

June 2021

LASSONDE INSTITUTE
UNIVERSITY OF TORONTO

Ontario Critical Minerals Strategy Framework
Discussion Paper Response



Lassonde Institute of Mining
UNIVERSITY OF TORONTO

Executive Summary

This response aims to provide strategic counsel to support the development of the Ontario Critical Minerals Strategy. The Lassonde Institute welcomes the opportunity to participate in further conversations to provide guidance where expert competencies could benefit Ontario and/or the strategy drafting team.

A cornerstone in this response, is the urgent need for responsible resource extraction and sustainable environmental, societal and governance (ESG) practices throughout the entire lifecycle of critical minerals. Ontario must help industry create a credible platform through which mines and the resultant value chains demonstrate their ESG alignment and contributions to the United Nations Sustainable Development Goals to provide confidence to investors and stakeholders. Without grounding the industry’s future activities in the broader sustainability context, economic viability will be ephemeral and stakeholder participation and license will deteriorate.

The International Council for Mining and Metals (ICMM), representing over 27 of the world’s largest mining companies, has created the “ICMM 10 principles” (Figure 1), the first set of benchmarks explicitly identifying the strategic central importance of sustainable development (SD) in mining. The ICMM 10 Principles reinforces the core commitment the mining industry must make to advance and integrate environmental performance, (social) licence to operate and good governance (ESG) practices, transparency and continued innovation.



Figure 1: International Council on Mining & Metals 10 Principles define good practice environmental, social and governance requirements for the mining and metals industry¹.

¹ International Council on Mining & Metals available: <https://www.icmm.com/en-gb/news/2016/how-mining-can-contribute-sdgs>

TABLE OF CONTENTS

Introduction

About Lassonde Institute	4
Acknowledgements	4

Response to OCMS Framework Objectives

Leveraging Ontario’s breadth and depth of naturally occurring mineral deposits	6
Expanding Ontario value chain to more than exploration and production	9
Growing Ontario’s talent pipeline and training to develop our CM workforce	10
Improving and resourcing our mining innovation sector	11

Key Areas of Focus for a Critical Minerals Strategy

Area #1: Supporting partnership opportunities with Indigenous communities	13
Area #2: Developing an Ontario critical minerals list	13
Area #3: Enhancing investment in mineral exploration and development	16
Area #4: Regulatory and policy reform	19
Area #5: Supply chain and manufacturing opportunities	20

About Lassonde Institute

The University of Toronto's Lassonde Institute is a mining industry champion delivering research-powered solutions with a commitment to strengthen our shared communities and planet. As an integrated, multi-disciplinary innovation and discovery hub, we are home to world-leading experts solving complex, global challenges.

The University of Toronto provides undergraduate, graduate and high-quality personnel (HQP) training to the mining and metals industry workforce. From professional engineers specializing across the mining life cycle to HQP working in policy, business and finance, geosciences, technologies, law and disciplines, the University of Toronto is preparing the next generation of mining professionals and leaders.

As a research-intensive academic institution, the Lassonde Institute represents 35+ Principal Investigators specializing in fundamental scientific inquiry, applied sciences research and the development of technologies and innovations to help support and catalyze the mining industry. Our expertise spans across the entire mining lifecycle. *Our 2021 Research & Innovation Priorities include:*

- 1) Energy & Sustainability
- 2) Safer Mines
- 3) Exploration
- 4) Society and the Economy
- 5) Robotics, Machine Learning & Big Data
- 6) Water & Tailings

Acknowledgements

This collectively written response by faculty members and staff at the Lassonde Institute would like to acknowledge the following contributors:

- Melissa Anderson, PhD
- Gisele Azimi, PhD
- Mansoor Barati Sedah, PhD
- Bridget Bergquist, PhD
- Carlos De Silva Leal, PhD
- Sebastian Goodfellow, PhD
- Murray Grabinsky, PhD, PEng
- Giovanni Grasselli, PhD
- Daniel Gregory, PhD
- John Harrison, PhD, PEng
- Bibhu Mohanty, PhD, PEng
- Emily Moore, PhD
- Vladimiro Papangelakis, PhD, PEng
- I. Daniel Posen, PhD
- Rachel Wallace
- Lesley Warren, PhD

Response to OCMS Framework and Stated Objectives

Recommendations:

- The OCMS should focus on:
 - I. Leveraging Ontario’s breadth and depth of naturally occurring mineral deposits;
 - II. Expanding Ontario value chain to more than exploration and production;
 - III. Growing Ontario’s talent pipeline and training to develop our CM workforce;
 - IV. Improving and resourcing our mining innovation sector
- The term ‘Critical Minerals List’ should be named Critical Materials and Minerals List to reflect its make-up and to be consistent with other jurisdiction terminologies mainly the European Union.
- “Criticality” definition: economic importance of critical material end-use and industrial applications and risk of supply chain disruptions (inclusive of ESG principles).
- The Ontario Critical Materials List should be evaluated in timely intervals to capture current and future CM priorities for Ontario.
- OCMS Framework Objective (1) is missing the explicit language to support the strategic creation of a robust training and talent development pipeline for highly trained personnel (HTP) and the workforce to generate job opportunities and economic development in Ontario. In addition, ESG principles and UN SDG alignment would elevate Ontario’s competitiveness improving talent attraction and increase interest in the industry for prospective and current university and college students.
- OCMS Framework Objective (3) and Objective (4) could be in counter position. To be a supplier of choice for the world, there will be sacrifices made at the local level. If companies operating in Ontario do not have the opportunity to provide value-added products downstream, those entities will miss substantial economic development and job creation opportunities.
- A missing objective needed to support Ontario’s CMS vision: Ontario must promote resiliency and fortify our critical material supply and value chains by strengthening our mining research and innovation ecosystem. This includes funding fundamental and applied research projects and their respective academic institutions.
- Current Ontario mining operations must evolve and innovate to embed the concepts of sustainable development and full lifecycle assessment in its planning and development processes. Academia and early TRL research are needed to link what activities early in the supply chain create better environment and closure outcomes in the future.
- Improved UN SDG alignment and ESG imbedded principles will increase investment opportunities.

Growing demand for critical materials and inputs needed to supply new technology and high-growth sectors presents both challenges and opportunities for Ontario. The associated complexities with our shifting global economy are altering the dynamics locally, nationally and internationally. Ontario can proactively respond to the market and galvanize our: i. rich natural resources; ii. mining and processing capabilities; iii. workforce and training; and iv. innovation sector (inclusive of academia, government and private sector).

I. Ontario's Natural Resources

This increased global demand will likely continue to drive growing competition for many critical materials inclusive of minerals, metals and other elements. To accurately reflect the necessary materials for the new global economy and to capture the breadth of natural resources Ontario will contribute to future supply chains, the term should be expanded from 'Critical Minerals' to 'Critical Materials and Minerals'. Strategically, it is important that Ontario also use an integrated definition to embed and direct Ontario's natural resources value in terms of meta-production within the global economy. The term 'Critical Materials' is also consistent with the EU description².

Criticality Recommended Definition

Ontario should align its definition of 'criticality' with the national and international definitions. The European Union's established 'matrix defines criticality by two key parameters: supply risk and economic importance. Thus, criticality is defined by strategic end-use importance and supply disruption risks.

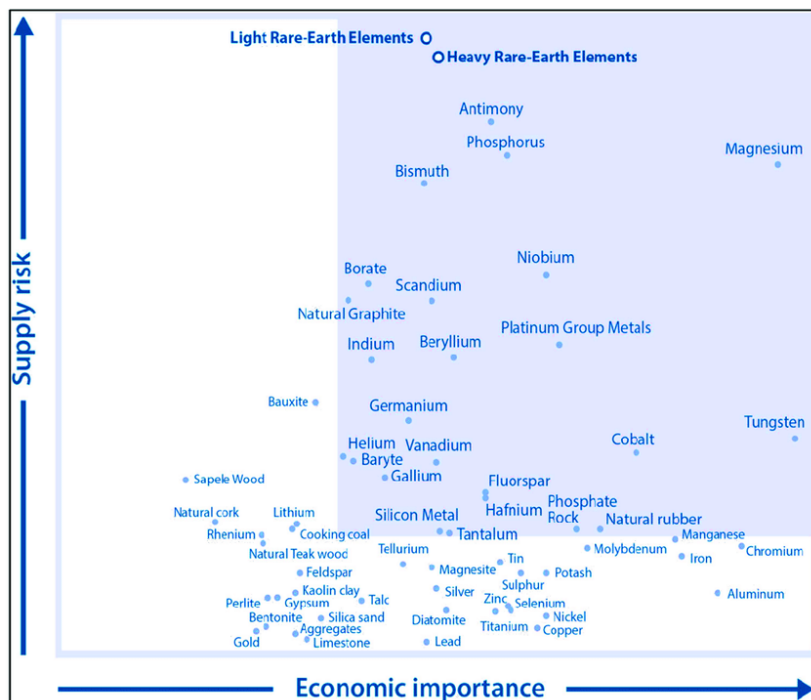


Figure 2: Diagram illustrating the critical metals according to EU reports based on economic importance and supply risk³

² European Commission. Critical Raw Materials available: https://ec.europa.eu/growth/sectors/raw-materials/specific-interest/critical_en

³ Papadopoulos, Argyrios & Tzifas, Ioannis & Tsikos, Harilaos. (2019). The Potential for REE and Associated Critical Metals in Coastal Sand (Placer) Deposits of Greece: A Review. Minerals. 9. 469. 10.3390/min9080469.

The economic importance criterium focuses on the end-uses of the materials based on industrial applications; while supply risk emphasizes the “national-level concentration of global production and sourcing to the EU including recycling, substitution and reliance and trade restrictions in third countries”⁴.

Aligned with the EU ‘criticality’ definition, the USA characterizes ‘criticality’ as “essential to the economic and national security” and where there “the supply chain is vulnerable to disruption”⁵. Again, ‘criticality’ establishes strategic end-use importance and supply disruption risks as predominant indicators.

Determinants beyond the supply chain itself impact raw materials supply risks leading to the chain’s overall sustainability. To be sustainable, the chain must operate within established thresholds that recognize environmental and societal limitations. ESG principles create a vital framework to capture the environmental and societal limitations accurately for the value chain must operate within. Failing to do so negates success over the long-term and ultimately reduces the dependability of the supply chain.

Moreover, when evaluating supply risk, implicit Sustainable Development alignment secures supply chain and improves reliability. Beyond the economic importance of function of materials and resources available, integrating vital ESG criteria allows the supply chain to continue operations without being negatively impacted by environmental and societal limitations i.e. environmental impacts and community licensing thereby increasing reliability.

This more robust assessment would afford some protection against the volatility of demand associated with developing technologies and possible changes in elements required, which could impact performance or cost of end-use applications.

Ontario should include the additional value of our processing and manufacturing sectors as well as end-use applications when determining ‘economic importance’. Ontario can leverage processing and manufacturing across the entire ecosystem and provincial capabilities to move from simply a supplier of choice within the global supply chain, to that of value-adding actor through processing and recycling downstream activities among other capacities improving Ontario’s strategic advantage. Figure 3 illustrates the increasing revenue over the entire copper value chain.

⁴ EIT Raw Minerals Co-funded by the European Commission available: <https://eitrawmaterials.eu/about-us/vision-mission/>

⁵ A Federal Strategy to Ensure Secure and Reliable Supplies of Critical Minerals. A Presidential Document by the Executive Office of the President available: <https://www.federalregister.gov/documents/2017/12/26/2017-27899/a-federal-strategy-to-ensure-secure-and-reliable-supplies-of-critical-minerals>

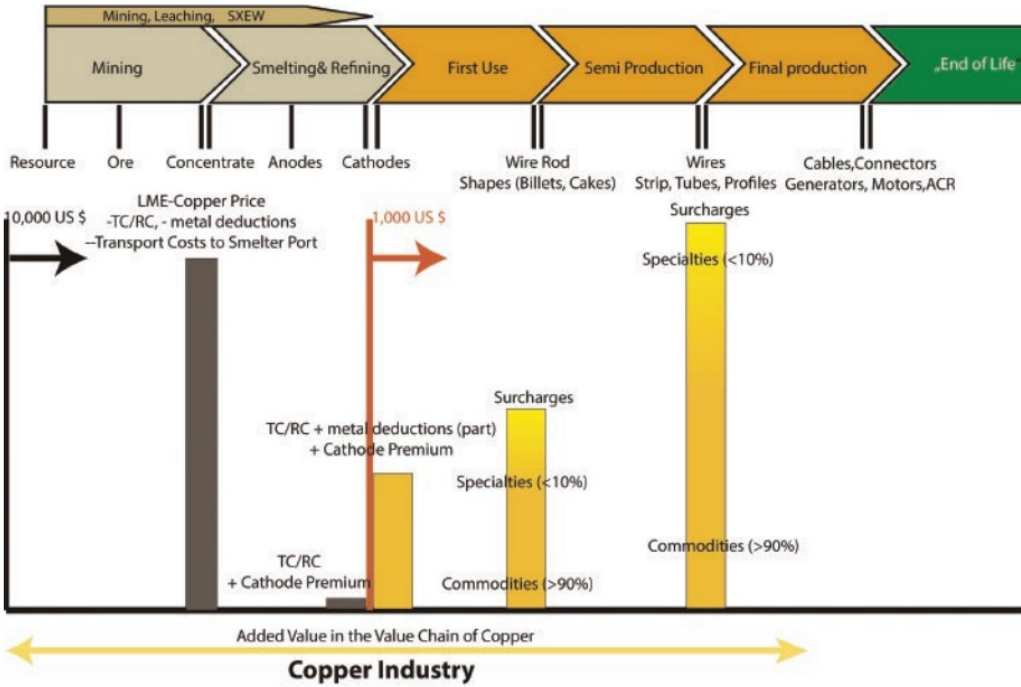


Figure 3: Revenues across the value chain of copper⁶

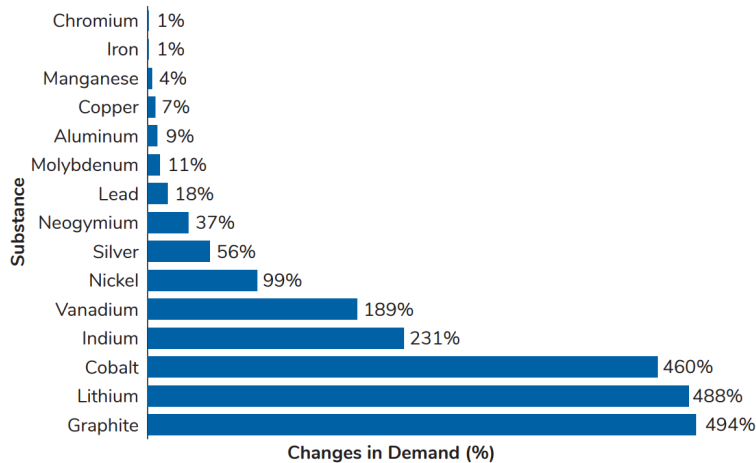
Ongoing Evaluation of “Critical” Designation

Ontario must build a criticality framework that is comprehensive and resilient. The definition needs to be aligned with global jurisdictional and mining sector best practices and future-proof for the rapidly evolving clean tech economy. Geopolitical and technological circumstances will change and criticality shift over time. What must be explicit to this strategy is a plan for how the list will be evaluated and updated in a timely manner to reflect needs as directed by Ontario, Canada and the global economy’s evolving priorities.

In addition, an exclusive focus on economic importance sets Ontario on the back foot with respect to possible mine project success. Ontario’s criticality framework must be built from a sustainable development (responsible mining) perspective, which should include important ESG determinants of Indigenous populations, northern communities, developing nations perspectives as well as environmental stewardship are integrated with prosperity. The largest players in investment and mining production (i.e. Blackrock CEO Larry Fink, Mike Henry CEO of BHP Billiton) are prioritizing ‘responsible mining’ at forefront of company strategy.

As demonstrated in Quebec’s: Plan for the Development of Critical and Strategic Minerals, the change in demand of necessary minerals advances as the global economy shifts (Figure 4). Our Critical Materials framework must be designed to include on-going evaluation that is reflective of current and future demands.

⁶ Examining the copper value chain. Copper World Wide Vol 5 No 1 available: http://www.understanding-copper.com/Documents/CW_ValueChain_Langner.pdf



Source: United States Geological Survey, 2019, and World Bank, 2020.

Figure 4: Change in Demand for Minerals Necessary for the Green Energy Transition 2018-2050⁷

II. Ontario Mining Production, Processing and Manufacturing Capabilities

The COVID-19 crisis has revealed how quickly and how deeply global supply chains can be disrupted. It is important we do not limit Ontario’s contributions to only exploration and extraction and expand the supply chain lens to represent Ontario’s roles and opportunities in the overall CM value chain.

The OCMS Framework lists: *Objective (3)* “become the supplier of choice on the international stage” and *Objective (4)* “increase local supply chain opportunities”. These objectives without proper attention could be in counter position. To be a supplier of choice for the world, there will be sacrifices made at the local level. If local economies are only providing inputs further up the supply chain and do not have the opportunity to provide value-added products through processing and manufacturing downstream, those entities will miss substantial economic development and job creation opportunities as evidenced in Figure 5.

Value-chain Component	Direct Employment (where nickel is produced or converted into value-added products)	Multiplier effect employment (support industries from legal to trucking to advertising)	Total Employment
Production and recycling of nickel: mining, refining, scrap collection and preparation	16,000	7,000	23,000
“First use” of nickel: production of alloys and chemicals	75,000	60,000	185,000
Intermediate products and services: fabricators, surface finishers, stockists	50,000		
“End-use”: nickel and nickel alloys in heavy engineering, chemical works, consumer goods	330,000	150,000	480,000
Total			688,000

Figure 5: Nickel-Dependent Employment in the European Union (2004)⁸

⁷ Critical and Strategic Minerals. Quebec Plan for the Development of Critical Strategic Minerals 2020-2025 available: https://cdn-contenu.quebec.ca/cdn-contenu/ressources-naturelles/Documents/PL_critical_strategic_minerals.pdf?1604003187

⁸ Nickel in the European Union. Nickel Institute available: <https://www.oma.on.ca/en/multimedialibrary/resources/NickelintheEuropeanUnionPDF.pdf>

By viewing Ontario's local capabilities as value add, not mere supply, the ability to attract investment would multiply. Not only would local economies benefit from exploration and extraction investment, but Ontario's entire value chain could offer additional investment opportunities through processing and other downstream activities for high value products.

We recommend the OCM Strategy to view the entire value chain and Ontario look to expand Ontario's processing capabilities by way of incentivizing/support companies' vertical integration and/or establishment of local entities. Beyond economics, Ontario could secure a sustainable development focus throughout the supply chain thereby minimizing supply disruptions to strategically important products as prioritized by Ontario and Canada's economic needs.

III. Ontario Critical Materials Workforce and Training

Ontario's critical minerals strategy Objective (1) states "enhancing economic development and job creation in Ontario" but explicitly missing from this objective is a plan for ensuring creation of a robust training and talent development pipeline for highly trained personnel (HTP). Moreover, the objective does not highlight the workforce required to meet those opportunities for job creation that can lead to economic development in local communities.

Ontario cannot simply focus on the end of the talent pipeline (i.e. increasing the number of jobs available to northern and Indigenous communities). Rather, to ensure prosperity for all and thus licence to operate for mining projects, Ontario must support earlier in the pipeline to ensure all Ontarians, and especially those within local mining project catchments benefit. The current gap in technical expertise in Indigenous and local communities that prevent them from accessing the higher paying jobs available at a mine site will require development of innovative, co-created educational and training initiatives securing the workforce required for mines, ensuring prosperity for all Ontarians and enhancing Ontario's resource sector investment landscape through clear sustainable development aligned actions.

The mining industry needs a talented workforce that understands the value and principles of research and engineering capacities to keep Ontario's mining industry on the leading edge; these workers benefit with high paying jobs that bring prosperity to local communities. Coupled with technical ability and expertise, the critical materials workforce requires direct training and practice with ESG standards and frameworks to ensure Ontario's mining sector is a responsible one: attractive to investors and ensuring licence to operate.

OCMS affords an opportunity to create world-class talent development pipelines for responsible mining in Ontario through a strategic emphasis on building an elite mining industry hub with globally leading universities and colleges. This expanded and well-funded training pipeline would train a workforce for jobs that are high paying but also attractive to young people and thereby securing Ontario's mining future. In addition, expanding the talent pipeline's learning competencies to include training with UN SDGs alignment and ESG principles in operations, which would improve the industry and make it more attractive to new talent. While UN SDGs and ESG perspective will change the training and talent pipeline, this new type of talent will change the industry outlook and improve the outcomes and reputation for Ontario and Canada globally.

Beyond training our talent, Ontario, like many other mining jurisdictions faces challenges around attracting talent and retaining that talent within the mining industry and greater critical materials ecosystem. Considerable support, societal education, marketing and public relations efforts must

be made to highlight the strategic importance and vital impacts the mining industry is making to secure a more sustainable world with technological innovations and high-growth sectors.

IV. Ontario's Research & Innovation Capacity (academia, government and private sector)

Ontario must promote resiliency and fortify our critical material supply and value chains through strengthening our mining research and innovation ecosystem.

Ontario has substantive resource deposits relative to other jurisdictions, and while it is important, we focus on strategic end-use of these materials and alignment to growing tech sectors and energy demands, Ontario must focus on capitalizing on our natural resources deposits in a responsible, sustainable manner. Sustainable resource and material development is a particular area primed for innovation. Here, universities play a catalyzing role in knowledge discovery and technology development to drive that change as responsible resource extraction must be implicit in this strategy.

Creating a strong research and development ecosystem that prioritizes early technology readiness level (TRL) activities as heavily as near-commercialization projects will serve to fortify the Ontario CM Value Chain. Early TRL undertakings include fundamental and applied research pursuits and expansion of principles-based knowledge. Valuating actions across the TRL pipeline creates an inclusive and interconnected ecosystem leveraging all stakeholders' capabilities empowering greater Ontario success activities.

Current Ontario mining operations must evolve and innovate to embed the concepts of sustainable development and full lifecycle assessment. Academia and early TRL research are needed to link what activities early in the supply chain create better environment and closure outcomes in the future.

Investors are increasingly demanding lifecycle assessments to accompany revenue reports. In addition to sustainable investor requirements, the ability to operate and continue to operate within a community is necessary to carry out extraction and any subsequent activities, or more aptly called integrated social responsibility. To this end, ESG must be embedded and implicit to this strategy and must extend across the entire supply chain including raw material extraction through materials processing, manufacturing, distribution, and use. Ontario has an opportunity to foster the necessary innovation clusters of academic researchers, Indigenous peoples and industry to co-create new operational frameworks and technologies that will secure and catalyze action for success. Through expanded research and innovation funding and collaboration support, Ontario could help provide industry with the vital tools necessary to attract sustainable investors and highlight Ontario on the world stage as a leader in responsible mining.

Academia and research stakeholders need funding in a sustaining and substantive way to continue to secure Ontario CM value chain success. Not only should this funding come from the government but also the private sector. Ontario could support this activity by providing incentives to industry to fund long-term, strategic research programs to meet the complex ESG challenges the mining sector is currently facing.

Ontario should look to adequately fund and sustain fundamental scientific and early stage applied research through provincial grants and agencies specifically through direct financial investments and supports. Coordinating an R&D Roadmap with academia and national labs in partnership with

communities and industry could promote collaboration mechanisms, identify gaps and opportunities in the current research and innovation landscape and support enabling knowledge and technology transfers/mechanisms.

Key Areas of Focus for the Critical Minerals Strategy

AREA ONE: Supporting partnership opportunities with Indigenous communities

The Lassonde Institute supports the direct inclusion of Indigenous peoples and Nations in the development of the Strategy rather than their one-off consultations. Inclusivity of Indigenous values and knowledge, as defined by their community, in the strategy will set up Ontario mining projects for success with increased likelihood of investment, successful licence to operate and robust environmental performance that decreases liabilities and risks to business. If the Indigenous Community would like to invite our experts into the conversation, we respectfully will participate but at this time we endorse the Community to speak directly for themselves.

AREA TWO: Finalizing an Ontario critical minerals list

Recommendations

- Ontario's 'Criticality' definition must be aligned with the national and global definition for integration and fit.
- Ontario's Critical Minerals List names, both metals and minerals. We recommended renaming the list: Ontario's Critical Materials and Minerals List.
- OCMS Framework's listed consideration 'Exploration Potential' must be inclusive and of future opportunities and potential not just proven or current.
- Consideration should be given to the following for inclusion: gallium (Ga), germanium (Ge), and indium (In) necessary for high tech components. In addition: cadmium (Cd), hafnium (Hf) and scandium (Sc) should be considered due to their respective relevance for batteries, electronic equipment and aerospace industry components.
- To improve investment opportunities, linking and communicating the OCM's value chain in terms of the UN SDGs, as the global mining industry has already established (i.e. ICMM 10 Principles, see Figure 1) and investors continue to require as the benchmark for a responsible mining sector.
- Bringing lifecycle assessment to the forefront of the entire CM value chain, Ontario can create a credible platform through which the mining industry can demonstrate their alignment and provide confidence to investors and stakeholders.

Criticality Criterion

As aforementioned, when defining Ontario's 'criticality' it is important the definition reflect the global economy's definition to promote integration and fit. The EU defines Critical Raw Materials as the combination of raw materials of high importance to the EU economy and of high risk associated with their supply⁹.

⁹ European Commission. Critical Raw Materials available: https://ec.europa.eu/growth/sectors/raw-materials/specific-interest/critical_en

Ontario's scope must also be consistent with the definition provided by the Canadian federal government. Our 'criticality' definition must also look to value resource deposits and capabilities found outside of Ontario. Many companies based in Ontario rely on other provinces and territories' critical minerals to produce value added products contributing to the Ontario CM value chain.

Of the listed considerations in the OCMS Framework, 'Exploration Potential' focused on critical materials with current demonstrated value, will limit our ability to anticipate and proactively respond to future opportunities for other elements as the dynamic clean tech sector continues to develop. 'Exploration Potential' should be expanded to include materials of possible future and unknown potential. For example, capturing trace elements, not yet considered economically important and therefore not typically quantified, along with base metals during the exploration phase will provide a more robust knowledge base from which to set up strategic mine projects within Ontario.

Again, the 'criticality' factors established today must be evaluated unremittingly against the changing landscape and future needs projections because criticality now and criticality over the next 20-year and 50-year horizons will change as will future demand projections. That re-evaluation and future anticipation must be explicit in the analysis.

List Appraisal

Ontario's Critical Minerals List names, both metals and minerals. Many critical elements i.e. cadmium, gallium germanium, co-occur in much lower quantities in minerals hosting base metals, for example in sphalerite ((Zn,Fe)S), the most important economic Zn containing mineral. To that end, we recommended renaming the list: Ontario's Critical Materials List.

Further, the Lassonde Institute recommends inclusion specifically of important high-tech elements that could be produced in Ontario and that are currently not listed, especially gallium (Ga), germanium (Ge), and indium (In). In addition: cadmium (Cd), hafnium (Hf) and scandium (Sc) should be considered due to their respective relevance for batteries, electronic equipment and aerospace industry components.

Global Investment Opportunities and Attraction Activities

Beyond economic value and supply chain risks, 'criticality' must consider the value chain as it is situated in the broader sustainability context.

Criticality cannot simply focus on the supply side without addressing supply side reliability and sustainability by connecting performance to environmental and social thresholds. These thresholds including environmental considerations and, community building and partnering necessitate support through good governance and regulation to incentivize and support growth and expansion in these areas. Increased attention to ESG practices across the entire lifecycle fortifies Ontario's value chain from raw materials to final manufacturing and extends our participation in the global economy.

Furthermore, adequate economic activity must take place within thresholds established by societal and environmental contexts. The UN Sustainable Development Goals (SDGs) provides a frame of reference and starting point to assess these upper limits. By linking and communicating the OCM's value chain in terms of the UN SDGs, as the global mining industry has already established (i.e. ICMM 10 Principles, see Figure 1) and investors continue to require as the benchmark for a

responsible mining sector, ON would enhance the investment attractiveness for mining projects in the province.

‘Criticality’ must take a comprehensive viewpoint on lifecycle assessment. Viewing the value chain as a simple, linear supply chain discounts opportunities and further investment. Ontario must represent the full, multi-directionality value chain inclusive of all inputs and outputs to demonstrate the breadth and depth of prospects. These prospects, while simultaneously addressing ESG criteria, expand the Ontario value chain to include recovery and recycling as well as environmental services and expertise and mining workforce. Through recycling and recovery, the number of outputs we can supply increases, for example, previously discarded gangue can be feasibly recycled and converted to new value-add materials and mine waste and tailings can be revalorized, further expanding our resources on offer to the marketplace. Ontario needs to lead with policies for good governance that will ensure Ontario mining projects are responsible. Sound, evidence-based policies that include environmental stewardship and community benefits will stimulate job creation and the expansion of service providers and HQP locally and within the greater province area. Again, broadening Ontario’s scope beyond mining and production to include downstream activities further increases investment potential.

“Tesla will give you a giant contract for a long period of time if you mine nickel efficiently and in an environmentally sensitive way,” – Tesla CEO Elon Musk, 2020¹⁰. The sustainable finance space is a growing and expanding potential investment pool that Ontario is positioned to attract but must continue to calibrate towards for future opportunities. These investors use environmental, social and governance (ESG) considerations when making investment decisions, to improve long-term outcomes and sustainable economic activities¹¹.

Ontario must look to create a credible platform through which the mining industry can demonstrate their alignment and provide confidence to investors and stakeholders. This can be achieved by bringing lifecycle assessment to the forefront of the entire CM value chain. Investors, communities, and environmental regulators must see a demonstrated framework built on sustainability intrinsically representing the UN SDGs as performance indicators. By not including these important considerations, Ontario’s investment attractiveness will continue to decline as increasingly investors prioritize responsible mining over short term shareholder return.

¹⁰ Miner Vale in talks with Tesla, EV sector for Canada nickel: executive. Reuters available: <https://www.reuters.com/article/us-mining-canada-vale-sa-idUSKBN26N3HH>

¹¹ European Commission. Overview of sustainable finance available: https://ec.europa.eu/info/business-economy-euro/banking-and-finance/sustainable-finance/overview-sustainable-finance_en

AREA THREE: Enhancing investment in mineral exploration and development

Recommendations

- Leverage already existing exploration programs like the Targeted Geoscience Initiative.
- Look to support Junior's exploration efforts to secure and attract investment.
- Integrated ESG principles and UN SDG alignment in operations of exploration and development activities to boost sustainable investor confidence.
- Re-establish the roundtables with the Anishinabek Nation and the Ontario Ministry of Northern Development and Mines to move beyond performative 'partnering' with the Indigenous community.
- Ontario could require companies performing assays for major metals like copper, lead, zinc, and gold to identify CM trace elements also present in the assays to grasp the additional Ontario exploration potential currently in operating mines.
- The OCMS Framework must comprehensively integrate the economic focus with how we build responsible supply chains for critical materials that are linked to effective policies and partnerships with communities to attract responsible investors.
- The OCMS Framework would benefit from incorporating the concept of community capacity building in their interactions with the various local jurisdictions and peoples.

3.1 Promoting Exploration and Development Investments

Ontario can leverage already existing programs focused on critical minerals exploration in their Critical Minerals Strategy. The Targeted Geoscience Initiative (TGI) by the Geological Survey of Canada at Natural Resources Canada seeks to improve exploration effectiveness and mineral deposit formation process understanding to aid industry exploration success. TGI was recently renewed and with continued Ontario connections and collaborations, this program could contribute to the robustness of Ontario's exploration strengths with a focus on critical minerals and metals. Enhancing exploration methods, through knowledge expansion of how and where mineral deposits are formed, will increase mining industry effectiveness and improve efficiency to find and develop new deposits. This improved performance increases the number of mines in operation inviting greater investment, while simultaneously increasing the amount of materials available for other value-add products creating additional investment opportunities in downstream operations.

In analyzing investment opportunities, it is important to not limit Ontario's focus to major mining companies. Ontario Juniors are vital to the Ontario CRM supply chain. They are important actors in developing new deposits through exploration, which today is dominated by the re-development of old sites to repurpose CMs. As represented in the Lassonde Curve (Figure 6), Juniors developing new deposits from the first exploration stage struggle to attract investment as they predominantly operate in the initial steps of a mine lifecycle (Figure 7). Juniors require greater government support and policies to secure investments. Greater Junior investment promotes and expands their activities for the betterment of Ontario's CM supply. Indeed, social and environmental ESG determinants now drive Junior companies' abilities to successfully attract investment and permit

new projects, underscoring how ESG incorporation must be reflected in a Strategy that enables a resilient and responsible mining sector.

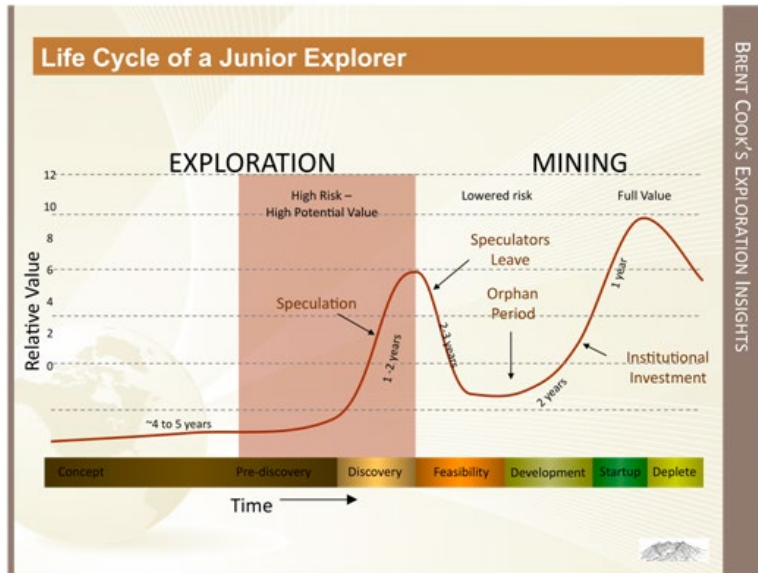


Figure 6 The Lasso Curve demonstrates the life of a junior mining company share ¹²

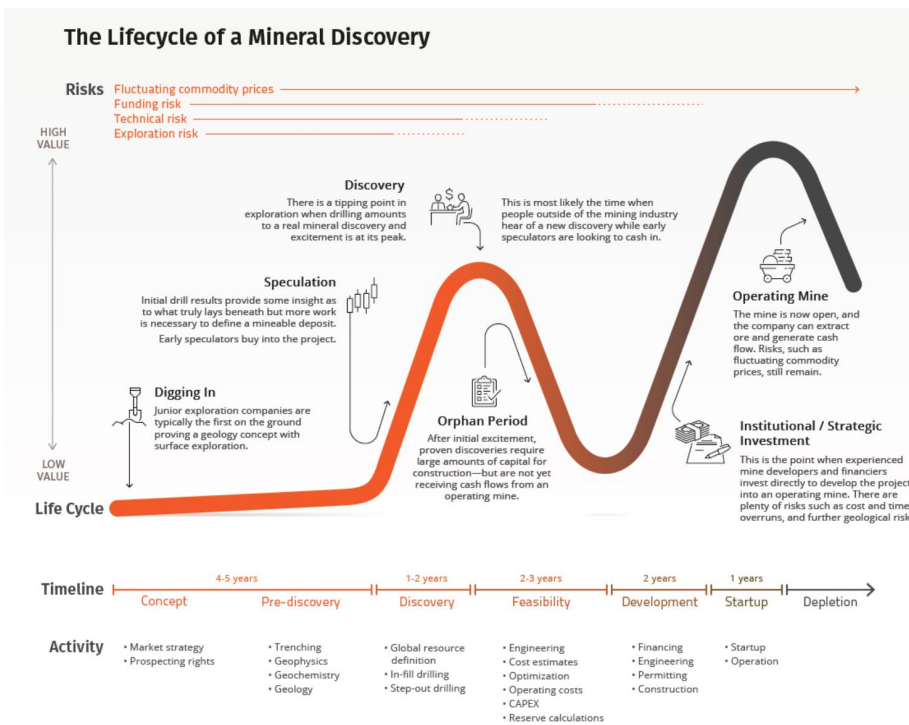


Figure 7 The Lifecycle of a Mineral Discovery via Lasso Curve ¹³

¹² Kitco Gold Report. Brent Cook: Gold miners and explorers face serious supply problems available: <https://www.kitco.com/ind/GoldReport/jun292010.html?sitetype=fullsite>

¹³ Visual Capitalist. Visualizing the lifecycle of a mineral discovery available: <https://www.visualcapitalist.com/visualizing-the-life-cycle-of-a-mineral-discovery>

Responsible Mining | Pathways to Solutions

Connection • Collaboration • Co-Valuation • Co-Creation • Co-Benefits



(1) Commitment ➔ (2) Action ➔ (3) Performance Tracking



Figure 8 The interconnected ecosystem and pathways enabling mining's contributions towards UN SDG success¹⁴

One recommended action Ontario could take would be employing geoscientists to go through the data that is submitted in assessment reports to see if there is potential for critical minerals / materials that have been missed for companies only looking at a couple elements in their larger data set. Acting as a data curator, assessing all elements and summarizing concentrations, the data could be tagged and referenced within a database for future reference. For example, in ten years time, if a given element that was once was only economic at 0.01% is now economic at the g/t level the database could then be leveraged to provide new opportunities for development.

We would also recommend directing funding towards transport, curation and storage of drill core from exploration projects. This would allow for revisiting of projects in subsequent years when new techniques/ models are developed for different needed commodities.

In addition, we would recommend the geoscience working group convene to assess best practices for CM exploration. A key outcome of this would be do recommend the best methods for the different CMs, while ICP is great for the number of elements there can be issues, especially for some elements that do not dissolve well. Thus, have a group determine what sample preparation methods and analytical methods are recommended could be useful.

Investors in this industry want operations to be sustainable and resilient while red tape reduction is part of the solution the strategy must be reflective of all stakeholders and address all their respective challenges. Indigenous communities require more than partnering and inclusivity but need systematic evidence-based policies to support. We encourage the Government of Ontario to re-establish the roundtables with the Anishinabek Nation and the Ontario Ministry of Northern Development and Mines¹⁵.

¹⁴ Image created by Dr. Lesley Warren for the Lassonde Institute Response to OCMS Discussion Paper. April 2021.

¹⁵ Anishinabek Nation. Minerals and Mines available: <https://www.anishinabek.ca/departments/land-and-resources/mineral-mines/>

These important conversations provide strategic opportunities for exchanges and sharing between the Anishinabek communities and the minerals and mines sector resulting in solution-orientated actions and outcomes for the community betterment.

Ontario must also incentivize industry members to move from public commitments to action and performance tracking to increase investment potential from ESG conscious investor pool.

3.2 Enhance Community Participation and Involvement

As previously discussed, environmental and societal thresholds must be adequately met and respected for any economic activity to be successful. The proposed OCMS Framework does not adequately address and embed Indigenous communities and ESG requirements. Beyond these factors being a driving force of investment today, these important aspects will reinforce the longevity of the Ontario's CRM value chain. Rather than emphasizing how do we get more dollars into Ontario we need to focus on how we build responsible supply chains for critical materials that are linked to effective policies and partnerships with communities to attract responsible investors.

Industry must be sensitive to what it brings into and takes out of local communities where they operate. Companies cannot operate simply at net zero harm but must be additive, bringing value to the community and contributing to its well-being as the Beyond Zero Harm Initiative outlines¹⁶. Focusing on value-add relationships with communities through sustainable supply chain operations, expands the economic focus to include community ecosystem components including the surrounding local environment further improving investment potential.

Ontario would benefit from incorporating the concept of community capacity building in their interactions with the various local jurisdictions and peoples. The United Nations defines 'community capacity building' as the process of developing and strengthening the skills, abilities and resources that communities need to survive, adapt, and thrive in a fast-changing world. An essential ingredient in capacity building is transformation that is generated and sustained over time from within and goes beyond performative actions¹⁷. One community capacity building action Ontario could take would be in training indigenous talent and HQP. Indigenous peoples have strong roots in their community and possess a unique understanding of the totality of perspectives represented in their community. Universities can play a pivotal role in training Indigenous peoples to equip candidates for higher-paying jobs. Universities could meaningfully start developing some of those talent pipelines to ensure that those communities and stakeholders are part of the benefit equation by way of support and investment by the Ontario government and beyond.

AREA FOUR: Regulatory and policy reform

The Ontario regulatory systems and policies in place are an important component to the OCM Value Chain success equation. Throughout this response, the Lassonde Institute has highlighted areas of specific regulatory concern that would support the development of the OCMS.

¹⁶ Devonshire Initiative. Beyond Zero Harm available: <https://www.devonshireinitiative.org/beyond-zero-harm>

¹⁷ United Nations. Academic Impact: Capacity Building available: <https://www.un.org/en/academic-impact/capacity-building>

AREA FIVE: Supply chain and manufacturing opportunities

Recommendations

- Capitalize on Ontario's processing capabilities while simultaneously leveraging research and scientific expertise housed at universities and academic institutions to improve Ontario's competitive advantage.
- Greater policy is needed to support present and future recycling capabilities and activities.
- More support must be given to support training Ontario and Canadian talent through academia and professional societies.
- Ontario lacks the manufacturing capability for domestic markets as in the case of batteries for EVs and needs expansion.
- Establishing a green supply of critical materials necessary for EVs through improved ESG exploration, mining, and mineral processing would help attract downstream investment in battery component manufacturing.
- Ontario needs more investment in pilot facilities, research grants and student scholarships for faculty and students working in the metals and mineral sector.

5.1 Ontario Opportunities beyond Mineral Exploration and Development

Ontario's processing expertise is vital to the success of the Ontario CM Value chain, including smelting but also including the downstream processing and hydrometallurgy capabilities. As previously mentioned, Ontario must view the CM supply chain as entire value framework to capitalize on opportunities beyond exploration and development.

Expanding Ontario's processing capabilities while simultaneously leveraging research and scientific expertise housed at universities and academic institutions, catalyzes innovation and leading-edge development potential improving Ontario's competitive advantage and value-add abilities.

5.2 Attracting Investment in New Ontario Processing Capacity

Please refer to section above for comments.

5.3 Key Industry Partners in Expanding Ontario's Supply Chain Opportunities

Early-stage research in universities is not separate from the talent pipeline. Post-secondary institutions are training high quality personnel (HQP) to prepare to the industry and work on near commercialization projects. Ontario and Canadian talent, academia and professional societies are decreasing due to the lack of investment in training. More support must be given to support this vital CM workforce.

5.4 Ontario CM Supply Chain Missing Linkages

To create a robust and resilient Ontario CM Value Chain, we must evaluate the chain in terms of what should drive development – instead of driving development from the resource – the chain development should be driven by the strategic end-use product like batteries and electric vehicles (EV).

When focusing on the end-use product, there is a gap highlighted in Ontario's Value Chain. The province's access to raw materials makes it exceptionally well positioned, but Ontario lacks the manufacturing capability for domestic markets as in the case of batteries for EVs. Moreover, establishing a green supply of these critical materials through improved ESG exploration, mining, and mineral processing would help attract downstream investment in battery component manufacturing. We cannot be only the supplier of choice, but as previously mentioned, we must also produce value-add products.

Critical Materials used to produce batteries for use in electric vehicles are highly vertically integrated. EV manufacturers are taking over the entire battery value chain, from mines to vehicle production. EV makers are investing and buying mines of critical battery materials to secure their supply to their battery manufacturing plants. And the produced batteries are exclusively for their respective vehicles, leaving smaller players, who cannot afford battery manufacturing, struggling to access batteries.

Moreover, the three big OEMs with plans to produce EVs in Ontario (Ford, GM, and Stellantis) will place tremendous demands for battery raw materials from Ontario deposits, yet these companies are building multi-billions battery manufacturing plans in the USA (in partnership with LG, Panasonic, Samsung, SK Innovations), not in Canada. There is a clear opportunity for Ontario to capitalize on the critical battery materials demands and provide downstream value.

To that end, Lion Electric in Quebec illustrates this point. Lion is one of five major electric bus manufacturers headquartered in Canada. Lion recently announced a battery pack manufacturing plant in Quebec (not cell manufacturing). A domestic battery industry could supply battery cells to companies like Lion¹⁸. From this article: *"I think this is the missing piece right now," says Lion Electric Co CEO Marc Bédard. Lion, he says, is currently in negotiations with third parties — the world's go-to major cell manufacturers — to get their supply of cylindrical 21700 cells, but that's largely because there isn't a Canadian option."*

Retaining or recovering Critical Minerals through recycling requires equal emphasis in the Ontario CM Value Chain. Greater policy is needed to support present and future recycling capabilities and activities. Some Ontario deposits will not meet future demands based on current production and Ontario must focus on spurring efforts to recycle CM back into the supply chain. In addition to recycling, another missing linkage in the OCMS is repurposing efforts directed towards previously mined sites and deposits.

The role of universities and academic institutions in strengthening the OCM Value Chain, reaches beyond the research and innovation ecosystem to educating and preparing the OCM people and talent - an input Ontario must secure. Universities have a strategic opportunity to train, re-tool and continually develop the OCM workforce.

5.5 Other Jurisdictions' Best Practices Recommendations

Domestically, Ontario is behind many other provinces' R&D and university investments. While Ontario has been heavily investing in medical sciences manufacturing, there has been little investment for pilot facilities, research grants and student scholarships for faculty and students working in the metals and mineral sector.

¹⁸ Electric Autonomy. Quebec lands new \$185-million Lion Electric Co. battery pack factory available: <https://electricautonomy.ca/2021/03/15/lion-electric-battery-factory-quebec/>

Quebec continues to deliver funding allocation to the universities and academic institutions supporting the mining and mineral sector. For example, The Mining Research and Innovation Support Program (PARIDM) launched in 2017 and renewed in June 2019. This financial assistance program helps fund research projects conducted with universities and recognized research organizations. Quebec's Joint Research Program on Sustainable Development in the Mining Sector represented \$16.5 million of investments to fund 63 university and college research projects. Lastly, the Quebec government has recently authorized the Ministry of Energy and Natural Resources (MERN) to distribute \$17 million to university researchers and \$3 million for college researchers to fund at least 60 projects through to 2022¹⁹.

The Saskatchewan government last year announced a \$400,000 investment to support approximately 100 student internships through a funding arrangement with the Mitacs Accelerate program²⁰. The Mitacs Accelerate program leverages provincial, federal and industry funds to connect university and college interns who have research and technological expertise with Saskatchewan companies. Since 2007, provincial contributions of \$2.8 million to Mitacs Accelerate have leveraged over \$7 million in federal and industry cash support, plus in-kind contributions valued at \$3.3 million, for a total investment of \$13.2 million from all funding partners to date. This has resulted in 483 graduate and post-doctoral internships directly funded by the province to address industry challenges in key sectors including agriculture, forestry, mining, oil and gas sectors, with companies such as Cameco, Syncrude, and Environmental Instruments Canada; industry associations; Indigenous organizations; and municipal, provincial and federal ministries and agencies²⁰.

In Australia, there are co-funded drilling programs for greenfields exploration undercover. A similar program might be useful in Ontario for enhancing deep exploration²¹.

¹⁹ Government of Quebec. Investing in Quebec's Mining Sector available: <https://mern.gouv.qc.ca/wp-content/uploads/investing-in-quebecs-mining-sector.pdf>

²⁰ Government of Saskatchewan. \$400,000 Investment to Support Saskatchewan Industry Internships available: <https://www.saskatchewan.ca/government/news-and-media/2020/september/25/industry-internships>

²¹ Government of Western Australia. Exploration Incentive Scheme (EIS) available: <https://www.dmp.wa.gov.au/Petroleum/Exploration-Incentive-Scheme-2251.aspx>