

Mining in British Columbia and Yukon with a Special Report on Vancouver:

The World's Mining Capital

A REPORT BY
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Vancouver: The World's Mining Hub

The British Columbia mining industry looks outwards to export its expertise

Days after the all-share merger between Barrick and Randgold became effective in January 2019, Newmont Mining Corporation entered into a definitive agreement with Goldcorp in a stock-for-stock transaction valued at US\$10 billion to create Newmont Goldcorp, as Newmont announced it will move its North American regional operations office from Nevada to Vancouver. While few mining companies can match Goldcorp's financial clout, the Vancouver-based major has one thing in common with hundreds of players across the value chain headquartered in B.C.: none of its operating mines or development projects are based in British Columbia.

Vancouver can lay claim to being the capital of world mining, with over 800 mining companies and juniors headquartered in the city, more than Toronto and Perth (home to the second and third most) combined. However, B.C. lags behind Québec and Ontario in terms of its ability to attract exploration activity and investment, according to a Fraser

Institute report from July 2018, citing factors including onerous regulatory and permitting processes. 2017 saw the first increase in exploration spending in B.C. since 2012, an indication that enthusiasm is returning to the province's domestic industry. Nonetheless, the real driver of Vancouver's mining economy has become its global reach: "Vancouver is truly a mining hub as well as a leading service center for the mining industry. Canada's leadership at extracting natural resources, and Vancouver's unlimited expertise in the sector, leads many to headquarter in Vancouver and then export knowledge around the globe," observed Bryan Cox, president and CEO of the Mining Association of B.C. (MABC).

This sentiment was echoed by Ken Embree, managing principal and president of Knight Piésold, the engineering and environmental consultancy that helps clients understand the regulatory regimes in which their projects are situated: "Many of our Canadian clients have mining properties in other areas

of the world... We encourage them to apply the same innovative developments, technologies and best practices to all their operations, including their projects located outside of Canada."

Global law firm Dentons has also noticed the evolving operational footprint of its clients: "Until a couple of years ago, Dentons was primarily focused on the mining industry in Canada and B.C., but the company's focus has now expanded to include Asia, Australia, Latin America, Africa, the Caribbean and Mexico," commented Brian Abraham, the Canada co-chair and a global lead for Dentons' mining group.

The Canadian service sector has been supplying remote locations in Canada's north for generations, and this expertise is being applied to similarly hard-to-reach areas throughout the Americas. "The cost of failure is high in remote locations, and we want to guard against this by being certain a system is designed for maximum operational up time," said Scott Plummer, president and CEO of RMS-Ross Corporation.

Working with small and mid-tier companies, RMS-Ross ships its heavy-duty mining equipment around the globe, designing and manufacturing recovery systems tailored to individual projects in over 60 countries. Its recent elemental analysis work performed at a gold mine in Bolivia led to the discovery of seven new saleable grade products.

Vancouver-based companies have long been exporting technologies to overcome challenges unique to South America. Global UAV Technologies can now service the high-elevation, surveying obstacles faced by companies operating in the Andes: "These environments are too risky to fly with a manned helicopter, and surveying is physically impossible by foot. Drones are thus the only solution, and we are able to fly surveys at an altitude of approximately 15,000 feet," said Michael Burns, Global UAV's CEO.

The rise of royalty & streaming financing

Since the end of the super-cycle in 2012, conventional equity and debt financing for mining projects has become incrementally harder to find, and even as optimism returns to the market, competition from the cannabis industry has taken even more capital from the natural resource space in Canada.



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Randy Smallwood, president and CEO, Wheaton Precious Metals.

The royalty and streaming model, on the other hand, continues to go from strength to strength. With commodity prices deflated, the value of upfront and periodic payments for a return of current or future mineral production has become increasingly attractive. "From a macro perspective, mining companies typically use royalty and streaming when equity becomes more expensive and when their share prices are down, which is why many royalty and streaming companies have been very busy in recent years," explained Brett Heath, president, CEO and director of Metalla Royalty & Streaming.

Streaming has brought a significant change in the mining landscape, originally for producing companies, but also now increasingly for development projects that require financing. "As the capital markets have been constrained, streams have been pursued all the way down the value chain," added George Pyper, director of Endeavour Financial.

Vancouver is home to a number of royalty and streaming firms that have seen significant growth in recent years, the larg-

est of which is Wheaton Precious Metals (WPM), a pioneer in the metals streaming space. Focusing on assets that fall into the lower part of the cost curve, WPM's portfolio includes Vale's Salobo mine, the largest copper deposit ever discovered in Brazil, and Glencore's Antamina polymetallic mine in Peru. Randy Smallwood, WPM's president and CEO, elaborated on the benefits of the financial model: "By taking a non-core value and reinvesting it into core franchise a company can continue to grow and that is exactly what streaming delivers," he said.

Sandstorm Gold Royalties has hit record production each year for the last eight years, and looks set to continue on an upward trajectory with a portfolio of streams due to come online including Yamana's Cerro Morro mine in Argentina, the Hod Maden project in north-eastern Turkey and Lundin Gold's Fruta del Norte gold project in Ecuador. "The world has truly changed with respect to the way capital markets function," stated Nolan Watson, Sandstorm's president, CEO and director. "The advent of passively managed capital has become such a strong force, as the fees are extremely low, and these passive ETFs are making investments based on only two criteria: the size and the liquidity of the company. Companies thus need to self-rationalize and merge to grow in size and liquidity to attract financing."

Vancouver-based mid-tiers diversify their international asset portfolios

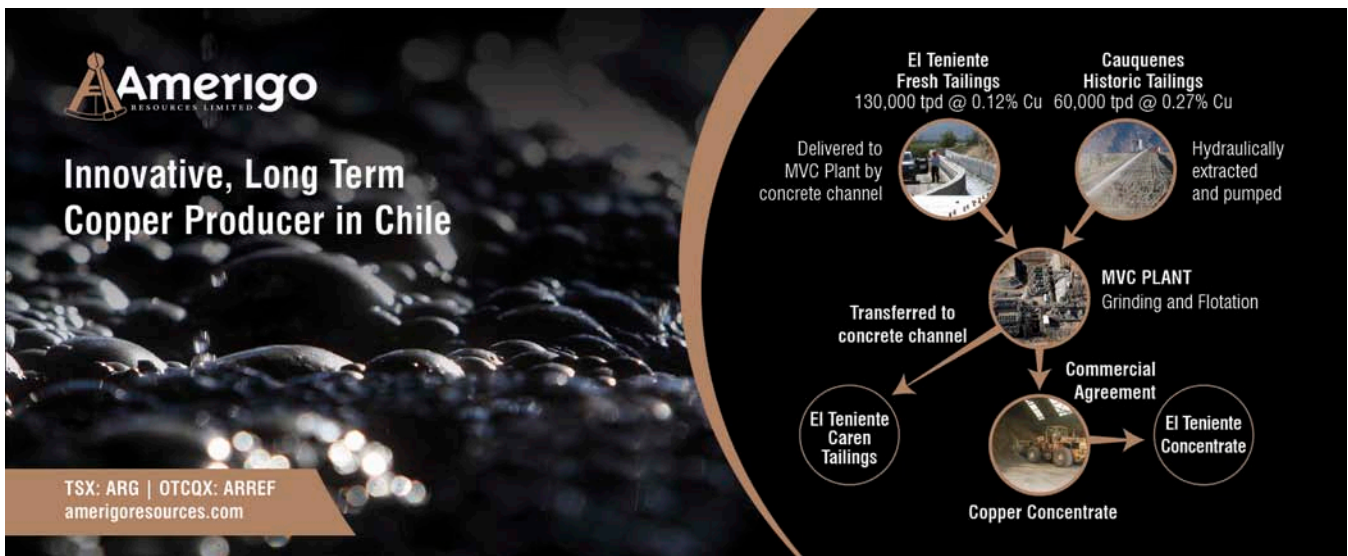
A number of Canadian mid-tier producers have experienced impressive growth in recent years, capitalizing on the availability of undervalued assets in a 'buyer's market.' Precious-metals producers like SSR Mining have been adding value to their asset port-

folios by diversifying across the Americas, and have completed four acquisitions in the past four years: the Marigold mine and Valmy property in Nevada, the Seabee gold operation in Saskatchewan, and the Puna operations JV in Argentina. "SSR is proactively on the lookout for more properties," affirmed Paul Benson, president and CEO.

Vancouver-based Silvercorp Metals, with its six operating mines at the Ying mine district in Henan and the GC mine in Guangdong, China, has managed to thrive despite a deflated commodity market, generating positive free cash flow of around US\$40-45 million per annum, according to chairman and CEO, Rui Feng. Citing the significant improvements made in the grades of silver, lead and zinc resources at its operating mines, Feng credited the 2016 implementation of Silvercorp's innovative productivity management tool, "Enterprise Blog", which has increased head grades and minimized dilution through improved efficiencies.

Silvercorp recently diversified its asset portfolio by investing US\$23 million for a 30% stake in New Pacific Metals Corp., and Feng sees great potential in New Pacific Metals' Silver Sand project in Bolivia: "We believe that the project has the potential to become a formidable mine. The first batch of drilling results were released on January 22, 2019, with a remarkable 94 out of 98 holes having returned attractive grades, the highlights of which included 135 m of 240 g/mt silver."

In January 2019, New Pacific entered into a mining production contract (MPC) with La Corporación Minera de Bolivia (COMIBOL), the national mining corporation of Bolivia. The MPC grants New Pacific the rights to carry out exploration, mining, and production activities in the areas adjoining



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Rui Feng, chairman and CEO, Silvercorp Metals.

the Silver Sand project, and the agreement is the first of its kind to be put into law with a foreign entity. Gordon Neal, New Pacific's president and CEO, believes the recently signed agreement will be used as a template for companies wanting to enter the mining industry in Bolivia. "Since New Pacific signed the MPC, I have had calls and meetings with at least four other foreign companies looking at Bolivia with investment interest. I expect the number of foreign companies operating in Bolivia to double before the end of 2019," stated Neal.

Another silver producer to have entered South America is Endeavour Silver, which

has added the Aida, Paloma and Cerro Marquez expansion projects in northern Chile to its portfolio. "We have a great portfolio of 'home run' exploration projects, and our goal is to make a world-class discovery. We want to become a larger, better and more sustainable company. Chile offers us a strategy to attain this. It is a high-risk and high-reward situation," said Brad Cooke, CEO of Endeavour Silver, which produced approximately 10 million oz silver and equivalents in 2018 from its four underground high-grade silver-gold mines operating in Mexico.

Chile is the main focus of Amerigo Resources, which produces copper concentrates at its 100% owned MVC operation by processing fresh and historic tailings from Codelco's El Teniente mine. Rob Henderson, Amerigo's president and CEO, believes the country's infrastructure is equivalent to Canada's: "There are people with strong technical skills and the government is supportive of mining, as it makes up 25% of their GDP. Environmental regulations are based on a high standard and are clear, and the rules of business are stable and transparent," noted Henderson, adding: "Additionally, the geological potential is enormous, under-explored, and its position in the Andes indicates there is much to find."



Gordon Neal, president and CEO, New Pacific Metals Corp.

Precious metals in the United States: new players head south of the Canadian border

While the influx of Canadian mining companies into Central and South America has gathered pace, others prefer to look closer to home. Nevada, a two-hour flight from Vancouver, is synonymous with gold and currently ranked the number three global mining jurisdiction by the Fraser Institute. Fiore Gold was founded in 2016 with a focus on exploration stage projects in Latin America, but soon realized the traditional exploration model of having to return to the market to source equity funding for exploration was not



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conductive to success during the down-cycle. A merger with the private company GRP in September 2017 led to Fiore Gold restarting the Carlin-style, open-pit Pan mine in Nevada. "The generalists in the mining sector were no longer involved and many of the mining specific funds had either shrunk or disappeared completely," said Tim Warman, Fiore Gold's CEO and director. "This resulted in us having to investigate more advanced, producing assets that could generate cash flow that in turn could fund exploration," he explained.

Another gold-focused company based in Vancouver to have entered Nevada in 2017 is Contact Gold, focusing on its flagship Pony Creek asset, a 13,771-hectare land package situated on the prolific Carlin trend. The group behind Contact Gold is hoping to repeat the success they had with Frontier Gold, which was acquired by Newmont in 2011 in a deal valued at US\$2.3 billion. Since going public in June 2017, Contact Gold has conducted comprehensive strategies including soil sampling and mapping at Pony Creek, enabling the company to generate six new targets that are supported by data sets. "Contact Gold now has tangible proof that its targeting mechanism is effective, and we are positive that further drilling on the other targets will support this," stated Matthew Lennox-King, president, CEO and director of Contact Gold.

Further south, Arizona Silver Exploration (AZS) has focused its attention on a high-grade gold-silver vein target in Mohave County, northwestern Arizona. In January 2019 AZS entered into a lease with option to purchase on 11 unpatented lode mining claims that cover the majority of the old workings and potential strike extension of the former operating Arabian-Philadelphia Mine in the Oatman Mining District, which has produced over 2 million ounces of gold. Mike Stark, chairman and director of AZS, is optimistic about the outlook for precious metals: "Here we are at the end of a long bear metals market, and hopefully we have turned the corner and are now heading into a long-awaited bull market. With the recent rise in both gold and silver prices, people will be looking for safe havens and history proven investments."

Ecuador aims to double its mining economy by 2021

The Ecuadorian government has the target of attracting US\$4 billion in mining investment into the country by 2021, backed by a wave of exploration and development projects and improvements to the country's fiscal regime, including the removal of the



Ron Hochstein, president and CEO, Lundin Gold.

windfall tax in August 2018. However, growing concerns from NGOs and rural and indigenous communities on the proposed uptick in natural resource extraction prompted Fitch Solutions Macro Research to rank Ecuador as a riskier environment than Mexico, Colombia and Chile.

The need to balance mining-friendly improvements to Ecuador's regulatory framework with respect for local heritage will be key to the development of the country's mining industry, as touched upon by Ron Hochstein, president and CEO of Lundin Gold: "The exploration potential in Ecuador is significant and the government realizes that


improvements still need to be made while protecting the environment and indigenous cultures."

Construction at Fruta del Norte began mid-2017 and its first gold pour is expected in Q4 2019. Hochstein sees potential for Lundin's flagship asset in southwestern Ecuador to expand significantly: "Fruta del Norte's reserves of 5 million oz at an average grade of 8.74 g/mt only represent 67% of our indicated resource," he elaborated.

The opening up of the cadastral system in 2016 created a staking rush for new concessions, and at the time the Ecuadorian institutions were not prepared to handle all the related permitting and processing, according to Marshall Kovall, president, CEO and director of Lumina Gold and Luminex Resources. However, Kovall has noticed improvements in the years since: "There is a significant amount of collaboration between industry, government and communities, and the country is very supportive of advancing its burgeoning mining industry."

After the storms: unlocking mineral potential in Argentina


As the IMF increased Argentina's bailout package to US\$57 billion in September 2018, storm clouds of the literal variety were forming, with torrential rains and flood-



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ing ravaging the country from October until the beginning of 2019. Despite the turbulence, Argentina's mineral sector has continued to attract investment, with Canadian mid-tiers SSR Mining and McEwen Mining advancing their Puna and Los Azules projects, and a host of juniors taking advantage of the economic context to purchase cut-price assets.

One such junior is Vancouver-based Portofino Resources, which has the right to acquire a 100% interest in the Hombre Muerto West lithium-brine project located in the Salar del Hombre Muerto in the Catamarca province, the region that has produced the most lithium in Argentina. "Although volatility in the lithium space affected valuations and made it difficult to raise money, projects have become cheaper to acquire," reflected David Tafel, Portofino's president and CEO, continuing: "Considering this context, Portofino is in the process of looking at other potential projects within the Catamarca province to expand its portfolio in this current buyers' market."

David Tafel is also the CEO of Centurion Minerals, a producer of gypsum, a fertilizer used commonly in the South American agro-industry. Centurion has built a pilot crushing and processing facility at its Ana Sofia agricultural gypsum project in Santiago del Estero, Argentina, with a current capacity of approximately 40,000 tonnes per annum. Interestingly, the torrential rains in rural Argentina may have presented an opportunity for Centurion: "As well as being a fertilizer, gypsum can be used to revitalize land which has been spoiled, for instance from flooding," explained Tafel.

The short drilling seasons in Canada have prompted some juniors to add assets in warmer climates, allowing for year-round exploration. Falcon Gold entered into an option agreement with Esperanza Resources in 2017 for its La Rioja project in Argentina to give the Vancouver-based junior a two-pronged focus: exploration on its Central Canada gold mine property in north-western Ontario in the

summer, and exploration on La Rioja during the Canadian winter. Stephen Wilkinson, Falcon Gold's CEO and director, elaborated on his company's diversity-focused business model: "We are trying to eliminate some of the liability of exploration work by having a number of commodities covered, but anchored by gold."

Brazil looks to attract foreign investment as Vale cleans up after the Brumadinho tragedy

President Jair Bolsonaro was elected with a mandate to attract foreign investment and reduce the red tape that has hindered mineral production in Brazil. A mere 24 hours after Bolsonaro had officially taken office as Brazil's 38th president, South America's largest country was rocked by the news that a tailings dam at Vale's Brumadinho mine in Minas Gerais had collapsed. By February, the death toll from the disaster had risen to 134 and a further 199 reported as still missing, and Brazil's biggest mining company had lost a quarter of its market value – approximately US\$19 billion. Disasters such as Brumadinho, the Samarco dam failure in 2015 and Mount Polley in 2014 reverberate beyond borders and negatively impact the image of the global mining industry as a whole.

As the dust settles and fallout from the tragic event in Minas Gerais begins, the Brazilian mining sector must balance image reparation with investment in an industry of enormous potential. For Michael Bennett, president and CEO of Altamira Gold, the government is being proactive in reducing bureaucracy, one of the major roadblocks to South American mining development: "It seems that the new government is looking for people with experience in different sectors and who really understand the business," he said.

Altamira's focus is on the Jurueña Belt and Alta Floresta Belt in the state of Mato Grosso, south of Para. The Vancouver-based junior currently holds a land package of approximately 260,000 hectares, and Bennett sees multi-million oz resource potential in a region occupied by Anglo American, Nexa Resources and Codelco.

Nordic exploration: the emergence of Scandinavian mining

Scandinavia has a rich mining history, with historical production from mines such as Falun in Sweden, which supplied Europe with copper for a millennium from the 10th century to 1992. Today, Sweden is the largest iron-ore producer in Europe and, with its Nordic neighbor Norway, is attracting the attention of a junior community looking to take advantage of a region yet to receive as much widespread attention as many jurisdictions in the Americas.

In 2018, Norra Metals (formerly OK2 Minerals) acquired a past producing mine and advanced stage exploration assets in Norway and Sweden, after re-evaluating the focus and direction of the company and deciding to look for assets in jurisdictions that would allow for operating projects 12 months of the year, according to Mike Devji, executive director and CEO. This year, Norra Metals intends to work towards establishing a resource estimate at its Bastuträsk project in the central Skellefteå belt, the main massive sulfide producing belt in Sweden. In addition to this, exploration work will begin on its Bleikvassli, Sagvoll and Meraker assets in Norway. "The advantage of Sweden and Norway is that the properties have not been intensively explored by historic operators so the potential upside is excellent," stated Devji.

Patricio Varas, chairman and director of Boreal Metals, another Vancouver-based junior active in Scandinavia, expanded on the economic benefits of mining in Sweden: "The cost of power in Sweden is probably the cheapest in Europe, which means one can mine lower grades without the excess costs. There are also a lot of smelters in Scandinavia, so ore does not have to be shipped very far."



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Exploration in BC, Yukon and Canada's North

B.C. mining enters
an era of reconciliation



RAB drilling. Photo courtesy of White Gold Corp.

At the Association of Mineral Exploration's (AME) Roundup 2019 conference, Premier John Horgan emphasized the British Columbia government's commitment to its mining industry. Horgan vowed to make the Mining Flow-Through Share Tax Credit and the B.C. Mining Exploration Tax Credit permanent, and also outlined plans to invest C\$2 million in developing a road map for innovation and expanding the BC Regional Mining Alliance (BCRMA).

The focus of industry players on reconciliation and collaboration led to the creation of the BCRMA, a partnership between the provincial government, the Tahltan central government, the Nisga'a Lisims government, the AME, Dolly Varden Silver Corp., Skeena Resources Ltd. and GT Gold Corp. The target is to develop a culture of support amongst all actors from permitting to mine closure.

The BCRMA represents industry players in the Golden Triangle, a region in Northwest B.C. that has a 150-year mining history. Rich in gold, silver, zinc, copper, lead and molybdenum, the area covers nearly 25% of the province. With strong road connectivity, three new run-of-river hydroelectric facilities and the completion of the Northwest Transmission Line, which provides miners access to the power grid rather than relying on diesel, the industry is strongly positioned for development. "Projects that were generally diesel-powered now have a chance to plug into US\$0.04-kWh electricity. The far north will get serious amounts of snow, but the flip side is that we have a very supportive government, and local communities understand mining. The Tahltan and the Nisga'a, who are south of us, are dream partners in terms of their understanding of mining," said Walter Coles, president and CEO of Skeena Resources.

The intent is to ensure that companies not only take from the land, but also share and give back to communities. B.C. is working on its image in order to convey that the province is open for business and able to support mining companies wanting to move into production. It hopes to increase transparency and public confidence while advancing reconciliation with indigenous groups. "Perception plays a key role in attracting investment, so building on the successes of the BCRMA will help address any concerns directly," explained Edie Thome, president and CEO of AME.

Lengthy permitting processes have certainly dissuaded some from entering B.C., but these efforts ensure that communities benefit. "We must also remember that this province is the largest employer of indigenous peoples, and they play a paramount role in developing the

mining industry in B.C.," said Bryan Cox, president and CEO of the Mining Association of B.C. (MABC).

Only a select few of B.C.'s indigenous groups have established treaties with the government. Chad Day, president of the Tahltan nation, is trying to modify the online staking program that the government administers for companies wanting to enter their land: "Through this system people from all over the world are allowed to stake claims in our territory. We receive notifications of the permits and can then provide feedback or concerns," said Day.



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Their goal is to develop a land use plan with the government where some areas are open for business and others are not. The determining factors will be assessing whether mining negatively impacts species, water and the environment, and preserves culturally significant areas.

In 2017, BC saw its first increase in exploration spending since 2012, reaching C\$246 million, compared with C\$205 million in 2016. About C\$37 million of that increase was in gold exploration, an interesting statistic considering the province's strength in copper resources. One of the gold-focused juniors to have continued extensive exploration is Aben Resources, having drilled 45 holes between 2017 and 2018 at its flagship Forrest Kerr property. Jim Pettit, president and CEO, elaborated on Aben's exploration results: "The first hole of 2018 blew the market away: we ended up with four separate distinct high-grade zones from our first hole alone. We hit 10 m of 38 gr/mt and, within that, we had a section of 6 m of 62 g/mt, which was spectacular."

Boom times on the horizon for Yukon mining

In November 2018, the Conference Board of Canada released a territorial outlook economic forecast that points to Yukon having the fastest growing economy in Canada in the next few years, anchored by three new mines moving into production: Western Copper and Gold's Casino project in 2025, Goldcorp's Coffee project in 2021, and Victoria Gold Corp's Eagle Mine, which expects its first gold pour in September 2019.



Edie Thome, president and CEO, AME.

The Eagle Mine will be the largest gold mine in Yukon history and, to tackle the impending HR challenge, Victoria Gold Corp has developed a program to retain talent, in collaboration with the government's apprenticeship programs: "There are many Yukoners who have left to work in other provinces because they could not find a job locally. We are starting a campaign to attract and recruit Yukoners across Canada, and give them an opportunity to come back home to work," revealed John McConnell, Victoria Gold Corp's director, president and CEO.

Western Copper and Gold Corporation's Casino project is currently in the permitting phase, but when in operation will initially

produce over 100,000 mt/y of copper and 400,000 oz/y of gold, with an Internal Rate of Return (IRR) of over 20%, and a Net Present Value (NPV) of close to C\$2 billion at today's commodity prices, according to Paul West-Sells, Western's president and CEO. "The Casino project's revenue distribution will be approximately 50% from copper, 40% from gold and 10% from molybdenum. Finding such a large amount of gold in a single deposit, approximately 18 million oz including the reserve and inferred resource, is quite rare," he added.

Shawn Ryan received PDAC's Prospector of the Year award in 2010 and appeared on the cover of the New York Times Magazine in May 2011, dubbed "the king of a new Yukon gold rush" after his prospecting led to the discovery of Goldcorp's Coffee project. Now serving as White Gold Corp.'s CTO, Ryan is bullish about the district-scale potential of White Gold's 439,000 hectare land pack-

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White Gold’s CEO, David D’Onofrio, went on to outline how the company’s flagship Golden Saddle deposit had expanded in the last two years: “In 2017, we added approximately 300,000 oz to the existing 1 million oz, and in 2018 another 200,000 oz were added to the resource,” he said.

Copper tumbled into a bear market in the second half of 2018, as the U.S.-China trade dispute, a strong U.S. dollar, and increased supply from Chile and Peru saw the price of the base metal fall from US\$3.30/lb in June to US\$2.60 in December. However, the medium to long-term outlook for copper is more promising, with BHP Billiton estimating that the build-out of the electric car market will add 5% to global copper demand, requiring US\$25 billion in new copper supply investment. Doug Ramsey, president and CEO of Copper North Mining, has focused on transforming Copper North’s flagship Carmacks project in the Yukon, to make it economically attractive regardless of the commodity cycle: “We have reengineered our metallurgical process, specifically bringing the precious metals within the Carmacks resource into the economic model,” he explained, continuing: “This decreases the cash cost of copper production from C\$1.67/lb as a copper-only heap leach project to C\$1.08/lb as a copper-gold-silver project after precious metal credits.”

Another Vancouver-based junior active in the Yukon is Alexco Resources, currently focusing on the expansion of its Birmingham silver deposit at Keno Hill, which has increased reserves significantly, from approximately 23 million oz of silver, to over 40 million oz of silver today, according to Clynton Nauman, Alexco’s chairman and CEO. Alexco aims to establish production towards the end of 2019, market conditions considered, and Nauman praised the mining-friendly environment in the Yukon, benefitting from 11 of the 14 First Nations in the territory having final and self-government agreements: “This context gives insurance that there is jurisdictional safety and that companies can move their projects from exploration to production,” he said.

This sentiment was echoed by Brandon Macdonald, CEO and director of Fireweed Zinc, one of the new players to enter the Yukon junior community: “A key benefit of working in Yukon is that the mining community has the attention of senior members of the government and the Council of Yukon First Nations,” stated Macdonald.

Fireweed Zinc was created in 2016 following the signing of an agreement with Hudbay Minerals to acquire the Tom and Jason projects. Since Fireweed’s IPO in mid-2017, the company raised an additional C\$12.5 million and grown the project size from 55 square km to 540 square km through deals with Newmont and Teck.

District-scale opportunities in the Northwest Territories and Nunavut

Canada’s three federal territories sit to the north of its 10 provinces and are much less inhabited than their southerly neighbors, each with populations below 50,000. Due to their remote location, they also have underexplored mineral potential, with short exploration seasons and expensive logistics limiting historical resource development. However, favorable geology and the availability of substantial



Shawn Ryan, CTO, White Gold Corp.

land claims are increasingly attracting the attention of a mining community in need of district-scale discoveries.

Northwest Territories (NWT) is home to TerraX Minerals’ flagship Yellowknife City Gold project, a 783 square km property located on the Yellowknife Greenstone Belt, covering 67km of strike length on the southern and northern extensions of the shear system, which hosted the prolific high-grade Con and Giant gold mines. Working in collaboration with the Geological Survey of the NWT and the Giant Mine Remediation Project, TerraX managed to recover 16,000 m of historical drill core. After sorting through and recovering the material, TerraX identified

that the core came from holes that were drilled on three of its four targets that had been identified for expanding the deposit. “To find 16,000 m of core in a market where capital raising is difficult is an extraordinary advantage,” stated David Suda, TerraX Minerals’ president and CEO. “This enables us to advance our project at very low cost,” he added.

To the west of NWT sits Nunavut, the current focus of Blue Star Gold Corp., which rebranded from WPC Resources in January 2019. The name Blue Star is taken from the official flag of Nunavut, representing the company’s dedication and focus on Canada’s north. Through its subsidiary, Inukshuk Exploration Inc., Blue Star owns the 8,015 hectare Hood River gold property located contiguous to the Ulu mining lease. Blue Star also has an option for the right to acquire the entire Ulu property, subject to the approval of the Kitikmeot Inuit Association (KIA).

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The Future of Mining

Innovative solutions transforming a traditional industry

Low commodity prices, a lack of new mining operations and a dearth of market capital has forced producers to focus on improving productivity by increasing mine life on existing assets, and forced juniors to dilute their share structures just to stay afloat. Neither of these solutions is sustainable, and significant improvements in performance require the industry to put down its pickaxes and think outside the box.

B.C.'s tech sector generates around C\$15 billion in GDP, the equivalent of 7% of its economy and, while mining currently represents a fraction of this, one of B.C.'s oldest industries is also ripe for the development and implementation of new technologies that can leverage the global reach of its companies to export to jurisdictions worldwide.

One of the companies leading the charge in the march towards modern mining is Minerva Intelligence, which provides artificial intelligence software and services to reduce costs and improve success rates in mineral exploration. At PDAC 2019, Minerva launched MinSem - short for Mineral Semantics - a software-as-a-service (SaaS) application that helps companies interoperate their knowledge assets across their mineral exploration, metallurgical and environmental protection activities.

Emphasizing the importance of combining machine intelligence with human intelligence, Clinton Smyth, Minerva's CEO, stated: "We work in a knowledge-intensive industry where there are short-

ages of professionals. At the same time, we are inundated with data. The only solution to thriving in this environment is to manage knowledge assets and commit knowledge to computers to augment how humans carry out their tasks."

Another company to have implemented AI into their product offerings is Motion Metrics, headquartered in the heart of UBC, with their most recent release being BeltMetrics, which uses stereo-imaging and deep learning algorithms to analyze rock fragmentation on mining conveyor belts. "Now mines can continuously measure rock size distribution in real time along the entire mine-to-mill comminution circuit," explained Shahram Tafazoli, president and CEO.

LlamaZOO, one of the finalists in Goldcorp's #DisruptMining 2018 competition, made the transition from the videogame industry to producing a software platform for representing a mine plan from exploration to reclamation using virtual reality. Charles Lavigne, LlamaZOO's co-founder and CEO, noted how mining companies struggle to obtain and share information from numerous non-interoperable software packages across different organizational silos, and elaborated on how LlamaZOO's technology can help: "MineLife is disrupting the mine planning process by centralizing data into an interactive and visual VR experience, and making that data accessible on-demand and remotely, from anywhere in the world."

Future metals players diversify and create cash flow from processing technology

While players in the battery metals space have attracted substantial investment in recent years, the capex of constructing a new lithium mine, for instance, is so significant that a number of companies have instead decided to focus on the optimization of processing technology. Through R&D, some of these companies have had such success that they have made the transition from conventional mining into providers of technology that is being exported across the globe and generating cash flow.

MGX Minerals has a portfolio of mineral assets across North America, but since its founding in 2012, has transitioned into a diversified



Underground mining at Lundin Gold's Fruta del Norte project. Photo courtesy of Sandstorm Gold.



Clinton Smyth, CEO, Minerva Intelligence.

clean energy and mining technology company. Using low capital expenditure costs and robust filtration systems, MGX aims to help the industry transition to a greener energy future through cleaner extraction processes and technology and investing in commodities that power batteries.

MGX is looking to partner with majors in Latin America through their rapid lithium extraction technology, which won the 2018 S&P Global Platts Metals Leadership Base and Specialty Metals award. "The government of Chile has announced that it will no longer allow for the solar evaporation of lithium. With a current 300 million gallons of water evaporation in the country, the government wants to see rapid extraction," said Jared Lazerson, president, CEO and director, "We see these new policies as a potential niche for MGX Minerals", he continued. MGX also intends to apply its lithium extraction technology to the shale market in eastern USA.

Another company with mining assets but a focus on exporting its technology to foreign jurisdictions is Surrey-based VanadiumCorp, joint owners of VanadiumCorp-Electrochem processing technology (VEPT), a chemical process that addresses the recovery of vanadium, iron, titanium and silica feedstocks. In December 2018, Ultra Power Systems signed an exclusive patent option agreement with VanadiumCorp to purchase a full license of VEPT to utilize in Australia. "Ultra's main focus is on using the technology to expedite construction of the world's first dedicated vanadium processing facility," Adriaan Bakker, president and CEO of VanadiumCorp, explained.

On February 26th 2019, VanadiumCorp announced that national entry phases had been filed in South Africa, India and the United States for VEPT, and Bakker is bullish about its potential moving forward: "We are confident VEPT will revolutionize the cost and sustainable nature of energy storage as well as vanadium, titanium and iron production worldwide."

The rise of 'urban mining'

Conventional mining relies on the development of a finite resource that will, by definition, eventually stop producing. 'Urban mining' of electronic waste (E-waste), on the other hand, tackles a growing problem by recycling metals from an ever-increasing feedstock of used electrical goods. Rather than having to construct high-capex mines to extract metals, urban miners can have feedstock delivered to them from all over the world.

EnviroLeach was founded in 2016 after developing an alternative chemistry to cyanide for gold processing. Today, the company also has an E-waste division, working in partnership with some of the largest recyclers, electronic manufacturers and smelters in the world, according to EnviroLeach's CEO and director, Duane Nelson. "There are 380 mt of gold going into electronics annually and less than 20% of that is being recycled. A lot of money is going into landfills. There is C\$62 billion worth of precious metals that can be recovered," observed Nelson, adding: "The average grade of gold mines around the world is less than 5 g/mt. We see E-Waste with an excess of 100 g/mt."

The recycling of lithium-ion batteries (LIBs) has become a key focus for American Manganese, which shifted attention away from its portfolio of mining assets in North America after the price of manganese dropped to a level that would take 11 years to pay back its Artillery Peak project in Arizona. American Manganese partnered with Kemetco Research to work on a solution to produce electrolytic manganese metal from samples at Artillery Peak, using a sulfurous acid method of extraction. Recognizing that the chemistries used in this process could extract the cathode material out of the manganese, a five-part pilot plant program was established, due to be completed by Q2 2019.

"American Manganese is able to get a 100% recovery of metals from lithium-ion batteries, such as cobalt, lithium, nickel, manganese and aluminium – all strategic future metals," explained Larry Reaugh, president, CEO and director of American Manganese. "If we put 1,000 mt of batteries through American Manganese's treatment process, it is worth C\$360 million in recovered cathode materials."

Collaboration between research organizations and industry for a carbon neutral footprint

For meaningful innovation to truly mature, an investment of time as well as money must be committed to R&D that is not restricted by commercial demands. From the biophar-

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MINING IN BRITISH COLUMBIA AND YUKON

ma superclusters in Massachusetts and the San Francisco Bay Area, to the Fraunhofer institutes and research establishments in Germany, some of the most transformational advances in innovation originate from universities working in collaboration with industry partners.

The Bradshaw Research Initiative for Minerals and Mining (BRIMM) at the University of British Columbia (UBC) is dedicated to solving large-scale lifecycle problems for the mining industry, bringing together the traditionally siloed academic and mining groups to collaborate on issues that need an inter-disciplinary focus. "BRIMM is directly focused on solving the industry's problems in the near term, not just 10 or 20 years from now," explained Greg Dipple, BRIMM's director.

Peter Bradshaw provided the seed funding to launch BRIMM, but collaboration with industry players across the value chain is helping advance BRIMM's R&D to a commercial stage. BRIMM has been working on a CO₂ sequestration project for almost 15 years with mining companies across Australia, Canada and Southern Africa. De Beers, the world's largest diamond producer, and FPX Nickel, the Vancouver-based junior, have been at the forefront of funding research work at UBC on the issue of carbon seques-

tration using mining tailings. FPX's flagship Baptiste deposit in the Decar nickel district in central B.C. is rich in a mineral called brucite. When brucite is exposed to CO₂, either from flu-gas or atmospherically, it acts as a carbon sink and catches carbon and stabilizes the tailings material. Martin Turenne, president & CEO of FPX, sees transformational potential in BRIMM's CO₂ sequestration project: "We believe that there is the potential here to demonstrate that mines with the right mineralogical characteristics could potentially have a neutral carbon footprint. In the context of global concerns over climate change, this would be a revolutionary step for the mining industry."

Conclusion: lean times prepare a diverse Vancouver mining community for the impending upturn

For some companies, the downturn has been a blessing in disguise, forcing the hand of a traditional industry to develop new solutions which, in turn, can be exported to a global audience. "The downturn sparked the drive for more innovation, and because the new upcycle has been slow and incremental we have had the opportunity to develop innovative solutions and allow them to mature organically," observed Wayne Barnett,

principal consultant (structural geology) from SRK's Vancouver office.

For the swathes of small-cap juniors residing in Vancouver, lessons must be learned from the barren years, and an adaptation to the current mining context, where promising drill results alone will not guarantee financial gain, is critical. Mike Vint, vice president of Endeavour Financial, emphasized the need for smaller companies to have a long term goal and keep their options open with respect to financing: "At a junior stage, and when equity markets are not there, they have to be open to alternatives. Do not jump into bed with the first person that comes along."

The mid-tiers and majors operating on a global scale must take note of the potential pitfalls of unsustainable growth in an environment ripe for M&A activity. When acquiring a company, you also acquire its liabilities and, in a worst case scenario, tragedies such as the Brumadinho tailings dam collapse can leave scars far deeper than the balance sheet. "I have operated gold mines in Canada and recognize how important a social license is when doing so. When you work in a community you need to make sure you deliver a sustainable and positive effect to the community long after the mine has closed," concluded Randy Smallwood, president and CEO of Wheaton Precious Metals.



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MGX Minerals is leading the transition from fossil fuels to renewables through investments in battery commodities, extraction processes and clean technologies.

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