive Vice President of Exploration, Eloro Resources

"Airborne geophysics is a quick way to establish a clear understanding of the subsurface. We have no boots on the ground, so there is minimal environmental impact, and there are limited issues with local communities because we are not looking to drill holes in the ground."

Davin Allen, Managing Director - Canada, Xcalibur Multiphysics

"Over the past 15 years, I have seen a shift toward a stronger focus on technical requirements. That is very healthy, because an airborne survey can be a large part of a junior mining company's exploration budget for the year. As the airborne provider, I want to give them the best solution for the longest term use of the data that they can get."

Mandy Long, General Manager, SkyTEM Canada Inc.

Software and Equipment Maximize Efficiency

"Data capture from sensors also allows us to predict failures, so we can service machinery ahead of time. We are making money when those cutter bits are cutting salt, and whenever they are not, our productivity drops. The more time that we can keep those bits on the salt face, the more apt we are to be profitable."

Kevin Crutchfield, President and CEO, Compass Minerals

"Mining equipment operates in highly abrasive environments, and therefore aftermarket services and support are extremely important. Equipment wears, and we have to ensure that our clients have stock availability to avoid extended downtime or loss of production."

Rob Fawcett, Managing Director, Weir Minerals

"One of the biggest things we heard from our clients is that geologists are basically overpriced data entry clerks. They look at the rock and then they spend an inordinate amount of time on data entry and performing repetitive tasks. We built our entire system to make this process a lot faster and more consistent."

Vince Gerrie, President, KORE Geosystems Inc.

"On a recent project with a Tier 1 company embarking on an electrification project, the client wanted to look at how the Trolley Assist technology will impact their mine – what their electrical consumption, the reduction in fuel consumption, and their increase in productivity will be. Hexagon is helping them plan and schedule based on the constraints and opportunities imposed by the Trolley Assist implementation."

Derek Cooper, Managing Director US/CAN, Hexagon Mining

AB

DA

Andrés Blanco & Davin Allen

AB: CEO
DA: Managing Director - Canada
XCALIBUR MULTIPHYSICS

Can you provide an overview of Xcalibur Multiphysics?

DA: Xcalibur Multiphysics is the leader in airborne geophysics in the community that we serve. Our main clients are junior miners and majors, but we also service a number of governments around the world. Additionally, we have oil and gas customers, and we are increasingly looking to serve the emerging geothermal, hydrogen and other alternative energy markets. We are present in 13 countries across six continents.

How has the acquisition of CGG Multiphysics better positioned Xcalibur?

DA: Xcalibur has been a very strong player from 2002 onwards, but their main focus was in magnetics and radiometrics, and typically they were doing larger scale country mapping programs in Africa. Their focus was to take the next step and become a more global player with the most diverse number of technologies to service their clients. From a technology and geographic perspective, it was a perfect union.

What are some of the most important offerings Xcalibur will be introducing into the Canadian market in 2023?

DA: One of Xcalibur's crown jewels is its XMAG system, which is a magnetic and radiometric system that utilizes a fixed-wing aircraft to deliver ultra-high resolution data, with a quick turnaround time. The system is flown on a crop-dusting aircraft designed specifically to fly at ultra-low levels. We are going to be exporting that technology around the world, and Canada is a key place to receive that technology.

Similarly, an existing technology that was formerly part of CGG is TEMPEST, which is a fixed-wing time-domain system.

AB: Considering all the pressure to develop critical minerals, prospecting must be done faster with high resolution techniques. These solutions based on fixed-wing platforms are more efficient and will help companies get access to information faster.

How is Xcalibur positioned to contribute its services to boost the speed and accuracy of exploration efforts for critical metals?

DA: Airborne geophysics is a quick way to establish a clear understanding of the subsurface. We have no boots on the ground, so there is minimal environmental impact, and there are limited issues with local communities because we are not looking to drill holes in the ground. What we really want to do is provide a much clearer understanding of the subsurface for our clients, and then help them focus on the most highly prospective areas, so they limit their environmental impact and community disturbance. We have flown every technology in Ontario, but the primary ones of late have been our gravity gradiometer, which we call our Falcon system. One of our big wins was conducting a large survey over the Ring of Fire with our Falcon technology for the Ontario Geological Survey. That is public domain data, and a lot of mining companies have used that before deciding where to stake claims. The other widely used technology would be our HELITEM, which is a time-domain helicopter EM system. The demand for those technologies has increased substantially in the last couple of years primarily from junior companies looking for nickel and copper.

AB: We want to support the fast mapping of energy transition minerals in Ontario, and that is why we are investing US$40 million in R&D for acquisition technologies, as well as technologies that apply machine learning techniques in the interpretation of the data. We are also investing in enlarging our fleet and the number of systems deployed in Ontario to assist the large number of juniors that will be ramping up exploration in line with Ontario's emphasis on developing a critical minerals supply chain. A unique advantage Xcalibur offers is that we are very agile and creative with our financial models, so we are ready to partner with juniors to provide technical and financial solutions.

Can you outline the steps Xcalibur has taken to minimize its environmental footprint?

DA: Xcalibur has partnered with Monte, a company that is focused on delivering zero-emission aircraft and retrofitting existing aircraft with electric, hybrid or hydrogen propulsion technologies. We are committed to transitioning all of our aircraft engines when the technology is there and robust. ■

Compared to active sources airborne electromagnetic technologies, MobileMT has much greater depth of investigation.

Andrei Bagrianski

President and Founder
EXPERT GEOPHYSICS LIMITED

What was the inspiration behind founding Expert Geophysics and your flagship MobileMT system?
Myself, along with Peter Kuzmin, who is one of the best engineers in the industry, decided that there was an opportunity for us to build a company that offers airborne geophysical surveys with advanced electromagnetic systems. I knew from previous experience that the technology was lacking a number of features, so when I talked to Peter, he laid out a clear vision on how to improve the technology.

Ultimately, we came up with our MobileMT system, which possess several advantages over existing airborne electromagnetic technologies. Compared to active sources airborne electromagnetic technologies, MobileMT has much greater depth of investigation. That is very important because most of the near surface deposits have been discovered by now, and many companies are looking for deeper targets. Of the airborne electromagnetic technologies, MobileMT is the deepest penetrating. We are measuring three components of magnetic variations in the air, and we have X, Y and Z components, which means that we can recover the geology of any shape.

Can you provide a brief overview of the suite of products Expert Geophysics offers?
We have three primary technologies that we have launched. The first system is the MobileMT system, which is our flagship system. That system exploits passive electromagnetic fields arising from lightning events and storm activity that cause variations in the earth's magnetic field. This is what we are measuring. Our MobileMTm system, is a further development of that technology, and that is built to identify discrete targets and strong structural features with a focus on the relatively near surface depth range. The final system that we are flying is the mTEM system, which is a time domain system. That is designed for very detailed near surface investigation. What differentiates this system is its ability to reject industrial voids and electromagnetic destruction. By the end of 2022, Expert Geophysics will be offering clients the full range of electromagnetic services.

Does MobileMT work across a variety of geological settings?
This technology works with a wide range of minerals because of the wide resistivity range we are able to detect. The technology has proven to work well with orogenic and epithermal deposits, kimberlites, and uranium deposits in the Athabasca basin. Here we have flown surveys to pick up not only conductive units in the basement but the zone of alterations in the sandstone. In Ontario, we recently completed a survey for lithium pegmatites. We flew our MobileMTm which has a smaller sensor, and it has a magnetic gradiometer.

The biggest thing that we want to emphasize is that we have used the technology for 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.

Is MobileMT still able to perform effectively in areas with existing infrastructure?
The infrastructure creates noise in any kind of electromagnetic data. However, we have several examples where we flew close to existing infrastructure and collected good data. It is an issue, but we can deal with this particularly because our system better handles any infrastructure noise because of our wide range of frequencies. Usually the noise is not on all frequencies. That means we can still connect useful data in looking at alternative frequencies.

To what lengths does Expert Geophysics go to translate the raw data it collects into a format that is easily interpreted by customers?
Our clients are looking for the geological answers, not just geophysical data. At Expert Geophysics we emphasize this part of our product offering because we do not only deliver the data, we also deliver the interpretation while working closely with geologists to help them better understand what the data means. We have expertise in both geophysics and geology, so we advise our clients to provide us with the geological information they have on the property we are surveying. We can then interpret the data, and provide them with the geological information they require. ■

There have been significant improvements in sensitivity and resolution, depth of investigation, and the interpretability of airborne geophysical data via robust analytical software.

Daniel McKinnon

President and CEO
MPX GEOPHYSICS

Can you provide an overview of the products and services MPX offers for mineral exploration?
MPX offers the most modern airborne technologies on both fixed and rotary wing platforms, as well as state of the art drones. We also offer full data processing and interpretation services. The technologies we work with include Magnetics, Radiometrics, Gravity, Time Domain EM (TDEM), VLF-EM, MobileMT, and LiDAR.

To what extent have technology and sensors used for exploration evolved over time?
Multi-parameter systems have evolved substantially. They allow for multiple mineral applications, and they help locate mineral deposits essential for the transition to a climate neutral economy. There have been significant improvements in sensitivity and resolution, depth of investigation, and the interpretability of the airborne geophysical data via robust analytical software. There have also been massive improvements in system power, noise reduction, and better target detectability. 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.

Multiparameter system sensors are rapid, low cost means of targeting areas of high mineral potential, which delivers overall risk reduction to drilling programs. There are four main geophysical methods: Magnetics, Radiometrics, Electromagnetics, and Gravity. However, there has also been significant technology innovation in airborne Electromagnetics, GNSS, Gradient Magnetics, and Drones.

What would you say are some of the most significant macro trends that are driving MPX's business?
With the increased demand for electric vehicles, batteries, and greener energy storage options, both exploration and funding for technology metals such as cobalt, copper, nickel, platinum group elements, graphite, lithium, rare earth elements and silver has increased which is driving our business to new levels of growth.

Do you view drone surveys as competition to MPX or is this an additional method MPX could use in the future?
For me, in 2022, UAV still have a very limited and specific application. They have improved over the last decade, but they are still not in a position where they are in competition with fixed wing or helicopter platforms. The UAV market does not replace what an aircraft or helicopter can do at this particular stage of the game. The limitations are cargo space, weights and measures, and duration. We do have a UAV LIDAR platform, and we are currently flying a survey in Manitoba and in LATAM. We only use this for very small, specific areas in part as some of these UAVs duration is limited to 20 or 60 minutes.

To what extent does MPX add value in processing and doing interpretation modelling?
One of the historical drawbacks that geophysics has had is that many geologists had not assumed the challenge of being trained to process and interpret the data resulting from geophysical acquisition. For this reason, those who have 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. This allows us to provide the client with real and adjusted geological information of the area. We have addressed this, and we have a group of professionals capable of carrying out the teamwork that provides the client with the added value in the processing and interpretation of the acquired data.

What are the key factors that differentiate MPX?
Rather than offering a technology we like to offer the solution to a particular client depending on the problem they are facing. It is a complex process, and there is not one technology or one discipline that you can do to find a particular mineral. We are results driven and committed to offering solutions, we are recognized for our customer service and full satisfaction. All our surveys combine not only our technology but our industry leading health and safety practices. We are known for our strong strategic partnerships with airborne vendors and suppliers, we supply superior efficiency in acquisition and product delivery, our team are all experienced and professionals. ■

> **The areas of mining in which DDC drones are well positioned to add value include sending a drone instead of people to do gas detection. The other application is in core sample extraction.**

Steve Magirias

CEO
DRONE DELIVERY CANADA

Which mining specific applications are DDC drones best suited for?
Drone Delivery Canada (DDC) has been working on a full logistics solution for years and continues to push technologies forward.

The areas of mining in which DDC drones are well positioned to add value include sending a drone instead of people to do gas detection. The other application is in core sample extraction. Instead of driving a truck down into the mine, you can send a drone with the payload and range to do that. It is a lot faster and a lot safer than driving all the way down into the mine. We believe an unmanned helicopter can do that task in the most efficient and cost-effective manner.

Can you provide an overview of the different drones DDC offers?
The first drone we developed was the Sparrow. It has a maximum payload of 4.5 kg and a range of 20 km. It is battery powered, which is beneficial from a cost and environmental perspective. We have primarily used our Sparrow to deliver medical goods and packages. We are currently working on the successor to the Sparrow, the Canary, which has the same payload, and range as the Sparrow, but has slightly better aerodynamic characteristics. The key improvement of the Canary is that it is equipped with a parachute. This takes care of the ground risk and allows us to fly directly over people which is something we are not able to do with the Sparrow. Once validated by Transport Canada, DDC will be able to take more direct flight routes. The Sparrow today has to avoid areas where people are located, for example, sidewalks, golf courses, parks, and the like. The idea with the parachute is that should something go wrong with the motors, the parachute deploys, and it brings the drone safely down to land.

The larger drone that we are working on is the Condor. It is based on a manned helicopter, but we have converted it into an unmanned version. It is currently in testing and development, and our goal is to have a range of 200 km and a payload of 180 kg and we anticipate key milestones to be achieved for the Condor in 2023.

In the event that a drone crashes, is that cost taken on by DDC, or is it on the mining company?
Today we own the drone; all the hardware is ours, and we manage it for our customers as a managed service. In the future, as drones become more mainstream, the ideal situation would be that we either sell or lease the hardware, license the software, and the mining company would operate and monitor the drones themselves.

To what extent does weather influence the capability of these drones?
Weather can definitely be a challenge. The Sparrow today has an operating window of -20 °C to 40 °C, and wind conditions can also pose challenges if gusts are above 20 Knots. The Canary has slightly better parameters, but we are still working to finalize those through final development testing. The Condor, being a much bigger drone, will perform better in windy conditions.

What are the keys to establishing product market fit?
Understanding what we have developed and how it can be leveraged within the mining industry overall is extremely important for us. Our priority is to continue advancing the technologies alongside our commercially available drones, as well as those that are still in development. There are always different pieces of information and technology that need to be added. Drones today are smart, but they are also dumb: a drone is programmed to fly its route. It is geofenced, so it does not go astray, but it will fly its route regardless of what is coming in its way. If a Cessna or a non-cooperative that you cannot detect is coming, with detect and avoid technology, the drone would detect that something is coming in its path. It would respond by stopping, descending, and then it would continue to scan until the coast is clear, before continuing its preprogramed path. That is the holy grail of the drone industry that everyone is working towards: getting beyond the visual line of sight. ■

Mining Equipment

Miners rely on innovative technology to maximize value

Image courtesy of Sandvik

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 attractive 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. 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.

Material Handling

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.

Weir Minerals is also betting on HPGR technology to reduce particles by compressing and crushing the feed between two parallel rollers with an adjustable gap. Rob Fawcett, managing director at Weir Minerals, outlined that with the technology, a very high percentage of the energy input reports to the material, making it extremely efficient compared to conventional milling circuits. Added advantages are less maintenance requirements and ease of operation. “I believe HPGR technology will become a go-to milling option for mining projects looking for energy efficiency and a competitive edge. Where HPGR technology has replaced traditional methods of crushing and grinding such as SAG or ball mills, customers have witnessed energy savings above 40% depending on the material,” he explained, mentioning that both Côté Gold and Greenstone are the first Canadian hard rock mining operations to introduce this technology in their process.

Incorporating ESG

Metrics such as the ones FLSmidth, Weir Minerals 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 operations 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.”

Underground Equipment

As mining operations are increasingly conducted at greater depths, various obstacles arise. Two of the most critical issues are related to air quality and energy consumption. Veteran technologist, and Maestro co-founder and CEO Michael Gribbons identified ventilation as the critical factor in managing those risks: “To start to control ventilation, you must monitor it first.”

Maestro’s new ModuDrives are a full digital system that allows real time data coordinate and control ventilation, resulting in lower energy costs. Gribbons points out that Maestro is getting RFQs all over the world. “Before companies did not care, they cared about productivity because in dollar terms, a 10% reduction in energy is not equivalent to a 10% increase in productivity. Companies always looked at productivity because energy had a small impact on bottom lines. That has now changed,” he said.

As a leading player in gas monitoring underground, Maestro has two key ecosystem partnerships with autonomous devices. One is with Exyn on their autonomous drones that can find their way around a mine. The other one is Boston Dynamics' Spot, the robotic autonomous dog. “The whole application is about getting data back to the face, and both Exyn and Boston Dynamics enable technology to go into places where there is no network. I see this foremost as a worker safety apparatus. If you have an explosion in a mine and the network is down, you can send in either Spot with a big payload, or you can send in an Exyn drone to get the job done quicker,” added Gribbons.

Howden’s Raphaël Pelletier, an account executive overseeing the Americas region, expressed optimism that, despite increasing technical challenges, underground mining can still be done safely: “Many mines have heat problems, but with proper ventilation, the heat loads can be managed to a certain point and help provide appropriate and safe working conditions for miners,” he said.

Howden supplies compressors, blowers, steam turbines, fans, rotary heat exchangers, and software solutions across various industrial end markets, mining being a crucial one. The company recently rolled out its Ventsim software suite, which includes a mining ventilation software that models the ventilation, cooling, and heating requirements based on mine design and scheduled production scenarios, which ultimately helps select the ventilation equipment required for the operation. Its Ventsim CONTROL offering is a ventilation control system that enables a mine to autonomously optimize fresh air distribution in real-time, adjusting the ventilation infrastructure based on airflow requirements, toxic gas concentrations, scheduled activities, or based on the location of personnel and engine status of the machinery. ■

Maestro is not interested in incremental improvement. We are looking at step change, and we typically do that by disruption. The type of disruption we pursue is about simplifying our products.

Michael Gribbons

President, CEO and Co-founder
MAESTRO DIGITAL MINE

Can you provide an update on the most significant events of 2022 for Maestro’s business?

We had two large new wins with Newmont and Yamana in Argentina and Dundee Precious Metals in Bulgaria. Overall, we are in 40 countries now, and our technology is in over 200 mines. We are also getting orders from unexpected markets like India, Denmark, and Norway. On the product side, we released our ModuDrive, which is an IoT actuator that is used on our MaestroFlex regulators to control the air to different mine levels. This drives out 30% of the capex using IoT technology. Similar to what we have done with our Vigilate, Zephyr and Marquee products, we are now doing on control devices. We also released the software for our Vigilante 2, and we grew at 15% YoY despite supply chain issues. Unfortunately, this was accompanied by a 40% increase in inventory, which was largely driven by the automotive industry's move from just in time manufacturing to inventory. We are paying 10-15x for microchips than we were previously. Another accomplishment is that we increased our engineering and software team by 30%, and we expect revenues to increase 20-25% in 2023. If we can get everything out the back door, revenue will be even higher, but we are still suffering from supply chain problems.

What are the keys to Maestro’s success in consistently introducing new technology into mines?

Product development is about predicting what the next phase of evolution is going to be. In that respect, you must understand the mining industry, and the new technologies that are available. You must then tailor those technologies for the industry. Maestro is not interested in incremental improvement. We are looking at step change, and we typically do that by disruption. The type of disruption we pursue is about simplifying our products. For example, we try to avoid adding a PLC, panel or any other associated pieces of software, or engineering services.

What products are driving the most revenue today, and what customer needs are they meeting?

It is an equal split between our last mile networking devices, and our IoT products, which are mostly made for ventilation monitoring and control. Looking at our network devices, in spite of this new shiny thing called LTE, people are realizing that the Plexus PowerNet can do all the things that they need it to do. That means increasing productivity and safety in an efficient and effective manner. The Plexus is low jitter, low latency, and high bandwidth, and this allows you to do tele-remote operations, which is the most burdensome application. The other aspect is our IoT devices for ventilation. Now we have our new ModuDrives which are a full digital system that allows real time data to come up and control ventilation, resulting in lower energy costs.

Can you outline the importance of your partnerships with Exyn Technologies and Boston Dynamics?

Maestro has two key ecosystem partnerships and both are with autonomous devices. One is with Exyn on their autonomous drones that can find their way around a mine. The other one is Boston Dynamics' Spot, the robotic autonomous dog. We are lucky to have been identified by both of these companies as being the ideal partner for technology and gas monitoring. The whole application is about getting data back to the face, and both Exyn and Boston Dynamics enable technology to go into places where there is no network. I see this foremost as a worker safety apparatus. If you have an explosion in a mine and the network is down, you can send in either Spot with a big payload or you can send in an Exyn drone to get the job done quicker.

How would you assess the overall health of the mining ecosystem in Sudbury today?

At Maestro we are currently trying to scale our business, but sending products out in tens of thousands rather than thousands is a very different challenge. The same old talent pool that we have had before in Sudbury is just not suited for high volume exporting. Instead, we have had to get people that have come into Canada and come from a manufacturing background. ■

New orebodies are more complex to exploit and are situated at greater depths. This creates new challenges because of higher temperatures. We are seeing that the number of ventilation engineering and mine cooling-related inquiries is rising.

Raphaël Pelletier

Account Executive - Americas
HOWDEN

Can you introduce us to Howden and outline the nature of your work in Ontario?
Howden has been in the industry for around 160 years and is present in 35 countries with over 6,000 experts. We supply compressors, blowers, steam turbines, fans, rotary heat exchangers, and software solutions across various industrial end markets such as power, energy & renewables, mining, and infrastructure.

In the Ontario mining sector, we support many clients and consultants through their pre-feasibility, feasibility and detailed engineering milestones all the way to the specification and supply of our equipment. Moreover, near Toronto, we have a plant where we manufacture the equipment we provide.

What is the importance of ventilation and heating systems in mines?
Because of the toxic gasses generated by blasting activity and diesel particulate matter (DPM) exhausted by equipment with diesel engines, ventilation is crucial to clearing the toxicity in the air and for miner safety. Moreover, many mines have heat problems, but with proper ventilation, the heat loads can be managed to a certain point and help provide appropriate and safe working conditions for miners.

As mines move toward electrification, what is the source of energy of the ventilation systems?
The source of energy for ventilation depends on the location of the mine. The fans normally run on electricity provided by the electric grid. However, if the mine is in a remote location, they may rely on their electricity through different methods - diesel generation being the most common. Regarding heating, mine operators typically use fuels to heat the air, but there is an increasing demand from our customers for electric heating.

What can you tell me about the digital solutions that Howden offers?
VentsimTM DESIGN is a mining ventilation software that models the ventilation, cooling, and heating requirements based on mine design and scheduled production scenarios.

Ventsim CONTROL is a ventilation control system that enables a mine to optimize fresh air distribution in real-time. It adjusts the ventilation infrastructure based on airflow requirements, toxic gas concentrations, scheduled activities, or based on the location of personnel and engine status of the machinery. All of this is achieved autonomously without human intervention.

Another digital solution that we offer is Howden Uptime. This digital platform pulls data like vibrations or temperatures from a Howden asset to make preventive decisions. Howden Uptime provides the foundation for preventive maintenance and enhancing operational performance, determining an asset's life cycle before any failure occurs.

What is Howden's strategy to help its customers meet their ESG demands?
One of the solutions we offer for companies to reduce their carbon footprint is Ventilation on Demand (VOD). With an optimized ventilation system that distributes the airflow more efficiently, companies can reduce the amount of heated air and, by extension, the use of fuels. Howden also has an engineering department that identifies heat recovery strategies, which are site-specific. The hot air the mines exhaust and the heat generated from the processing plants can be recuperated and reused for the heating system or other types of applications.

What trends are you seeing in terms of underground mining in Canada?
In Canada, easily accessible orebodies are depleting. New orebodies are more complex to exploit and are situated at greater depths. This creates new health & safety and operational challenges because the temperature underground increases as mines go deeper. We are seeing that the number of ventilation engineering and mine cooling-related inquiries is rising. Howden has engineered, supplied, and built mine cooling systems for some of the deepest mines in the world. Howden can provide end-to-end mine cooling and mine ventilation solutions on a turnkey basis to deep underground mines. ■

Tom Juric

Divisional Director
LIEBHERR-CANADA

Can you give a brief overview of Liebherr?
Liebherr is a sales and service company represented in almost every province in Canada. Our business supports several product lines, including our earthmoving, civil and construction arm, our all-terrain cranes, crawler cranes, and maritime cranes, and our mining arm. Our mining team is today approximately 50 people, up 50% from last year.

What are the main milestones the company has achieved over the last few years?
Liebherr managed to move out of our stronghold, the Alberta oil sands, and have successfully launched a product with Argonaut Gold who acquired a fleet of our dozers in mid-2022. We have also launched into aftermarket component sales, and have had significant success around the country with these products, including cylinders, swing bearings, and travel drives for large excavators.

What role is Liebherr playing in enabling the decarbonization of the mining industry?
We have partnered with Fortescue Metals Group and its subsidiary company, Williams Advanced Engineering, to adapt their battery technology into our haul trucks.

Liebherr has an electrification solution for all our excavators and trucks, and one is under development for our dozers. The challenge is the infrastructure burden placed on the mining houses, and the shortage of available renewable power in country in general. Batteries are only one piece of the puzzle and there are other technologies, such as hydrogen for example, that will form part of the patchwork quilt.

What role does automation and digitization play in Liebherr's business?
Our company's philosophy on automation is to operate on an open protocol. We are moving towards a very fluid situation, and we are participating in our area of expertise, together with others in their areas of expertise, to deliver what could perhaps be a better product than what an OEM could do on its own. ■

Stella Holloway

Vice President
MACLEAN ENGINEERING

What were some of the key events driving MacLean Engineering's business in 2022?
Some noteworthy projects this year include the Glencore Onaping Depth project and Canadian Malartic Odyssey fleet Battery Electric Vehicle orders. Successful launches of several new products such as our GR5 Grader and the expansion of our manufacturing footprint in Mexico have all been pivotal steps for growth and future success.

In 2023, a large focus will be on the development of our MacLean Learning Academy and our Command Center. We will finalize our plans to expand on our footprint in Sudbury Ontario by adding a large facilty aimed at the service and support of our customers in Ontario and Canada.

We will also continue building on our technolgy road map with advancements in Automation, Interoperability, Shotcrete scanning and our Next Generation Bolter.

Onaping Depth is a significant project. The future of mining in Sudbury is deep mining, and this requires battery electric equipment and other advanced vehicle systems to access these ore bodies. This ore body was only financially feasible when the advantages provided by BEVs was made possible.

Aside from supplying the equipment itself, MacLean will establish a training plan to ensure the successful transition from diesel over to battery electric. Our Research and Training facility has an underground test mine, which will provide a real-life mining environment where Glencore will have access to BEV equipment for hands on training.

How will the new heavy-duty ZEV tax credit encourage further adoption of BEVs in mines in Ontario?
While the the total cost of ownership for a BEV is already proving to be as good or better than a diesel unit, there is a higher upfront cost to purchase BEVs and the tax credit should help offset this to enough to help support mines to make the switch. ■

> The Tire Operations & Management System (TOMS) can track tire performance in real time. This enables us to compare results of different manufacturers, and assess how they perform at different times of the year.

Dave Allan

Vice President Canada
KAL TIRE MINING TIRE GROUP

What were some of the highlights for Kal Tire's business over the past year?
One of Kal Tire's most significant investments over the past year was our purchase of 17 GCR Tires & Service stores in Eastern Canada. This gives us exposure to three of the most prolific mining jurisdictions in Canada: Val-d'Or, Chibougamau and Wabush. It also marks a major expansion for a company whose success was rooted in the oil sands and Western Canada to a company with a coast-to-coast presence.

Can you provide an overview of Kal Tire's approach to recycling tires?
Kal Tire is an active participant in the legislative recycling program in Ontario for giant OTR tires. We also help customers in Western Canada recycle their tires through a shredding facility in Northern Alberta. In Chile, our investment in a mining tire recycling facility was driven by legislation from the government that said all tires need to be recycled in some fashion. To achieve this, Kal Tire went down the road of thermal conversion. This technology is very important to us because we are big proponents of a circular recycling of tires using thermal conversion. Thermal conversion is a much more circular option than just shredding. The shred is great, and it can be used as mulch, or other multi use products but at some point, it will go back into a landfill. With thermal conversion, the tire is converted back to its original components which can then be reused. It's a much more circular process. Moving forward, Kal Tire has signed a joint venture with Mitsui & Co. to identify opportunities to advance mining tire recycling solutions in a variety of countries.

Do companies invest in recycling solely due to regulatory requirements, or is it becoming a mainstay of ESG strategies?
We see a customer base that is interested in doing something with their tires to help achieve ESG goals. Kal Tire is determined to provide viable options for customers to help accomplish those goals. At the end of the day, legislation makes actions happen; however ESG and shareholder feedback also encourages companies to do the right thing, which is to not bury tires.

What are the ways in which Kal Tire adds value for customers?
Giant OTR tires are not simple. There are five-piece wheels, four piece wheels, and it is difficult to change tires. I believe that there should be a technical certification for tire technicians because it is a complicated and technical process. Changing tires is a specialized field, and we believe that we have one of the best training programs in the industry. Customers want to have a tire distributor that they trust. Therefore, we take a brand agnostic approach when it comes to what tire works best for the application. Having a tire distributor that is flexible enough to change tires, compounds, and sizes is where we think we provide substantial value to the customer. When it comes to how that tire is working, we have the technology of our Tire Operations & Management System (TOMS) to track tires in real time to see how they perform. This enables us to compare results of different manufacturers, and we can assess how they perform at different times of the year. We carefully watch the evolution of the tire to make sure that the customer is getting as many kilometers out of the tires as they should.

On the ESG side, we also have our Maple Program that gives customers actual and accredited data about the fuel and carbon emissions saved in choosing sustainable solutions such as retreading or repairs. At the foundation of the program is a carbon calculator verified by an international leader in third-party environmental certification so customers can use the data in environmental reporting.

How is Kal Tire leveraging Pitcrew.ai technology to help customers improve performance?
We've been able to create autonomous inspection stations that use the thermal imaging software of Pitcrew.ai. Cameras scan the tires of passing haul trucks and flag anomalies such as hot tires and tread and belt separations. That reporting is fed into TOMS, which automates work orders so a technician can inspect and repair that tire. ■

John Schellenberg

Mining Product Manager
HITACHI CONSTRUCTION MACHINERY

What challenges must be overcome in order to get industry to adopt electric haul trucks?
One of the challenges we have with battery technology today is related to onboard energy. With a typical haul truck, the fuel tank can run 24 hours. That is a lot of energy onboard, so when you think of a diesel engine as 40% efficient, that means 60% of the energy that they are carrying gets wasted. If we move to either hydrogen or electricity, in that same space and weight envelope, you can barely get 35 to 40 minutes of operational time with a battery in the heavier applications. There is 30 times the usable energy in a diesel vehicle compared to a battery. That is the magnitude that we must make up. It means we have to change how we think about moving these vehicles around, and that is why there is a huge push right now to develop high speed flash charging.

What expertise is Hitachi Construction Machinery leveraging to be a leader in the electric haul truck space?
We have been using a diesel trolley configuration for 50 years, so we have a pantograph that is similar to electric rail. There are overhead brushes that go up, and electricity is drawn from the overhead wires. When we are in high load areas or going up steep grades we have overhead wires in place, which allows us to draw power from an external power source. We can also split it so that we are charging the battery and driving the truck at the same time. If you can cover more distance or haul more material, without putting the energy through the battery, you are increasing your battery's life and consequently reducing your cost per tonne on material movement. ■

Iggy Domagalski

President and CEO
WAJAX

Can you provide an overview of Wajax?
Wajax was founded in 1858, and is one of Canada's longest standing and most diversified industrial companies. Mining represents 16% of our revenue, and we touch nearly all areas of the mining process including extraction, conveyors, crushers, grinders, and air, water and oil filtration services. Our capabilities enable us to provide full turnkey services ranging from work on motor gearboxes to repairing hydraulic cylinders and pumps. Specifically pertaining to open-pit mining, Wajax is the exclusive Hitachi representative in Canada, so we provide Hitachi shovels, loaders and trucks. For underground mining, we offer a suite of roof bolters, scissor trucks and boom trucks. We also have a business focused on servicing, fixing, and doing any other aftermarket services needed for engines and transmissions.

What are the biggest pain points Wajax alleviates for miners in Ontario today?
From our customer's perspective, climate change, carbon footprint, labour shortages and worker retention represent the most significant concerns. Workforce turnover presents a significant challenge because there are safety concerns as a result of lost institutional knowledge. Consequently, Wajax' customers now lean more heavily on our workforce to fill knowledge gaps. Wajax and Hitachi are both putting extra effort into hiring and relocating people into Canada to support our mining customers.

How do ESG concerns affect the product portfolio you offer to your clients?
We often see our mining customers thinking in terms of the broad picture. It might cost them a bit more to invest in electrical or more technologically advanced equipment, but they have certain environmental and sustainability benchmarks they need to hit. If they don't invest in these benchmarks, they risk losing license to operate, be it social license or actual operating license. It's about balancing the profitability of today versus the long-term viability of the whole operation. ■

John Davidson

North American Regional Head of Capital Sales
FLSMIDTH

Can you give an overview of FLSmidth and its role in the mining industry?
FLSmidth is a tier one multinational OEM focused on mineral processing and material handling. We aim to be the supplier of choice for the mining industry, providing pit-to-plant solutions. We provide innovative engineering, equipment, digital and aftersales services to the mining industry to improve performance, drive down costs, reduce environmental impact and unlock additional value.

We recently closed our acquisition of Thyssenkrupp's Mining business (TK Mining), which strengthens our 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, and optimizing water and power usage.

Do you believe that achieving ESG goals will come at the expense of higher costs for miners?
Although implementing innovative solutions can be expensive, there are incremental gains companies can make through optimization. For example, there are digital tools for the optimization of slurry pumps where you can keep the pump in an optimal spot at all times, so it does not have to spin harder and consume more power. FLSmidth's SmartCyclone technology targets the closed-circuit grinding process by using sensor monitoring to maximize process efficiencies. This results in less process downtime, optimization of the flotation feed, and maximized production. We also have our LoadIQ technology which allows for optimal mill loading and ensures customers are making the most efficient use of their grinding mill.

What do you see driving growth?
Over the last years, digitalization and data optimization have become key parts of our goal to deliver performance optimization to customers and to help them lower their environmental impact. ■

Rob Fawcett

Managing Director
WEIR MINERALS

Can you provide an overview of Weir Minerals?
Weir Minerals Canada comprises three business units, including hard rock mining (HRM), oil sands and comminution. We manufacture a broad range of mining equipment – Warman® centrifugal slurry pumps, Cavex® hydrocyclones, Isogate® and Delta Industrial® valves, Enduron® screens, Linatex® rubber-lined pipe and hoses, Enduron® high pressure grinding rolls (HPGRs), a wide range of TRIO® comminution equipment, Multiflo® dewatering products, GEHO® positive displacement pumps and our Synertrex® condition monitoring platform. We have a team of 320 people covering Canada providing comprehensive service and support close to our customers.

ESCO, a Weir Group company, operates as a separate division which designs, manufactures and services mission-critical equipment in the mining and infrastructure markets. Recent acquisitions include Motion Metrics and Carriere Industrial Supply. Motion Metrics is a leading Canada-based global mining technology business with a sophisticated camera system that provides particle size analysis and monitoring for shovels, conveyor belts, and haul trucks.

To what extent can better equipment make up for an aging workforce and declining skill levels in the industry?
The skill levels that we had 20 years ago are very different. On-the-ground operator knowledge has been lost for a multitude of reasons, and equipment suppliers have to help customers bridge this gap. Operations cannot afford unplanned maintenance or failures. Scheduled maintenances are planned to the last detail, with downtime built into the overall operating model, while unexpected downtime can cost hundreds of thousands of dollars per hour. Thus, the skill and knowledge to assist customers in operating and servicing equipment becomes vital to ensure reliability. With more active shareholder oversight and marketplace pressures, the margin of error is far less than it has ever been. The focus has shifted from simply maintaining equipment to how to extend the life of the equipment. In this way, skills have become a shared responsibility. ■

Drilling and Blasting

Technology inspires more viable deposits

Image courtesy of Marathon Gold

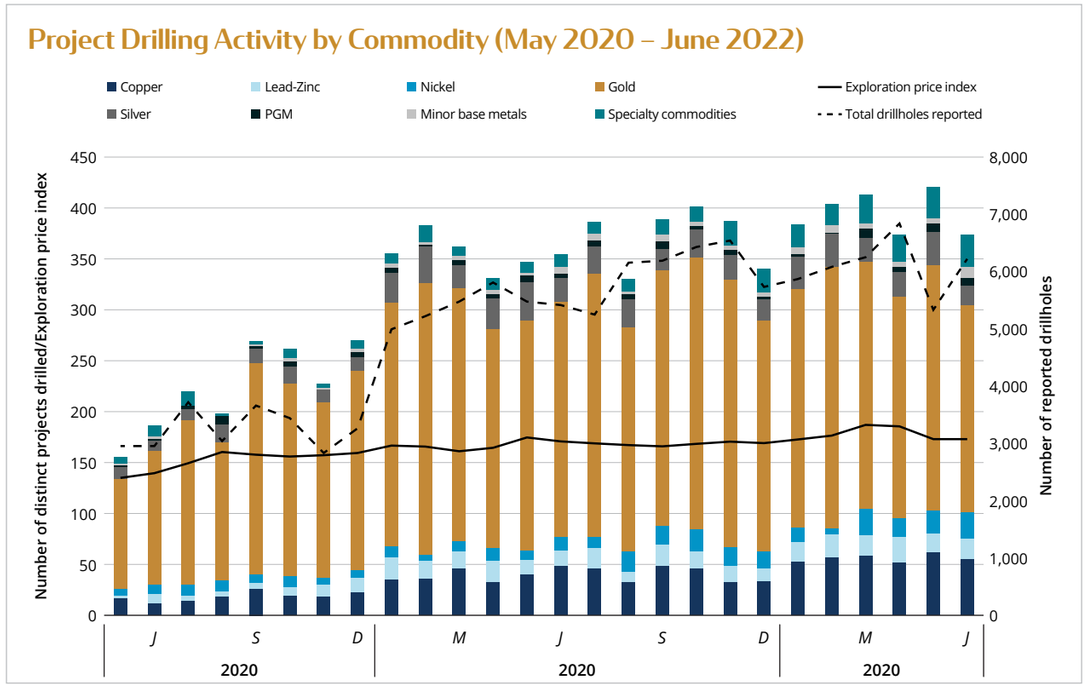
Drilling and blasting has long been a cornerstone of the mining industry. However, the technological advancements of recent times have brought about a significant evolution in the methods and equipment utilized in this process. An observer from the past would be astounded by the state-of-the-art machinery and sophisticated sensors that are becoming commonplace on equipment.

Demand for these services has seen a marked increase since the pandemic, as miners have boosted their exploration budgets and accelerated their activities in an effort to make up for a period of underinvestment. This has placed drill and blast service providers in a favorable, albeit challenging, position. The current shortage of skilled labor is a testament to the high demand for their services, with most, if not all, of the available rigs in constant use. Consequently, companies like Boart Longyear posted 1H revenue results unseen since the height of the previous bull market cycle in 2013.

Although drilling services make up 65-70% of its overall business today, Boart Longyear sees its fastest growth prospects in its segment technology business called Geological Data Services (GDS), which offers unique technology to the mining industry. In recognition of its work, Mines and Money recently awarded GDS Mining Innovation of the Year for 2022. GDS has two components: It offers downhole technologies, which includes core orientation and geophysical tools to gather information downhole, and on the other side of the business, they have a scanning technology that uses unique XRF technology that is calibrated by orebodies to produce a full elemental analysis of either core, or chips that are extracted from the ground to provide information to mining clients in a quicker, more accurate and far less expensive way than traditional methodologies. "As this technology becomes more accepted, you are going to see the ability to delineate ore bodies much quicker," noted Jeff Olsen, CEO of Boart Longyear.

An additional benefit, particularly for remote mining operations, is that the technology is highly portable. "We do not need to build any infrastructure, it is nondestructive to the sample, and we combine that with artificial intelligence to provide things like auto structural logging, which greatly reduces the number of geologists that need to touch the core," Olsen said.

Novamera is another company working to add to a mining company's toolset by developing enabling technologies. It's specific focus is to make surgical mining with conventional



Source: S&P Global Market Intelligence as of 5 July 2022. PGM = platinum group metals

drills possible. Novamera co-founder and CEO, Dustin Angelo, explained that in the first phase of its 3-phase Surgical Mining by Drilling (SMD) process, Novamera assists the mining company by deploying, via wireline, its near borehole imaging tool (NBIT) on a standard NQ size core rig down the dip of the vein to map the vein deposit in high resolution (up to 3 m in radius around the borehole), and calculate the optimal drilling trajectory using its proprietary algorithms. "Our data driven solution allows you to see a much clearer picture of the ore body unlike traditionally, where it would be cost prohibitive to drill conventional cross-cutting core holes at an equivalent spacing to achieve similar resolution," Angelo said.

The second phase is the extraction stage, where a conventional large-diameter drill armed with Novamera's course-correction device and positioning control system follows the trajectory path calculated by its imaging tool

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> Surface directional drilling has really helped Alamos because it brought down our costs. These are very expensive holes, and this technology enabled us to target the right depth with great accuracy. That is one of the key reasons why we were successful at Island Gold.
>
> **John McCluskey, President and CEO, Alamos Gold**

> **There is a huge economic benefit for companies to be able to get that incremental production, because they already have all the infrastructure in place, including people, permits and mills.**

Dustin Angelo

President, CEO and Co-founder
NOVAMERA

How would you define surgical mining?
Surgical mining is the use of conventional drilling equipment to be able to precisely extract ore from the ground while minimizing waste. Novamera developed Surgical Mining by Drilling (SMD), a 3-phase process, as well as the enabling technologies to facilitate the method. In the first phase, Novamera assists the mining company by deploying, via wireline, its near borehole imaging tool ("NBIT") on a standard NQ size core rig down the dip of the vein to map the vein deposit in high resolution (up to 3 m in radius around the borehole), and calculate the optimal drilling trajectory using our proprietary algorithms. Our data driven solution allows you to see a much clearer picture of the ore body unlike traditionally, where it would be cost prohibitive to drill conventional cross-cutting core holes at an equivalent spacing to achieve similar resolution. The second phase is the extraction stage, where a conventional large-diameter (approx. 2 m diameter cutting heads) drill armed with our course-correction device and positioning control system follows the trajectory path calculated by our imaging tool and extracts the ore using reverse circulation airlift assist. In the final phase, once the hole is open and the ore has been processed, the mining company will combine the tailings with cement to backfill the hole.

How can Novamera's technology help improve the economics of certain deposits?
Mining companies typically don't mine every tonne of ore out of their deposits because it is not economic to do so with the conventional mining method. If they have steeply dipping narrow vein deposits that are too complex or uneconomic to mine using conventional mining techniques, they can use our technology in a manner complementary to their existing operations to be able to extract more of their mineral resources. It essentially takes mineral resources and converts them to reserves. There is a huge economic benefit for companies to be able to get that incremental production, because they already have all the infrastructure in place, including people, permits and mills. Therefore, they can add to their bottom line far more efficiently and profitably using Novamera's technology.

Can you speak to the ease with which this technology can be integrated into an operation?
Because companies are not mining these resources using conventional methods, by definition, they are peripheral to the main operation of a project. Consequently, we are not disrupting the core operation, which is key when trying to introduce new technologies or innovative processes. We are off to the side, so companies can use this technology to unlock incremental production without risking the primary revenue stream.

What are some of the benefits of SMD?
SMD is a low capex method with relatively little development costs since you don't have a need for ramps, shafts, or portals, for instance. It enables a mining company to access ore quickly and has a lot of operational flexibility and scalability. Regarding ESG, companies create a smaller footprint because they minimize waste, generate less GHG emissions, and don't do any blasting. Finally, from a safety perspective, miners are out of harm's way because they sit on a drill above the surface, and do not have to go underground.

How would you describe Novamera's revenue model?
It's a Hardware as a Service model where we are selling to the mining company the enabling technologies that make surgical mining with conventional drills possible. We generate recurring revenue through our imaging service and the software that drives the imaging and smart drilling. Our second revenue stream comes from one-time sales of our course correction device and positioning control system, which are the key hardware components that facilitate the 'smart' drilling of the large diameter pile-top drill rig.

At what stage is Novamera in its development, and what kind of traction has it seen in the industry?
We are past the proof-of-concept stage and are now doing field demonstrations for customers. Currently, we are performing a demonstration in Canada and in Brazil where we plan to do a trial of our imaging tool followed by a smart drilling pilot. Our field experience will allow us to build case studies and proof points to better articulate the tremendous opportunity of surgical mining. ■

> **Technology applied to our services business means geologists can cut out mundane tasks like logging core, in order to spend more time understanding the orebody. That is more attractive to everybody and it opens up a very diverse workforce.**

Jeff Olsen

CEO
BOART LONGYEAR

Can you provide an overview of Boart Longyear in Ontario?
Ontario is a fundamental part of Boart Longyear's business, and we work with many companies on high profile projects throughout the province. Our company can be broken down into three key segments. First is our services business wherein we perform drilling of all types and specialties around the world. This segment drives about 65%-70% of our business. Second is our products business where we make the tooling consumables on the exploration and production side of drilling, as well as the capital equipment rigs that we sell to third parties and use in our own operations. That generates about 30% to 35% of our revenue. Our third segment is our technology business called Geological Data Services, or GDS, which is a rapidly growing part of our business that offers unique technology to the mining industry. In recognition of our work, Mines and Money recently awarded GDS Mining Innovation of the Year for 2022.

Can you elaborate on GDS?
There are a couple different parts of GDS. We have downhole technologies, which includes core orientation and geophysical tools to gather information downhole. TruGyro is the latest tool we introduced for this application in 2022. On the other side, we have a scanning technology that uses very unique XRF technology that is calibrated by orebodies to produce a full elemental analysis of either core, or chips that are extracted from the ground to provide information to mining clients in a quicker, more accurate and far less expensive way than traditional methodologies. The technology is highly portable, and we do not need to build any infrastructure, it is nondestructive to the sample, and we combine that with artificial intelligence to provide things like auto structural logging, which greatly reduces the number of geologists that need to touch the core. It also greatly improves accuracy, because you do not have the chain of custody problems that you might have when you move core around the world and have multiple geologists logging core from the same deposit.

How is Boart Longyear's embrace of technology helping it to attract a more diverse workforce?
One of the things that we are very proud of is the number of women drillers that we have hired. That is enabled by some technological progress we made in improving the drill rigs we use. Technology applied to our services business means geologists can cut out mundane tasks like logging core, in order to spend more time understanding the orebody. That is more attractive to everybody and it opens up a very diverse workforce.

What are some of the key challenges associated with drilling at depth?
There is a lot more expertise needed for deep drilling, particularly deep directional drilling. Boart Longyear offers that, and we also offer drill rigs that are capable of facilitating deep drilling. We have drilled several of the deepest holes in Africa with our equipment.

What will drive the exploration cycle moving forward?
The price of gold and copper always indicates how much exploration money is spent, and how much drilling gets done. We went through a significant downturn in the mining industry, and a lot of companies decided to reduce their costs by reducing their drilling and using their existing reserves to meet their production demands. That lever has been pulled for a number of years now. As we get into a bull cycle, you will see that dynamic driving activity, but you are also going to see the need for these companies to replace reserves that they have used over the last few years. If you look at the average reserves for gold or copper companies, they are significantly less than what they were 10 years ago. A gold company needs to have reserves to cover their production out years into the future, and I do not think 10 years does it. They used to approach 20 years, and I think that is a much healthier position to be in. ■

Denis Larocque

President and CEO
MAJOR DRILLING

Can you give an overview of the key milestones achieved by Major Drilling over the past two years?
Major Drilling has seen significant revenue growth, particularly in North America, because we have been able to grow our market share with many of the larger mining companies who are looking for higher quality services. We have also acquired McKay Drilling in Western Australian, which gives us access to a great mining market.

You mentioned that the current cycle is analogous to that of the early 2000s. What is the difference in Major Drilling's positioning as a company today versus then?
There is a huge difference. We came out of the downcycle in the early 2000s with a lot of debt on our balance sheet, and we had to play catch up in terms of upgrading our equipment, bringing people on, and restocking our inventory, which took us a while. This time around, through the downturn we had a very strong balance sheet which allowed us to keep our key people in place, invest in new equipment, and keep inventory on the shelves ready to go. This meant that the minute the cycle turned, we were out of the block ready to serve customers, which significantly helped in growing our market share.

Can you speak to Major Drilling's presence in Canada and more specifically in Ontario?
Major Drilling is one of the largest drilling companies in Canada. We are a major player in Ontario partly due to the acquisition of Norex that we made three years ago. Through this acquisition, we significantly grew our underground presence in Ontario, particularly in the Timmins and Sudbury regions. We also operate in major areas such as Red Lake.

How is Major Drilling positioned to help its customers explore at greater depths?
We have built our company and strategy on what we call specialized drilling. This encompasses deposits that are more difficult to access. Oftentimes they are deep, remote, high altitude, or deposits that are more technically challenging. ■

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and extracts the ore using reverse circulation airlift assist. In the final phase, once the hole is open and the ore has been processed, the mining company will combine the tailings with cement to backfill the hole.

The glaring opportunity Novamera recognized was that if a company has steeply dipping narrow vein deposits that are too complex or uneconomic to mine using conventional mining techniques, they can use Novamera's technology in a manner complementary to their existing operations to be able to extract more of their mineral resources. "There is a huge economic benefit for companies to be able to get that incremental production, because they already have all the infrastructure in place, including people, permits and mills. Therefore, they can add to their bottom line far more efficiently and profitably using Novamera's technology," Angelo commented.

Blasting

By spending a bit more on one process, a mining company can save significantly on their overall operation if they are able to see the overall value in a solution. In the case of blasting, this may mean choosing a more expensive but more performant explosive product or a different blasting technique that will ultimately help to reduce overall costs. "By spending more on one aspect of mining, we will make large savings down the line," said Paul Kuznik, DynoConsult manager - Canada at Dyno Nobel, adding that Dyno Nobel has proven that gassed emulsion and electronic detonators are the future of rock breaking. "Customers recognize that using these products is quickly justified by making huge savings on fuel, equipment wear and tear, and energy consumption at the crushers."

iRing started in 2003 after receiving a large IRAP grant with the mission to design software to help mining engineers design better blasts. The company developed its Aegis software to transform blasting operations into a controlled industrial process, repeatable and predictable. "The goal of this new tool is to help close the loop on the data side so that mining engineers can better understand the rocks they are trying to blast so they can design and utilize the energy of the explosives in a more efficient manner to produce consistent results every time," iRIng president Troy Williams said. Building on this capability, in 2023, the company plans to introduce a new geomechanics probe to help better characterize rock properties.

iRing's software helps companies produce reports that can be consumed by operations. With the current state of technology, some drills can take direct uploads from their software and can start drilling the holes automatically with minimal assistance. Getting blasting right can also have important implications on energy costs and GHG emissions:"If blasts can be designed to generate a consistent feed size, the mill has capacity that can be used to reduce energy consumption (and therefore related emissions) because it doesn't have to handle the variable feed size," Williams affirmed. ■

Farzi Yusufali

Co-Founder
STRATUMAI

Can you provide an overview of Stratum and its technology?
Stratum is a mining technology company that leverages deep learning to create more accurate resource models, using just the data a mine has, to produce a much more accurate resource model. This affects everything in the value process from de-risking development stage projects, all the way up to what a company is going to mine out next week, next month, next year, through to mine closure.

How does Stratum develop better models?
Mining data is not naturally compatible with machine learning; in fact, many groups in the mining industry have tried using conventional machine learning methods. However, my co-founder and I felt that there was a technical breakthrough that could be made where, if constructed correctly, our unique processing techniques and machine learning architecture allows us to take whatever mining data is available and extract the complex patterns in the deposit; namely just exploration and production data. If you have those two things, even though the data is sparse, it implicitly carries the geological patterns of the system and, therefore, can be used as is to extract the geological patterns of the system. It just requires a lot of work on the machine learning side to be able to ingest the data and extract something logical. From there, the next challenge was to deliver an outcome that is much more accurate than the best resource model created by the mining operation. ■

Paul Kuznik

DynoConsult Manager – Canada
DYNO NOBEL

Can you provide an overview of Dyno Nobel?
Dyno Nobel provides customer solutions through our people, products, and services. Dyno Nobel provides a full range of reliable explosives products and blasting services from a distribution network unmatched in the industry. Our R&D is focused on practical ways to use new technologies to benefit our customers, and the DynoConsult team supports and guides customers in better and safer use of our products.

How can blasting impact a company's financial performance, and how are you leveraging technology to improve blast efficiency?
By spending more on one process, we can save significantly on the entire operation. Choosing a more expensive but more performant explosive product or a different blasting technique may help to reduce overall cost. We need to have a broad view of the whole process and avoid seeing every step in mining as an expense and trying to reduce each cost individually. By spending more on one aspect of mining, we will make large savings down the line.

Dyno Nobel has proven that gassed emulsion and electronic detonators are the future of rock breaking. We have completed numerous tests and field trials that showcase our efficiency and value. Customers recognize that using these products is quickly justified by making huge savings on fuel, equipment wear and tear, and energy consumption at the crushers. ■

Troy Williams

President and CEO
IRING

How will iRing's Aegis software improve advanced blast modelling?
The understanding of the material miners are trying to blast is not sufficient enough for advanced blast modeling to work correctly. The goal of this new tool is to help close the loop on the data side so that mining engineers can better understand the rocks they are trying to blast so they can design and utilize the energy of the explosives in a more efficient manner to produce consistent results every time. Essentially transforming the blasting operations into a controlled industrial process, repeatable and predictable.

How will better blast outcomes improve carbon footprint?
Better blasting can reduce the environmental impact of mines. Blasting is the most efficient way to break rock. The most expensive and environmentally unfriendly processes is the milling process, which takes a tremendous amount of energy to break rock into smaller rock. Blasted rock is pre-condition (micro-fractures) and is usually easier to grind. If blasts can be designed to generate a consistent feed size, the mill has capacity that can be used to reduce energy consumption (and therefore related emissions) because it doesn't have to handle the variable feed size. ■

Make Your Pitch

On Efficiently Lighting Underground Mines:

"If a typical mine is using the standard lightning system they have been using for decades, they can see an 80 to 90% reduction in energy consumption by switching to our LED strip. We look at lifecycle costs, so our initial cost might be 10 - 20% higher than a standard system. However, there is a clear payoff over time, because standard lights are typically replaced every six months, as opposed to every five years with x-Glo's LED strip lighting."

Don Bertrand, General Manager, x-Glo North America Inc.

On Underground Surveying:

"The specialized Miner Operated Survey System (MOSS) is a machine control guidance system for underground mining. MOSS superimposes the mine design on the rock face, providing the miner with the line and grade direction and the complexity of the rock formation, letting them know where to drill. By combining Leica Geosystems' hardware with MOSS software, we can create a 3D picture of the mine that miners can visualize in an augmented reality space."

Bruno Lalonde, President, NSS Canada

On Drones Used in Mining:

"The areas of mining in which DDC drones are well positioned to add value include sending drones instead of people to do gas detection. The other application is in core sample extraction. Instead of driving a truck down into the mine, you can send a drone with the payload and range to do that. It is a lot faster and a lot safer than driving all the way down into the mine. We believe an unmanned helicopter can do that task in the most efficient and cost-effective manner."

Steve Magirias, CEO, Drone Delivery Canada

"Drones can be seen as a low cost helicopter or airplane suitable for airborne surveying. Sensors on drones can collect data that can be useful for exploration. A camera for photogrammetry or LiDAR sensors can collect data on topography or the visualization of potential veins or outcropping. In the drone space, you can use all types of different sensors to provide different data that mining professionals can then leverage."

Graham Anderson, Regional Manager Business Development, Volatus Aerospace

On a New Engine Architecture for Diesel Generators:

"There are a lot of mines that have grid access, and they will try to make use of electrification as much as possible. But there are a lot of scenarios that are off grid, and have very heavy dependence on large megawatt scale diesel generators, and their fuel operating costs are very high. Our engine can have a huge impact in applications like that. Remote locations also suffer from additional cost and difficulty to deliver diesel fuel to the site, so it is even more of an advantage to have a generator that can run on multiple fuel types."

Kyle Faller, Co-founder and CEO, Intelline

ENGINEERING, CONSULTING AND CONSTRUCTION

"Ontario is the engine room of the Canadian mining industry, and it will keep being that."

Zimi Meka,
Co-founder & CEO,
Ausenco

Image courtesy of Technica Mining

Engineering, Consulting and Construction

Market challenges necessitate business evolution

Image courtesy of Novamera

Ontario's reputation as a jurisdiction where companies have consistently delivered successful projects has made it a top destination for contractors. As a result, competition in the province is intense as businesses strive to secure contracts and establish a foothold in the market. From the mining company perspective, the expertise EPCM's offer is another factor that makes Ontario an attractive location. Ultimately, the knowledge and experience that contractors and consultants bring to the table increases a miner's chance of success in managing budget and schedule, and enables companies to continually reconsider pathways to optimization as assets mature. This is key in maintaining operations that function profitably over long periods.

Zimi Meka, co-founder and CEO of Ausenco, which has expanded into the Ontario market, and has the EPC contract on Argonaut's Magino project, observed that raising finance on the junior end of the client base has been increasingly difficult, especially in the latter half of 2022. Nevertheless, good projects are progressing despite capital being more expensive. His perspective on future projects in the province: "Ontario is the engine room of the Canadian mining industry, and it will keep being that."

Optimizing and Innovating Underground

As companies go to increasing depths to mine, this presents an opportunity for contractors specialized in that space. Technica Mining, Cementation, Redpath Mining, Dumas Mining and DMC Mining Services each have a strong 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."

Redpath sees a promising future underground and is already exploring ways to boost the safety profile of a mine by 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.

Cementation also has a core competency in shaft sinking, and is currently sinking one of the deepest shafts in the Sudbury Basin. In outlining the advantages of shaft sinking, Cementation managing director Eric Smith noted: "Depending on orebody depth and size, constructing a hoisting shaft is a bit more capital-intensive upfront versus using diesel trucks to haul ore to surface, but over time, less energy is required for hoist haulage and it carries a lower carbon footprint. Using a shaft or other haulage solution that relies on electricity can be greatly beneficial to our clients in the long run."

Dumas Mining distinguished itself for its work on The Hudbay Lalor mine project after being awarded the sinking of the main production shaft in 2011. The company successfully executed the sinking of a 1,000 m deep, 6.7 m diameter, concrete line production shaft, which was completed in 2014. Because of the quality work Dumas demonstrated, it was contracted to return to site in 2016 to assist Hudbay in mine development, mine production, and several other mine construction and infrastructure projects. "One of the things that stands

out from that project, outside of all the mine physicals we achieved, is the relationship and the supporting contract structure. It is truly a testament to how a mine owner and a mine service provider can work in complete unison realizing a one team approach," said Jeff Huffman, president and COO of Dumas Mining, which is now majority owned by STRACON.

Contract Labor

While the technical achievements are deservedly celebrated, Huffman's observation is that one of the biggest threats to the industry in recent years has been the skilled labor shortage. As a contractor, Dumas is often looked upon as a feeder of skilled workers to operating mines, and as demand for workers continues to outstrip supply, the company finds itself in an increasingly competitive environment. "We are specialists in recruiting, and we have a high skillset for training. We also own a lot of mining equipment, but we do not own a mine," explained Huffman, who went on to speak of the added issue that the large cost associated with training poses. "Training at the levels and the quantities required to feed this industry for the future is going to be a huge challenge. There are thousands of jobs that are going to be required to feed projects coming online," he said.

Pierre Julien, president of DRA Americas at DRA Global, which completed the Kamoa-Kakula mine in the DRC this past year, and has grown its Americas presence from about 45 employees four years ago to over 350 employees today, conveyed that from a human capital perspective, the mining industry is putting in the effort to engage society. However, more needs to be done to increase the flow of people into mining specific sectors. "One suggestion is to fast-track immigrants with specific mining area capabilities through the process if they commit to working in mining. The other suggestion for getting our own Canadian students into mining programs is to offer them student loan forgiveness if they work in the mining industry for three years following graduation," Julien offered.

Best Practices

When it comes to best practices at a mine site, it is exceedingly clear that in the current market companies must be careful in how they manage risks. Cementation managing director Eric Smith's advice to companies contemplating projects to develop or build mines is that they must have a sound understanding of the risks, and then be realistic about putting contingency against those risks. "There is the temptation to "goal seek" a project budget to align with pre-determined finance limitations. However, this leads companies and contractors to leverage themselves on committing to project budgets and schedules that are difficult to achieve."

Exploring New Models

Sudbury-based Technica Mining began with the goal to be the best contractor in underground infrastructure and construction with a specialty in planned and emergency plant maintenance, but continues to evolve with respect to offerings and contracting models. Technica Mining CEO Mario Grossi recalled: "We hit a pivotal point in 2010 when we realized that we needed to add mechanized development into our suite in order to be a full-service underground mining contractor," he said. Today, the company has expanded to approximately 400 employees, with additional offices in Timmins, and Val d'or, Québec.

Much of this growth came from executing large-scale, complex planned and unplanned plant maintenance shutdowns. "Millions of dollars a day in revenue are put on hold when mines shutdown production to work on their ore handling systems (grizzlies, ore passes, chutes, conveyors, loading pockets, shafts, headframes etc.) and every minute counts. We have consistently delivered these highly technical and very complex projects ahead of schedule and on budget," Grossi commented.

Today, Technica is in a position financially to help juniors with alternative financing models. Grossi explains that he identified a gap in service offerings for the transition from junior exploration to advanced exploration bulk samples, and then into early-stage production. This gap came in the form of either knowledge, skills, and experience, and or money, and sometimes both. "We have a fantastic in-house geologist, which is rare in the contractor world. He evaluates junior mining projects that have good potential to move forward into production, and we then offer our services with the option of our fees being paid through equity. We realized that this model works really well when used with extreme discipline, and has been a fantastic tool to help take Technica Mining to the next level," Grossi highlighted.

Consultants Mitigate Financing and ESG Risks

The mining industry is well known for being extremely capital intensive, but as inflation has taken hold and borrowing costs have risen, it is now even more difficult to obtain the financing. necessary to continually hit milestones. This, coupled with the issue of needing more mines to come online in an expedited manner to fill looming supply gaps, has necessitated a rethink around business and partnership models.

EY mining and metals leader for the Americas and Canada, Theo Yameogo, observed that while talks of new business models have been commonplace for years, they are now seeing rapid adoption. These changes are being manifested in the form of clients migrating across the value chain. Yameogo points to the example of a traditional nickel concentrate company that is building a battery grade nickel sulphate plant in Québec to supply an automotive company. There was also a 50/50 joint venture that was recently created between a gold mining powerhouse and a base metals major, with the gold mining company sharing its development and operating experience in the region, in return of a 50% ownership. Yameogo even noted that he is seeing mining companies taking stakes in technology businesses, because they realize they need to branch out and anticipate the next waves of value creation. "Another area in which we expect to see massive change is indigenous involvement in mining. Though it is not new, we expect tremendous improvements to the consultation, collaboration and integration models. We expect the partnerships to be deeper with increased levels of trust," he added.

In explaining his macro view, Yameogo expressed that he believes there is a reluctancy to make the same mistakes of previous cycles, which means companies will need

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> We have got the completion of Argonaut's Magino project happening in the first half of 2023, we will keep going on Treasury Metals feasibility study on Goldlund, and overall, there is some great exploration happening in the province.

Zimi Meka

Co-founder & CEO
AUSENCO

What are your general observations on Ausenco's performance in 2022?
2022 was a record year for Ausenco. We will have done just over a billion dollars (AUD) of revenue this year, all achieved through a very busy backlog of work and by taking market share. I am confident that we are well positioned for 2023.

What environmental initiatives are most feasible in helping mining companies achieve their ESG targets?
Pit-to-port energy usage in mining is significant. Simply grinding the ore pre-processing accounts for about 2% of the world's CO_2 emissions. The challenges are going to be around how we reduce energy consumption on the processing side, and with grades falling, companies are having to grind more rock without any mineral in it. Preconcentration and coarse particle flotation will come to the fore, where companies will not necessarily have to grind as fine, and they will reject material that is non mineral bearing.

The other issue to consider is with respect to water reduction, specifically around tailings. Looking at filtration of tailings, we are seeing a lot of work done in dry stacking, where you filter tailings, recover the water, and stack a dry tailings product. This is better environmentally and geotechnically, it's safer, and at the same time helps recover water, which is a cost saving.

There is a lot of work being done around electrification of mining trucks, and I think there is going to be a lot of enhancements in that area. Finally, with bulk materials, here in Australia, coal and iron ore are typically transported to ports by diesel train. There is a lot of work being done to use electric trains.

Given rising interest rates many companies are considering a bootstrapper model to get to cash flow quicker. Do you feel this is an appropriate model given the current environment we are in?
Capital is key, so the way we have been taught is to bootstrap and expand later. Companies should see how much money they can raise, work back, and use that to inform their development plans. If they can get the project up and running, bootstrap cash flow and then do a stage two in 2-3 years' time, increase tonnage or do more exploration, they are off to the races. Some of the great mines in the world have started this way. Projects that began with a five-year life turned into a 50-year life, and they never would have gotten off the ground if they considered it a 50-year project initially.

To what extent are inefficient permitting processes dissuading investors from allocating capital into mining projects?
You can have a list of economically viable projects, but it can take between five and seven years to get a permit. We are working on a lot of projects, in particular in Canada, where permitting is a holdup. When permits do come through, there are often numerous conditions that must be reviewed. There must be some methodology to expedite this process, so companies know early on what they are dealing with.

What is Ausenco looking forward to in Ontario in 2023?
We have got the completion of Argonaut's Magino project happening in the first half of 2023, we will keep going on Treasury Metals feasibility study on Goldlund, and overall, there is some great exploration happening in the province. Ontario is the engine room of the Canadian mining industry, and it will keep being that.

Ausenco has been named one of Canada's Top 100 Employers for Young People in 2022. What does this say about the culture you have developed?
We received that award in Brazil, Peru and Canada. Over the last six or seven years, we have put a major focus on supporting graduates and young professionals. We have a well-developed graduate program where we hire from various universities globally for two years, and then progress these graduates into our young professionals program. Our young professionals and graduates are very dynamic groups here at Ausenco, and every time we survey them, they score very high in terms of their engagement with the company. We promote from that group quite heavily, and we get great results. ■

Pierre Julien

President – DRA Americas
DRA GLOBAL

Can you give a brief overview of DRA Global over the past year?
In 2022, DRA successfully completed many projects and studies including the large Kamoa-Kakula mine in the DRC.

DRA Americas have transitioned from a company predominantly working on studies to now being a company executing a number of projects in Canada, Mexico, US and South America.

What is the nature of DRA Global's work in Canada, specifically Ontario?
In Ontario, DRA Global's Toronto office is leading a large number of NI 43-101 compliant studies for TSX(V) based development companies who are advancing projects. In Toronto we have invested in building a depth of capabilities around process simulation and the deployment of innovative process technologies such as CPF (Course Particle Flotation). Earlier in 2022, we were awarded a contract to work on Foran Mining's McIlvenna Bay project in Saskatchewan, the first carbon neutral mining project in the world. Our Toronto and Montreal offices, are also executing the Nemaska lithium project in Québec.

Has the definition of what constitutes a viable project shifted in the past five to 10 years?
From an economics perspective, no. What constitutes a good project economically has not changed. There are however innovative technologies today which optimize the extraction processes and impact a project's economics. Coarse particle flotation is one area in which DRA has gained significant expertise, but companies first want to see proven results before adopting these technologies due to their capital intensity and risk.

What can be done to speed up the process to get more mines into production?
To advance projects through the PEA-PFS-FS stages requires access to capital for development. A second challenge is the availability of talent. Thirdly, the efficacy of permitting needs to be optimized. ■

Paul Healy

President, Americas
REDPATH MINING

Can you elaborate on Redpath Mining's business model, and what services are currently most in demand from the market?
Redpath Mining is exclusively an underground contractor. We provide engineering services and design work for infrastructure that we end up building. We do a significant amount of tunneling and lateral development work, different types of vertical excavation, as well as underground contract mining. Ultimately, our business is driven by the demand for metal. As mining companies need to increase their capacity, they will call on us to develop a new ore body or to supplement their crews. A lot of the work we do is essentially building the mine prior to it going into production.

How have inflation and supply chain issues impacted work on the ground?
The price of steel has risen, and steel lead times have been stretched due to availability. Mobile equipment such as loaders and trucks are suffering the same issues, as the automotive industry is starved for microchips.

To what extent have elevated commodity prices over the past two years helped push projects forward into construction?
Although there are new projects coming online, there are also projects being pushed out. We have experienced this through being awarded work expected to start in March of 2023, but the projects are now been pushed to January 2024. People are cautious in this current environment and want to see things stabilize before making significant investments.

Can you highlight some key projects Redpath has been involved with in Ontario?
Redpath has essentially done all the underground development and construction for Vale's Voisey's Bay in Northern Labrador, and we just completed shaft refurbishment at Vale's Copper Cliff mine in Sudbury. We also work on Glencore's Raglan mine, Agnico Eagle's Macassa mine in Kirkland Lake, and on basically all the Newmont properties in Canada. ■

We are investing in safety and moving from reactionary safety to predictive and preventative safety. The mining industry is extremely careful around safety culture compared to different industries, and I am proud to play a part in helping to improve mine safety.

Mario Grossi

CEO
TECHNICA MINING

In 2020, Technica Mining announced the company's new surface mining and drilling department. How has this business developed over the past two years?
I found that there was a real gap in service offerings for the transition from junior exploration to advanced exploration bulk samples, and then into early-stage production. There was a gap of either knowledge, skills, and experience and/or money, and sometimes both. Technica Mining realized that we can bridge that gap.

We have a fantastic in-house geologist, which is rare in the contractor world. He will evaluate junior mining projects that have good potential to move forward into production, and we would then offer our services with the option of our fees being paid through equity. We realized that this model works really well when used with extreme discipline, and has been a fantastic tool to help take Technica Mining to the next level. In that journey, we discovered that some of the advanced explorations were also open pit, and we did not have that expertise. That was the real driver behind the company getting into the open pit business.

Can you highlight some case studies in Ontario to illustrate the work Technica Mining is doing?
On one project, Technica Mining is offering a unique hybrid form of contracting where we take on all the project cost and scheduling risk, and we do not get paid until the product is delivered. This creates a strong incentive for us to care about the project, and not the contract. Consequently, we have an engaged workforce. Our adaptation of technology is also beyond any other mine contractor in the country, if not the world, and the amount of digital integration that we are using in our work allows us to step away from reactionary safety into predictive and preventative safety. With this project, we are proud to show not only the KPIs we meet, but we can actually document the cultural engagement of the workforce.

How does the move towards electrification impact Technica's business?
The mining industry's leadership and initiative to move away from fossil fuels and go battery electric is transformative. The safety benefits of not running diesel engines deep underground are also phenomenal for the workforce – the air is better, which improves health and safety. As a contractor, we do not really see the net benefit or end value of battery electric equipment, but rather see the value in the savings of mine design from a ventilation and safety perspective. This is changing how contracting is done. For example, instead of us bringing in the big battery electric LHD's and Trucks, where we do not get any trade off value or any benefit value, the owners are providing the capital equipment. Now, when our work is done, the equipment is already mobilized underground, and they can continue on. The move towards electrification continually challenges people's mindsets, and also gives a new sense of purpose for mining.

What are some of the technologies that Technica Mining finds most useful and are considering integrating?
Over the past three years, we have been adopting a platform that allows our workers to go home safe every day; Sofvie. We are investing in safety and moving from reactionary safety to predictive and preventative safety. The mining industry is extremely careful around safety culture compared to different industries, and I am proud to play a part in helping to improve mine safety. Companies are also on a journey to go digital, and Technica Mining is at the forefront of this journey, as we are utilizing data in a manner that allows us to gain insights we never knew existed in times when we relied solely on our gut instincts and experience. Now we conduct vigorous data analysis, and we are in the early stages of applying machine learning and artificial intelligence to good small data to start identifying trends in safety. With the use of this new digitized platform, we are able to take all the data, make predictions, and then prevent accidents from happening. ■

One of the key things is the relationship and the supporting contract structure. It is a testament to how a mine owner and a mine service provider can work in complete unison realizing a one team approach.

Jeff Huffman

President and COO
DUMAS MINING

Can you provide an overview of Dumas Mining?
Dumas was founded in Timmins, Ontario in 1994. Leading into the 2000s, the company experienced rapid growth expanding into Québec and other parts of Canada, as well as US. After strategic investment by private equity in 2008, Dumas took on work in Mexico, Guatemala and Peru. In 2018 the majority stake in Dumas was purchased by STRACON, a surface mining and construction company based in Lima, Peru. Dumas's core competencies are underground lateral mine development, vertical mine development using mechanized raise climbers, underground mine construction, and shaft sinking.

How has STRACON's involvement helped to bolster Dumas's offering?
In 2022, we have commenced an increasingly aggressive approach towards bringing the companies closer together. This means taking Dumas's North and Central American specialized underground skillsets and pairing it with STRACON's surface mine building experience across South America. We see that as being the perfect combination for synergistic and accretive growth over the next decade.

Can you highlight a case study in which Dumas has delivered a positive outcome for a client?
The Hudbay Lalor mine is a great recent example. We mobilized to site in 2011 when we were awarded the sinking of the main production shaft. We successfully executed the sinking of a 1,000 m deep, 6.7-m diameter, concrete line production shaft, which we completed in 2014. We returned to site in 2016 to assist Hudbay in mine development, mine production, and several other mine construction and infrastructure projects. One of the key things that stands out from that project, outside of all the mine physicals we achieved, is the relationship and the supporting contract structure. It is truly a testament to how a mine owner and a mine service provider can work in complete unison realizing a one team approach.

We executed upon a commercial structure that targeted less administration with respect to contract change, less confrontational or adversarial-type realizations that in some instances come with competitively bid contract arrangements for mining projects. We replaced all this with a structure that aided us in aligning our goals. This is the difference between relationship and absolute partnership.

How has Dumas contributed to Torex Gold's ELG operation in Mexico?
Every meter of underground mine development that has been established at Torex in their ELG complex has been done by Dumas. We are currently excavating over 900 m a month of high quality mine development and we are doing so with an industry leading safety record. The crews at Torex just surpassed four and a half years with no lost time injury. The other thing to be said about the Torex project is that it is a fantastic example of how a Canadian-based mining contractor and a Canadian-based mining company can partner together to work in a remote area such as Guerrero, Mexico. We are proud to support the surrounding communities and improve the quality of life for many through community investment. Following the lead of an extremely ESG-focused team at Torex makes it easy for Dumas to follow suit.

What are the biggest challenges contractors face today in Ontario?
The skilled labor shortage that continues to affect everyone in this industry. As a contractor, we are often looked upon as a feeder of skilled workers to operating mines, and as demand for workers continues to outstrip supply, we find ourselves in an increasingly competitive environment. We are specialists in recruiting, and we have a high skillset for training. We also own a lot of mining equipment, but we do not own a mine. There is also a large cost associated with training. Training at the levels and the quantities required to feed this industry for the future is going to be a huge challenge. There are thousands of jobs that are going to be required to feed projects coming online. What is required is getting all of the stakeholders contributing to one plan on a provincial or national level that solves the issue long term and encourages sustainability in our industry. ■

> **Ontario has one of the highest densities of expertise in underground mining out of any of the jurisdictions we work in.**

Eric Smith

Managing Director
CEMENTATION

What were some milestones achieved by Cementation in 2022?
This year, we are achieving record levels on revenue and also have record levels of employment due to the increased demand for our services.

We have been fortunate to work with some tier-one clients in Ontario that have stayed committed to sustaining their capital projects.

Which technology is Cementation finding to be most impactful for its business?
We are currently partnering with a client to test the use of battery electric equipment, and as the technology evolves, we will transition our fleet of mobile equipment from diesel powered to battery electric.

One of our core competencies is shaft sinking. Depending on orebody depth and size, constructing a hoisting shaft is a bit more capital-intensive up front versus using diesel trucks to haul ore to surface, but over time, less energy is required for hoist haulage and it carries a lower carbon footprint. Using a shaft or other haulage solution that relies on electricity can be greatly beneficial to our clients in the long run.

Today, data has significant value and is becoming a commodity. Cementation has been working with software providers to enable us to obtain instantaneous information, analyze the information, and make better decisions on safety, operating efficiency and continuous improvement.

What advice would you give to clients on how to mitigate key risks?
A unique risk to underground projects is that excavations are made in natural rock, which can have a lot of variability (unlike concrete, steel and other building materials). Cementation has a wealth of experience in overcoming challenging geotechnical conditions, and we work with our clients to proactively identify and mitigate these risks.

Another unique challenge to underground projects are the logistical constraints. There is limited access to the work face, and limited space to work in. It is very difficult to add resources to speed up the work. As a result, the work is very linear, and if schedule time is lost, it is difficult to make it up. Cementation has very robust management systems, including short interval control, which manages the work at the face on a minute-by-minute basis to ensure that the work is progressing to schedule, and any delays are quickly identified and managed.

There is the temptation to "goal seek" a project budget to align with pre-determined finance limitations. However, this leads companies and contractors to leverage themselves on committing to project budgets and schedules that are difficult to achieve. The risks must be identified and understood, and contingencies made for those risks. Prior to a project commencing, Cementation works with our clients to identify potential risks and mitigations. Once the project has started, we transparently manage our project performance and partner with our clients to quickly identify and mitigate risk events as they occur.

What makes Ontario an advantageous location to develop a mine?
Ontario has one of the highest densities of expertise in underground mining out of any of the jurisdictions we work in. Mining is very well entrenched in Ontario, and there is a realistic understanding of the mining industry's role in supplying minerals that are needed for the development of society. Government and industry are working together to ensure that mining is done in a safe and responsible manner.

Mines are becoming more complicated and going deeper underground. How does Cementation's capacity fit well with this trend?
We are currently sinking one of the deepest shafts in the Sudbury Basin, and it is a great accomplishment because there are rock stress, heat, and logistical challenges associated with getting people and materials to the work face. With our strong engineering team, as challenges come up, we can design solutions to ensure that we can continue the work safely and efficiently.

What is your long-term vision for Cementation in Ontario?
We want to be the mining service provider of choice. Globally and industry wide, there is currently a shortage of talent and expertise, and this is an opportunity for Cementation to provide our expertise and skilled workforce to mine owners. We aim to build long-standing relationships with our clients and support them with their projects along the entire value stream. ■

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to learn to do more with less. "Boards and management continue to show some restraints on flashy acquisitions or mega projects... The industry is taking a prudent approach when it comes to pursuing growth in today's market," Yameogo said.

For companies like Ausenco, the idea of doing more with less comes naturally, because, as Zimi Meka, the company's co-founder and CEO highlights, the ore bodies in their home country of Australia, in particular those containing gold, have not been as rich as they are in North America or parts of South America: "Capital is key, so the way we have been taught is to bootstrap and expand later," adding: "Companies should see how much money they can raise, work back, and use that to inform their development plans. If they can get the project up and running, bootstrap cash flow and then do a stage two in 2-3 years' time, increase tonnage or do more exploration, they are off to the races. Some of the great mines in the world have started this way. Projects that began with a five-year life turned into a 50-year life, and they never would have gotten off the ground if they considered it a 50-year project initially."

Another feature of being capital constrained is that many mining companies, particularly juniors, are not able to hire the full range of professionals they need. Instead, they augment their teams by hiring firms like Ronacher McKenzie Geoscience that provide a full range of services from helping a client determine where to stake to the point where a company is ready to estimate a resource. According to Jenna McKenzie, the firm's co-founder and principal geophysicist: "The long time it takes from targeting to mining is a huge issue, and we want to help in terms of the efficient targeting portion. We can bring all the data together to make sure a company is going after the right targets, instead of rushing to drill where it has always drilled without a thorough understanding of the results."

Her fellow co-founder and principal geologist, Elisabeth Ronacher, added: "The other pain point is that investors have a very short attention span. Consequently, companies are driven to publish news constantly without taking the time to reflect and maximize the value of each data set they collect."

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 auditing the upgrades on Vale's tailing's dams, thereby helping ensure that these facilities are safe and stable. In Canada, SLR does the engineering for new facilities, but also does 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 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 Containment, 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 Environmental Containment president Juice Lambert points out.

Illuminating Environmental Threats

Environmental concerns in the mining industry are multidisciplinary, which is why Ecometrix Incorporated CEO Bruce Rodgers has compiled a diverse team of scientists to interrogate issues from multiple angles. In his words: "Although a portion of our work was related to geochemistry, you cannot understand the geochemistry and how it fits into an environmental assessment without understanding the aquatic biology as well. Conventional wisdom is to manage towards a water or effluent quality objective, but we know that you need to also understand toxicology and biology to really put things into perspective."

This helped in achieving success as part of a consortium that did the environmental assessment in support of the licensing for the Marathon project. The key to success lied in the integration of diverse expertise, which provided an understanding of how a regulator, mine manager, and the community would view it, and clear and transparent communication to ensure common understanding by a diverse audience.

Sarah Barabash's, director of mining services at Ecometrix, thinks that in the feasibility stage there is often too much focus on the engineering portions of the project, and not enough credence on the collection

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The most recent trend is on inflation control and recession proofing operations. As a result, right sizing operations, reducing costs, and changing the structure of organizations have been on the rise in recent quarters.

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Theo Yameogo

EY Americas and Canada Mining & Metals Leader
ERNST & YOUNG

What areas of EY's Mining and Metals business were most in demand in 2022?
In 2022, we witnessed growth in every one of our offerings, particularly in assurance, consulting, integrated mobility, and strategy. First, our audit and financial advisory teams acquired several great clients. Second, the lifting of cross-border restrictions and the increase in expat hiring have kept our Integrated Mobility teams very busy. Third, in consulting we have seen a substantial demand for technology transformation anchored on updating, upgrading or implementing new ERP systems. In addition, we have helped a lot of clients in data analytics and data strategy, and that is tied most of the time to ESG, because the reporting requires good data.

Another area of high demand was Risk Services, where there is more interest in enterprise risk management to bring in the right specialists. Still in consulting, emerging areas of focus have been higher demand for cybersecurity and ESG strategy services. Finally, our EY Parthenon teams have been super busy on corporate strategy engagements and operations turnaround discussions. In fact, the most recent trend is on inflation control and recession proofing operations. As a result, right sizing operations, reducing costs, and changing the structure of organizations have been on the rise in recent quarters. We expect that there is going to be a need for operations excellence style work and cost optimization in the upcoming quarters. Finally, our clients continue to request our tax services.

Do you feel that the industry is being overly prudent in its pursuit of growth today?
The sector has always contemplated the three growth models - organic, inorganic or hybrid. Ultimately, boards and management focus on allocation of capital under some customized risk appetite. The various waves of consolidations have taught us all that the custodians of value creation should be extremely careful in adopting any of the models; some M&A have destroyed value, while some organic growth projects nearly wiped-out companies. So, there is a strong reluctancy to make the same mistakes of previous cycles. However, many indicators point to a potential supercycle for some minerals, but as we showed in our 2021 Top 10 Risks, uncertainty of demand remains. As a result, boards and management continue to show some restraints on flashy acquisitions or mega projects. We expect that approach to continue in 2023 because the global economic indicators are still mixed. On the critical minerals side, assurances are improving with more direct offtake agreements between mining and the EV companies, but overall, the industry is taking a prudent approach when it comes to pursuing growth in today's market.

How can investors be convinced that allocating capital toward critical mineral projects in North American will deliver a positive return on investment?
The Mountain Pass mine is a cautionary tale of boom and bust in the 'new minerals' world. There is a sensible concern about the robustness of the demand for critical minerals. We are hearing more questions like - should producers assign a premium to critical minerals being produced in Canada for being greener, owing to green input energy or shorter transportation distances? Or should we focus on brownfield? Or should we integrate more upstream and downstream to reduce unnecessary bottlenecks? And what will be the contributions of governments? The clear path of commitments has investors strongly recommending offtake agreements between the mineral producers and the EV ecosystem. For Ontario in particular, we need to see more investments in manufacturing to close the loop of the EV value chain.

Where do you expect the mining industry to experience the most change in the coming years?
Recently, many of our clients have been migrating across the value chain. For example, a traditional nickel concentrate company is building a battery grade nickel sulphate plant in Quebec to supply an automotive company. We are also seeing mining companies taking stakes in technology businesses, because they realize they need to branch out and anticipate the next waves of value creation. Another area in which we expect to see massive change is indigenous involvement in mining. ■

NF NR

Nigel Fung & Neal Reynolds

NF: Partner – Americas
NR: Partner
CSA GLOBAL

How has CSA Global's integration into ERM enhanced its capabilities?
NR: The interesting transformation since we became part of ERM three and a half years ago has bought a holistic approach to mining projects in a way that aligns with investors' expectations in terms of ESG compliance and First Nations relationships. From an early stage, we incorporate all the standard technical services like resource estimation or mining studies and put them into a framework that looks at the whole life of the asset, with an emphasis on gathering data early in a project's history that will inform optimization of that project, through to closure.

Advanced data analysis is a huge growth area, and we are overloaded with opportunities for our team to address issues to optimize operations at the study and operational stages.

What makes Ontario an advantageous location to explore and develop a mine?
NF: Ontario is a highly endowed part of the world with many commodities. It also has a significant mining history, and the province has grown significantly on the back of this industry. Toronto was basically developed to support the industry and is a short distance by flight or road from most mining areas such as Thunder Bay, Timmons, Val d'Or, and Kirkland Lake.

What are you seeing in terms of the discrepancies between public market valuations and companies' internal valuations?
NR: In any normal cycle, we would now be moving into a bust scenario, but currently, we have the counterbalance of the electrification narrative. We are experiencing the normal mining cycle going one way while the electric cycle is going another, and many juniors are caught up in this. Many companies are now endeavouring to turn themselves from gold to lithium companies due to their inadequately valued gold assets. ■

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of environmental data. "Collecting information at the start of the project allows you to look at your waste and water management in different ways, and it provides you with more options than if you wait until operation or closure to start thinking about those aspects. Many clients are starting to look at their projects in a more holistic manner, considering the full mine life cycle and thinking about closure and end land use after closure from day one," she affirmed.

CSA Global has also been working with Ontario-based mining companies to establish best practices in environmental management. Neal Reynolds, a partner, highlights that there are two aspects of water – hydrogeology and surface water hydrology. Globally, one of the biggest challenges for mining is the lack of water, which, in places such as Chile leads to operations in many cases budling desalination plants, that massively add to costs and carbon footprint. "Jurisdictions where water is abundant, like Ontario, are much more attractive for mining, but the challenge here is effectively managing the water in an environmentally and community-acceptable way," Reynolds remarked.

Nigel Fung, partner for Americas at CSA Global, elaborated on the situation in Ontario, saying: "As much as we want to know the geochemistry of the rock being mined, the chemistry of the water is just as important and is an essential part of the equation because of the environmental impacts and tailings."

Lowering Carbon Footprint
Perhaps one of the more overlooked components of the Yamana Gold acquisition was their GHG profile. Prior to the acquisition, the company brought in Thorn Associates to assist in developing their inaugural climate change strategy, which garnered praise across the industry. Having seen clients at a variety of stages, the Thorn's founder and CEO Emily Thorn Corthay is able to discern which companies are serious and those who are less so. "If a company only has a net zero 2050 target, it is a red flag for sustainability rating agencies or investors. These days, a mining company must have long term targets, but an interim target is also essential," she offered.

In recent years, Thorn has seen what it calls a "seismic" shift in the attitudes of C-suite and boards with respect to climate change and carbon reduction. This shift has largely been inspired by investors who are pushing miners to do things faster, as companies with significant ESG targets and initiatives can more easily obtain financing than others. "Moving forward, I believe we will see more sustainability backed bonds, such as what we saw with Newmont when they got preferential terms based on hitting certain ESG metrics. TCFD is also going to become mandatory, and there will be enhanced scrutiny on GHG inventory numbers. Companies will need to have those verified by a third party, and financing will increasingly be linked to ESG," Thorn Corthay affirmed. ■

BR

SB

Bruce Rodgers & Sarah Barabash

BR: CEO
SB: Director of Mining Services
ECOMETRIX INCORPORATED

Can you give an overview of Ecometrix?
BR: Ecometrix was established in 2004. We hire a diversity of technical expertise in areas such as geochemistry, hydrogeology, engineering, ecology, and risk assessment. We like to get involved in more complex projects, and the projects we are most proud of tend to involve a combination of each of those technical disciplines. The solution typically lies at the interface between our diversity of expertise. We like to think of ourselves as providing Environmental Intelligence to help our clients solve more challenging environmental projects.

What are some of the biggest environmental risks mining companies in Ontario face today?
SB: From a feasibility perspective, there is oftentimes too much focus on the engineering portions of the project, and not enough credence on the collection of environmental data at an early stage. Collecting information at the start of the project allows you to look at your waste and water management in different ways.

Ontario has quite a few legacy properties, and there is opportunity in trying to understand how we can better approach mine closure.

To what extent is Ecometrix leveraging technology and software?
SB: Ecometrix has developed a number of software products to support the mining industry, the two most significant ones being MineMod and IMPACT. MineMod is a software that looks at all operations on a mine site from a geochemical and water balance perspective. When we know the mass loadings of the various chemical constituents going into the environment, we can then apply our IMPACT software, which looks at how that constituent moves through environmental media to assess exposure and risk. Created to improve the decision-making process for mine managers, these tools help forecast and manage the initial feasibility study, environmental assessment, construction, operation, closure, and rehabilitation of a mine. ■

Juice Lambert

President
TITAN ENVIRONMENTAL CONTAINMENT

What is the suite of products Titan Environmental Containment has tailored for the mining industry?
Titan is a solutions provider and installer of geosynthetic products, which are mainly resin based materials used in civil infrastructure construction projects. These include geogrids used in base reinforcement for heavy-haul road building and under overburden stock dump areas, as well as specialty erosion protection lining products like Concrete Canvas® for mine channels and different types of geomembranes used to line tailings dams, tailings ponds and processing ponds.

All these products are considered smart alternatives in the sense that they can minimize or completely replace natural resources such as gravel, sand, or bentonite clay and at a much lower cost. So, there's both environmental and cost savings benefits.

What are some of the tailings-related products that Titan offers, and what do the clients want to see in terms of product offering?
There are two products that Titan offers for use in tailings dams. When it comes to geomembranes: the most common one in recent years is our bituminous geomembrane (BGM), a reinforced bitumen-based membrane. 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.

What are the main pain points that clients are experiencing, and how does Titan Environmental Containment moderate those issues?
One of the biggest pain points, I think, is the longevity and service life of their site infrastructure as it has big impact operations and production rates. Offering a premier product and a premier installation with good quality control alleviates some of that stress for the owner. Cost mitigation is another issue. A final pain point would be project management, and we help customers with this issue by recommending and offering the proper turnkey solutions. ■

» Today, most major and mid-tier mining companies have targets, and are working a plan to move it forward, but the targets are still not ambitious enough, and industry needs to accelerate and do more, faster. «

Emily Thorn Corthay

Founder and CEO
THORN ASSOCIATES

What is driving Thorn Associates growth trajectory?
Thorn Associates is exclusively focused on decarbonization, and we have been fortunate that many of our customers refer us to new customers. This has led us to achieve more than 100% revenue growth for the last three years, which coincided with the rise of decarbonization as a top priority for mining executives. We have been expanding our business into new areas as energy and climate opportunities grow, and we have done several task forces on climate related financial disclosure (TCFD) reports and reviews for mining clients as the market continues to evolve. Thorn Associates' mission is to help mining companies reduce their greenhouse gas emissions, which we believe is the existential crisis that humanity needs to solve this century. In collaboration with our mining clients, we have already helped them implement over US$100 million in energy cost savings, while also reducing carbon emissions by over 500,000 tonnes.

You said previously that you would like to see greenhouse gas data reporting be treated similarly to financial reporting data. Has there been progress on this front?
There is definitely still a lot of qualitative reporting, and the hard core quantitative financial impacts are still missing in many cases. However, there has been substantial progress in the number of mining companies who are reporting to the TCFD, and the ones who have done that previously are getting more sophisticated.

What are some of the ways mining companies can achieve more sustainable production?
In general, a mining company's carbon footprint is made up of two key elements – electricity-related emissions, and diesel emissions related to fleets. Companies can therefore look at different types of renewable power (e.g solar, wind, or hydro) with energy storage, alternative fuels (e.g. renewable diesel), and technologies such as battery electric vehicles, trolley assist, and hydrogen fuel cell vehicles to have more sustainable production.

What is your opinion on carbon credits?
There is definitely a role for carbon credits in the energy transition, but you have to be careful. The role is either at the end, or in addition to meeting your targets. When I say at the end, the Science Based Targets Initiative (SBTI), which is the global gold standard when it comes to setting credible GHG reduction targets, requires that you only use carbon offsets for residual emissions, and that would be only 5% to 10% of the very last emissions that you are trying to abate. You need to first focus on reducing your scope one and two emissions. Otherwise, if you wanted to do carbon offsets now, there is a place for that outside of your GHG reduction targets. You might have some co-benefits such as improved biodiversity and improved community relations from a social perspective, but they should not be counted towards the carbon reduction for your credit.

Is the industry moving in the right direction with respect to lowering carbon emissions, and to what extent does having a strong ESG profile benefit firms when it comes to obtaining financing?
Today, most major and mid-tier mining companies have targets, and are working a plan to move it forward, but the targets are still not ambitious enough, and industry needs to accelerate and do more, faster.

Investors are pushing miners to do things faster as companies with significant ESG targets and initiatives can more easily obtain financing. Moving forward, I believe we will see more sustainability backed bonds, such as what we saw with Newmont when they got preferential terms based on hitting certain ESG metrics. TCFD is also going to become mandatory, and there will be enhanced scrutiny on GHG inventory numbers. Companies will need to have those verified by a third party, and financing will more increasingly be linked to ESG. We led, in collaboration with Yamana Gold, their 2021 inaugural climate change strategy, and they now have been the subject of a bidding war between Gold Fields and Pan American Silver & Agnico Eagle. It is public knowledge that one of the great things about Yamana Gold is their GHG profile currently and going into the future. ■

Service Solutions

On BEV Adoption:

"BEVs existed at the Macassa mine before I arrived there, and I was given the opportunity to both build the machine and operate it. Beyond challenges posed by the simulation, the build, and the components, operating the machine is a completely different endeavor."

Mike Mayhew, Founder, Mayhew Performance

“A compelling reason why mines prefer BEVs is that ventilation costs are significant in underground mining, and at a certain point it gets uneconomical for diesel operated equipment to be utilized because of the cost of air. In these cases, there are not capital savings, but there would be operating cost savings because mining companies are not going to run fans as much as they would when using diesel equipment.”

Vernon Cameron, CEO, Mayhew Performance

“We have worked on a multitude of projects where we built battery electric assembly garages and charging station projects with various types of design, and we worked with an OEM and a multinational mining client to help design a retrofit kit for their electric haul truck. The kit will allow the battery powered unit to come off and on the overhead trolley, and that will permit on the fly charging of the haul truck, which eliminates the need to park and recharge or swap batteries.”

James Gagne, General Manager, Black Rock Engineering

On Permitting and Regulations:

“Amongst juniors, there is a lack of understanding of the level of effort, time and money it takes to attain permits to establish a mine and to maintain compliance with the various regulatory requirements. They also do not have a good understanding of the complexity of the regulations the environmental department must follow. They often underestimate staffing needs and environmental management costs.”

Linda Byron, Director, Blue Heron Environmental Management

“Noise from mine vent fans can be controlled, but doing it correctly is complex – it isn’t as simple as adding a silencer or acoustical cladding. Especially when these fans are installed in relatively quiet areas, away from urban noise and the steady sound of the mine, the fan noise is easily discernible by residents – even when the regulatory limits are achieved, complaints often arise. Simply, if the appropriate mitigation methods are not implemented at the outset, penalty from the regulators can result, and rectifying these issues can take significant time and capital investment.”

Andrew Dobson, Senior Consultant & Associate HGC Engineering

Background image courtesy of BHP

On Growth Strategies:

“Within a couple months of launching NORPRO Environmental, which focuses on environmental remediation of petroleum and other types of spills, we had the opportunity to acquire Lajoie Bros Contracting Ltd, which was providing not only emergency spill response services, but also petroleum maintenance services, fuel management systems, and tank installations. The two companies had great synergies and we knew it made sense to integrate the companies.”

Dan Hollingsworth, Vice President, N1 Solutions

“We acquired EcoVac as part of our strategy to use Halyard's skills to diversify into other industrial areas and expand our business. EcoVac is a fully permitted recycling plant in Toronto for excavated soils that used to be disposed of in unregulated ways. We have the capacity to process about 10,000 Hydrovac trucks a year and turn the soil into reusable construction materials. With EcoVac, we also contribute to sustainability because the excavated materials are repurposed.”

Justin Taylor, President, Halyard

“We recently took equity in KPI Industrial Controls, out of Val Caron, just north of Sudbury, to broaden our horizon on automation. We are also planning to take on a major role in the electric equipment underground space. We want to be part of the infrastructure being built that will ultimately minimize environmental impact.”

Mike Richer, Vice President and Owner, Civiltek Limited

COMPANY	WEBSITE
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Agnico Eagle Mines	https://www.agnicoeagle.com
Alamos Gold	https://alamosgold.com
Appia Rare Earths & Uranium Corp.	https://www.appiareu.com
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