Mackenzie Valley Operational Dialogue 2024 Presentations

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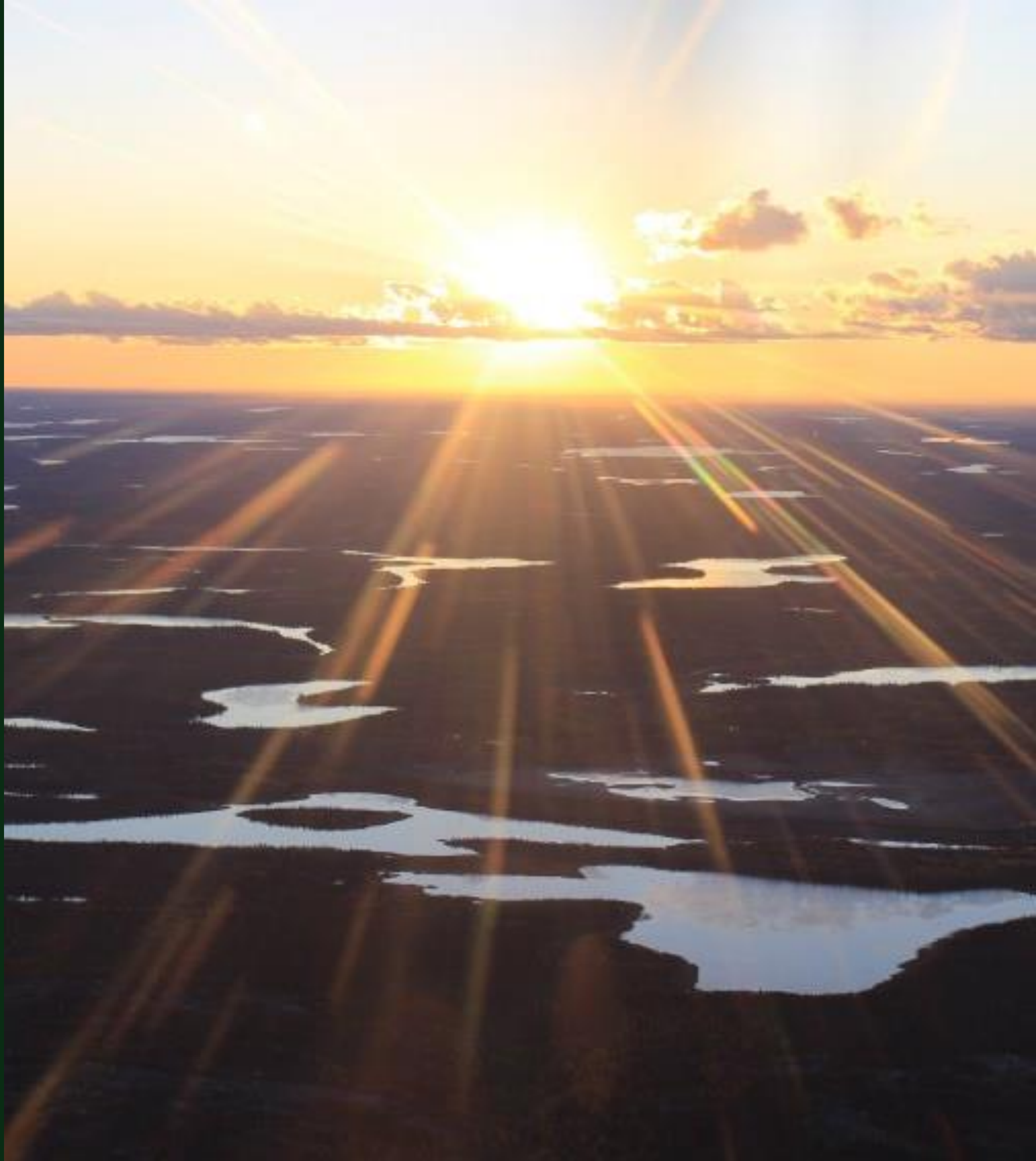


Sustainability is our business

Lithium Background and Geology

Objective: Introduce critical minerals and the physical properties of lithium.

Gideon Lambiv

Industrial Minerals Geologist, Northwest Territories Geosciences (NTGS), Government of the Northwest Territories (GNWT)

Government of
Northwest Territories

The Geology of Lithium Deposits

Gideon Lambiv Dzemua, PhD, P.Geo
Critical and Industrial Minerals Geologist
Northwest Territories Geological Survey

NORTHWEST TERRITORIES
GEOLOGICAL SURVEY

What is Lithium

- Lithium (symbol Li) is a soft silvery grey metal
- It is the lightest (least dense) and most reactive metal
- It floats on, and reacts vigorously with, water
- It has low melting point of 180.5 ^{O}C
- Discovered in 1817 by a Swedish geologist
- Fundamental raw material for the renewable energy transition owing to its widespread use in rechargeable batteries including those use in electric vehicles
- It has a high electrochemical potential (**energy density**), which together with its light weight underpin its application in rechargeable batteries

Geological Occurrence

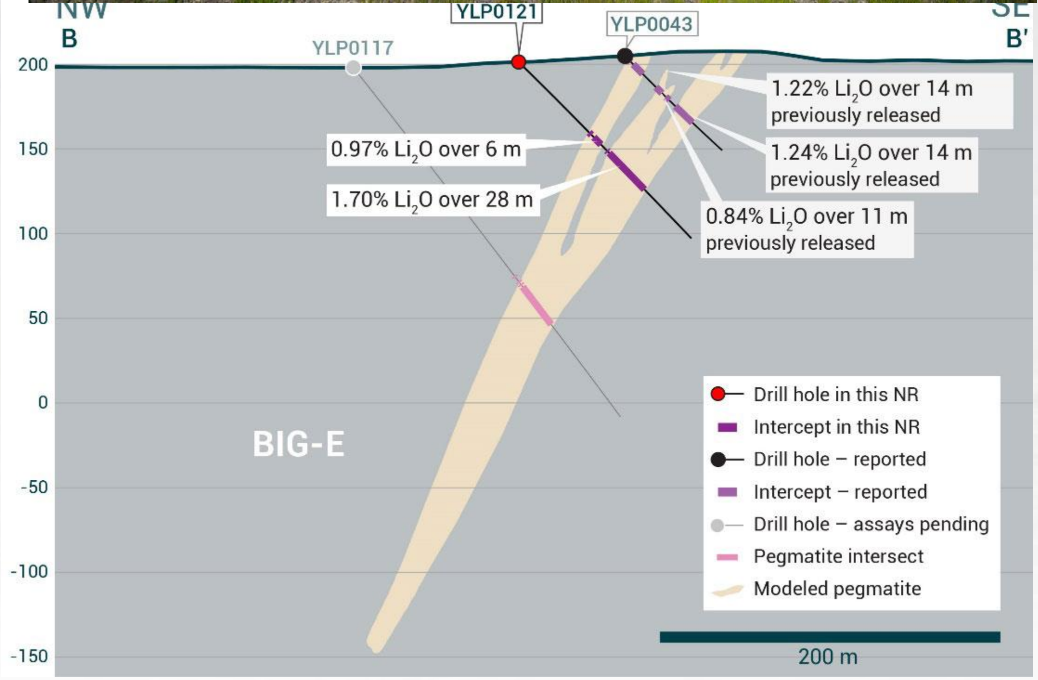
- Lithium always occurs as a compound with other chemical elements; never as a native metal because of its high chemical reactivity
- Economic concentrations of lithium occur in granitic pegmatites, oilfield brines (salty waters), and clays
- **Granitic pegmatites** (hard rock) are the second important source of lithium, after brines, with about 30% of *global lithium reserves*
- Lithium occurs mainly in LCT Pegmatites – a type of pegmatites enriched in lithium, cesium, and tantalum
- NB: A pegmatite (*s.s.*) is any rock with exceptionally large mineral grains (> 3 cm long)

LCT Pegmatites

- Main sources of hard rock lithium; occurs in all continents
- Typically contain higher grades of lithium than brines, up to 3%
- Account for the largest producer of lithium by mine (Australia's Greenbushes).
- Contain simple mineralogy, characterized by **quartz**, **feldspars**, subordinate muscovite mica, and varied minor to accessory minerals including those containing lithium
- ***They are generally devoid of sulfide minerals and the mining waste and tailings are generally inert with extremely low risk of acid rock drainage***
- *Common final products are lithium carbonate and lithium hydroxide*
- The other main type of *rare metals pegmatites* is the NYF, which grouped pegmatites with relatively higher concentrations of niobium, yttrium, and fluorine (NYF).

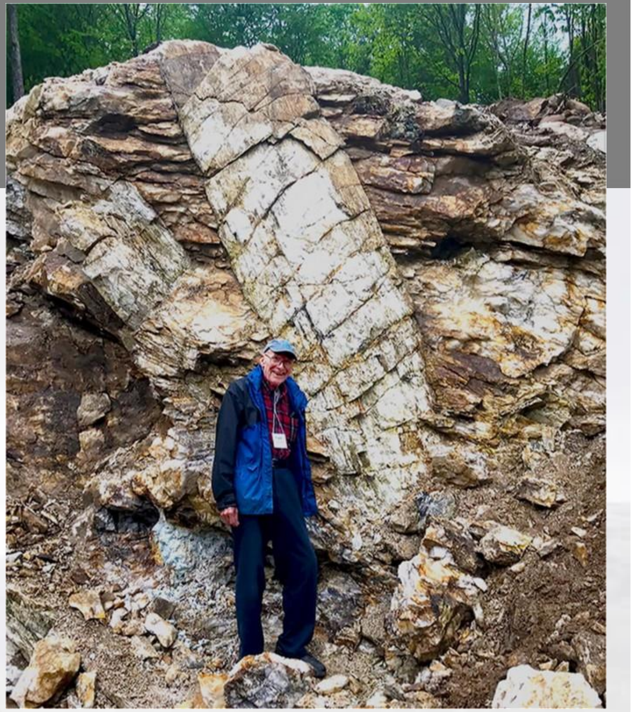
NWT LCT Pegmatites

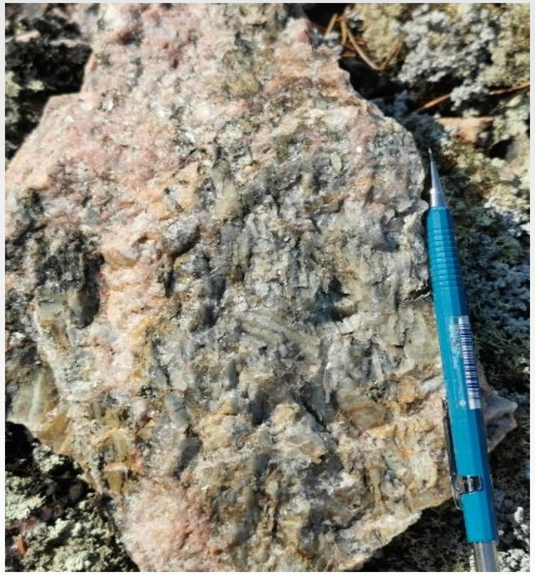
- Occur both in the Shield and in the Mountains
- Mainly as **dykes**, which are always younger than their respective host rocks
- The dykes are generally a few 10s of metres wide, hundreds of metres long, and dip steeply

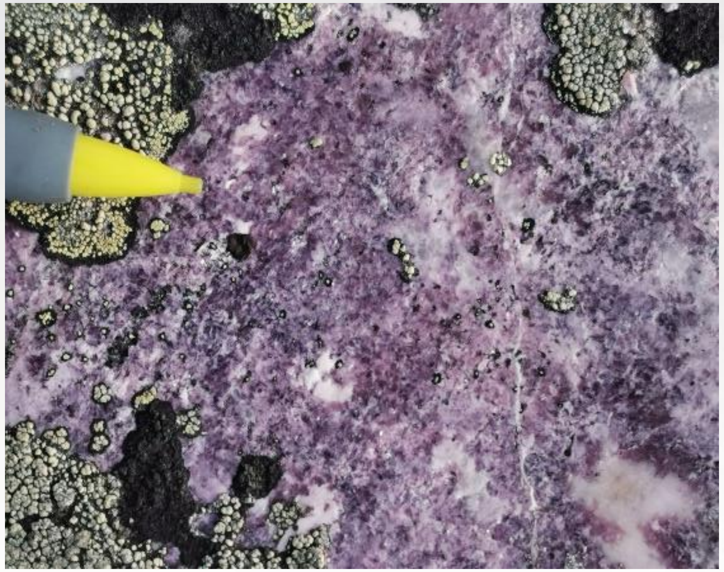


Lithium Minerals

- Lithium occurs in 124 minerals but the most important ones are **spodumene, *lepidolite***, *petalite*, amblygonite, triphylite

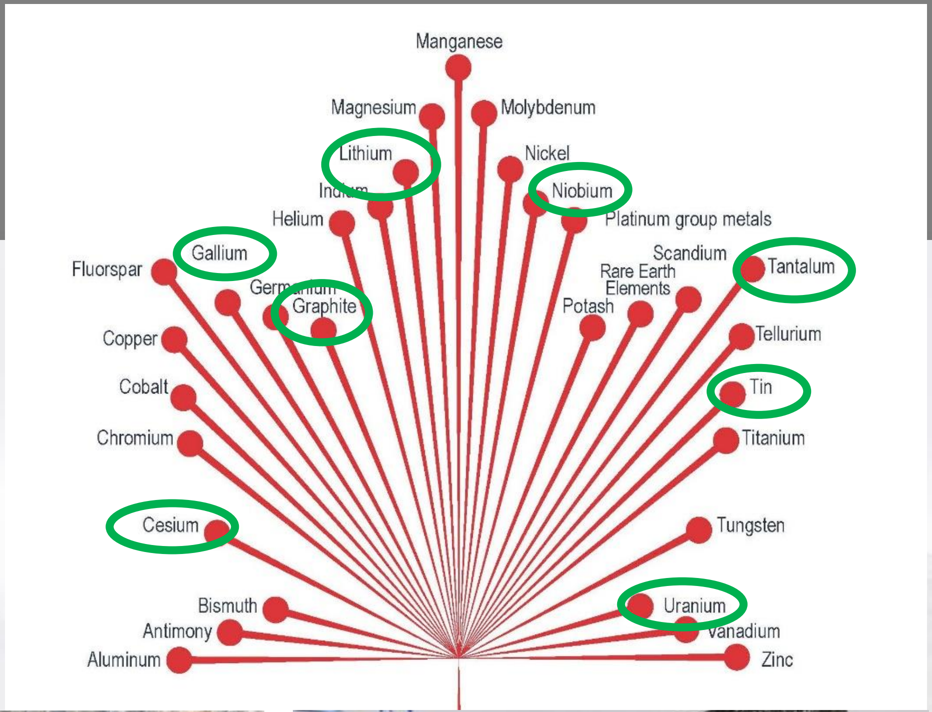






By-products of LCT Pegmatites

- Critical minerals/metals: tantalum, niobium, beryllium, tin, cesium, gallium, uranium, and graphite



Other (Potential) By-products

- Industrial minerals: high purity quartz, silica and feldspars
- Gemstones and museum-quality mineral specimens e.g. Emeralds, aquamarine, and elbaite

Government of Northwest Territories

Lithium Brines

- Lithium brines account for about 70% of global lithium reserves and include continental, oilfield, and geothermal brines
- Have lower grades, <3,000 ppm lithium, but higher tonnages
- Continental brines occur in underground reservoirs in arid regions such as in Chile, Argentina, and Bolivia where they are known as salars
- Production involves pumping the brines into evaporative ponds and allowing to evaporate for 12-18 months, which increases the lithium concentration to about 6,000 ppm
- Generally more economical for the production of lithium carbonate than hard rock, which involves high energy consumption
- However, they have higher environmental footprints because of excessive water consumption especially in arid environments.

Other Lithium Brines

- Oilfield and geothermal brines typically contain 50-75 mg/L and 200 mg/L Li, respectively, along with a diverse suite of other metals.
- Examples occur in Alberta (oilfield brines) and in New Zealand, Iceland, and Salton Sea – localities with significant geothermal fields
- Various technologies are being tested for the extraction of lithium out of the brines including direct lithium extraction, or DLE, in which lithium is pulled out of brine while leaving other dissolved compounds behind
- NWT has a high potential for oilfield type brines in its oil fields and salt flats. These, however, are yet to be evaluated

Lithium Clays

- Economic concentrations of lithium also occurs in clays in arid regions
- In these deposits, lithium is bound or adsorbed onto clay minerals especially hectorite - a type of smectite formed from volcanic ash, commonly in lakes.
- The source of lithium is still up for debate
- Currently, no lithium clay deposit is in production, but interest is ramping up. Advanced projects include Thacker Pass and Clayton Valley in Nevada and Sonora in Mexico. Similar deposits occur in California, Utah, Oregon, Arizona, Wyoming, New Mexico and in China
- The deposits generally have lower grades (0.3-0.6% Li) but larger tonnages and lower waste:ore strip ratios than pegmatites
- Unfortunately, NWT is not prospective for clay-type lithium deposits

Take Home

- There are 3 main types of lithium deposits: pegmatites, brines, and clays
- Although pegmatites accounts for only about 30% of current global lithium production, they are attracting a lot exploration and research interests because of their higher grades, simple mineralogy, and low environmental footprint
- NWT is endowed with hundreds of LCT pegmatites with demonstrated lithium potential
- Some of the pegmatites contain significant concentrations of other critical minerals
- The pegmatites occur both in the Shield and in the Mountains
- NWT has potential for oilfield-type lithium brines

Marsi
Thank you
Merci

Lithium Context

Objective: Provide an overview of the lithium industry and value chain in Canada and globally, including uses, market analysis, and socioeconomic perspectives.

Jesse Hembruf

Policy, Research Analyst, Natural Resources Canada (NRCan)

&

Alex Langer

President, LiFT

HARD ROCK LITHIUM EXPLORATION IN CANADA

Li-FT POWER

TSXV: LIFT | OTCQX: LIFFF | FRA: WS0   www.li-ft.com   March 2024

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The technical and scientific information in this presentation, related to Company projects in Quebec, Canada has been reviewed and approved by Don Cummings, P. Geo., OGX Member 2183, who is a Qualified Person for the Company under the definitions established by National Instrument 43-101 ("NI 43-101").

The technical and scientific information in this presentation, related to Company projects in Northwest Territories, Canada, has been reviewed and approved by Ron Voordouw, Ph.D., P.Geo, Partner, Director Geoscience, Equity Exploration Consultants Ltd., and a Qualified Person as defined by National Instrument 43-101 Standards of Disclosure for Mineral Projects (NI 43-101) and member in good standing with the Northwest Territories and Nunavut Association of Professional Engineers and Geoscientists (NAPEG) (Geologist Registration number: L5245).

Why Lithium? What is it, why should we care?

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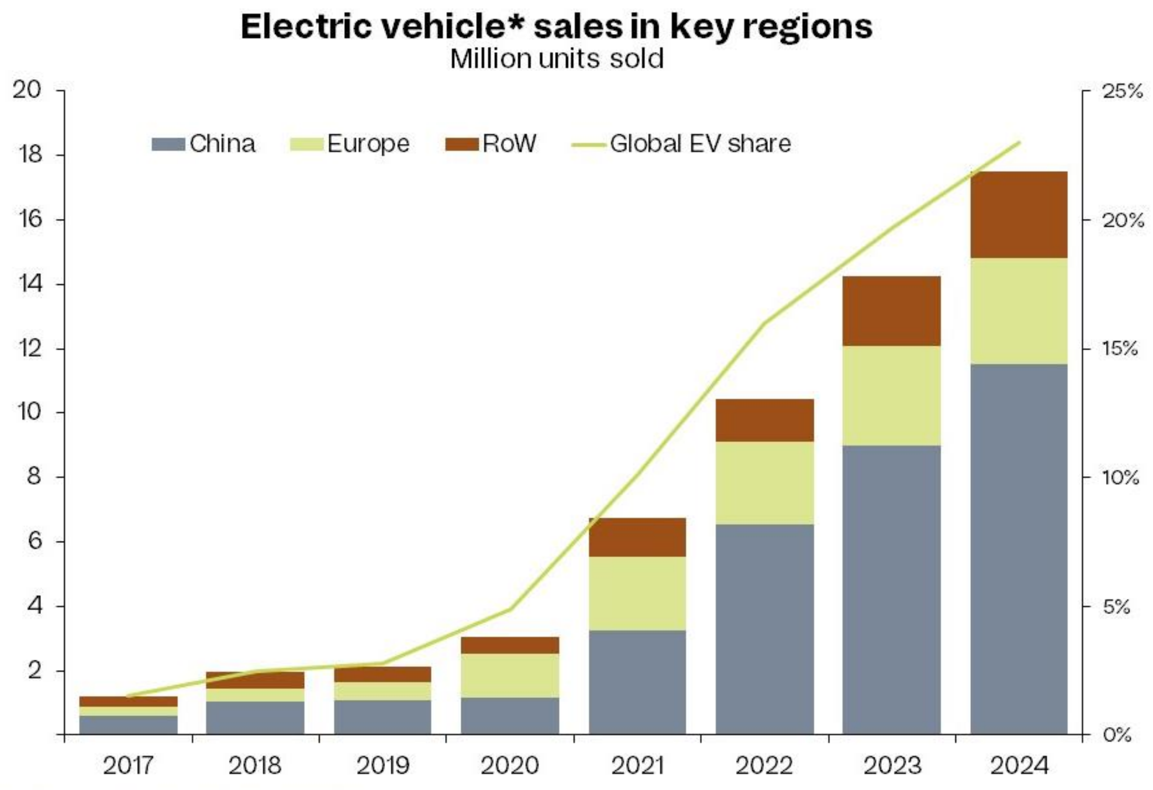
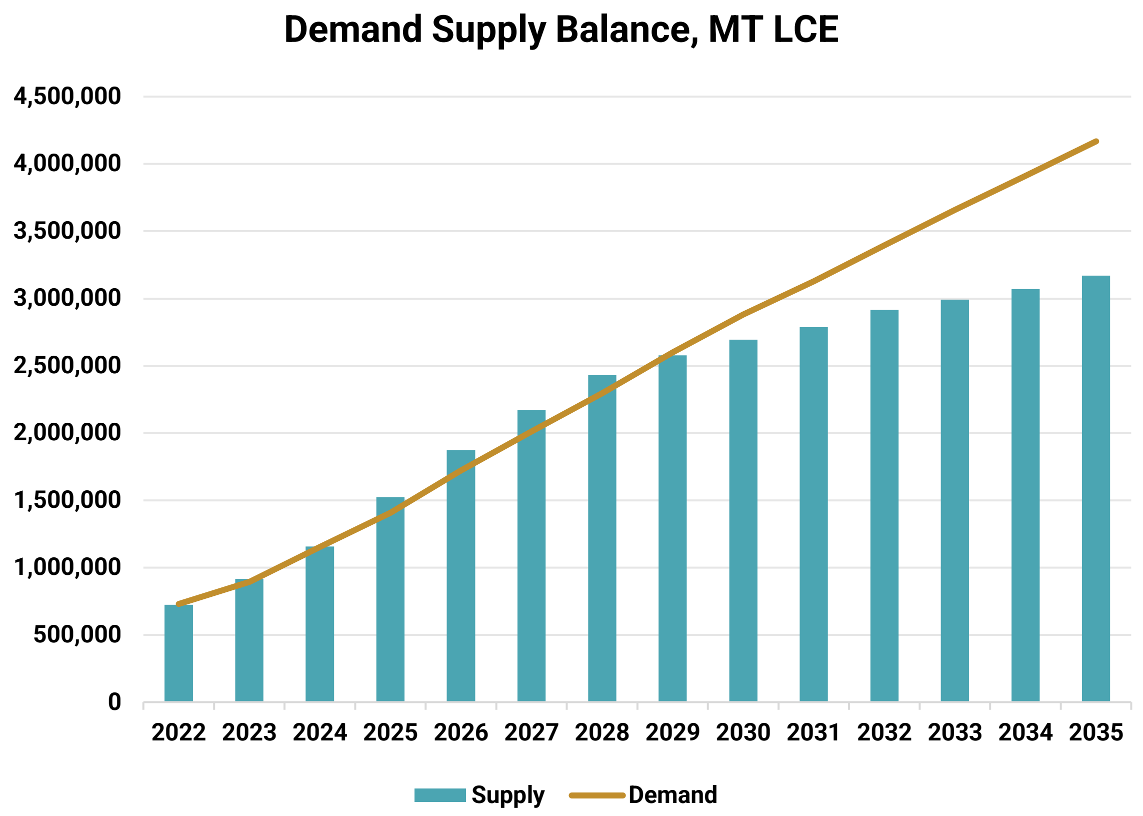
Climate change → Green Energy Transition → Renewable Energy & Storage

Lithium demand is driven by electric vehicle sales



*Includes new BEV and PHEV sales
Source: Rystad Energy's Energy Transition Solution, February 2024
A Rystad Energy graphic

Not enough lithium supply to meet demand



Lithium Market

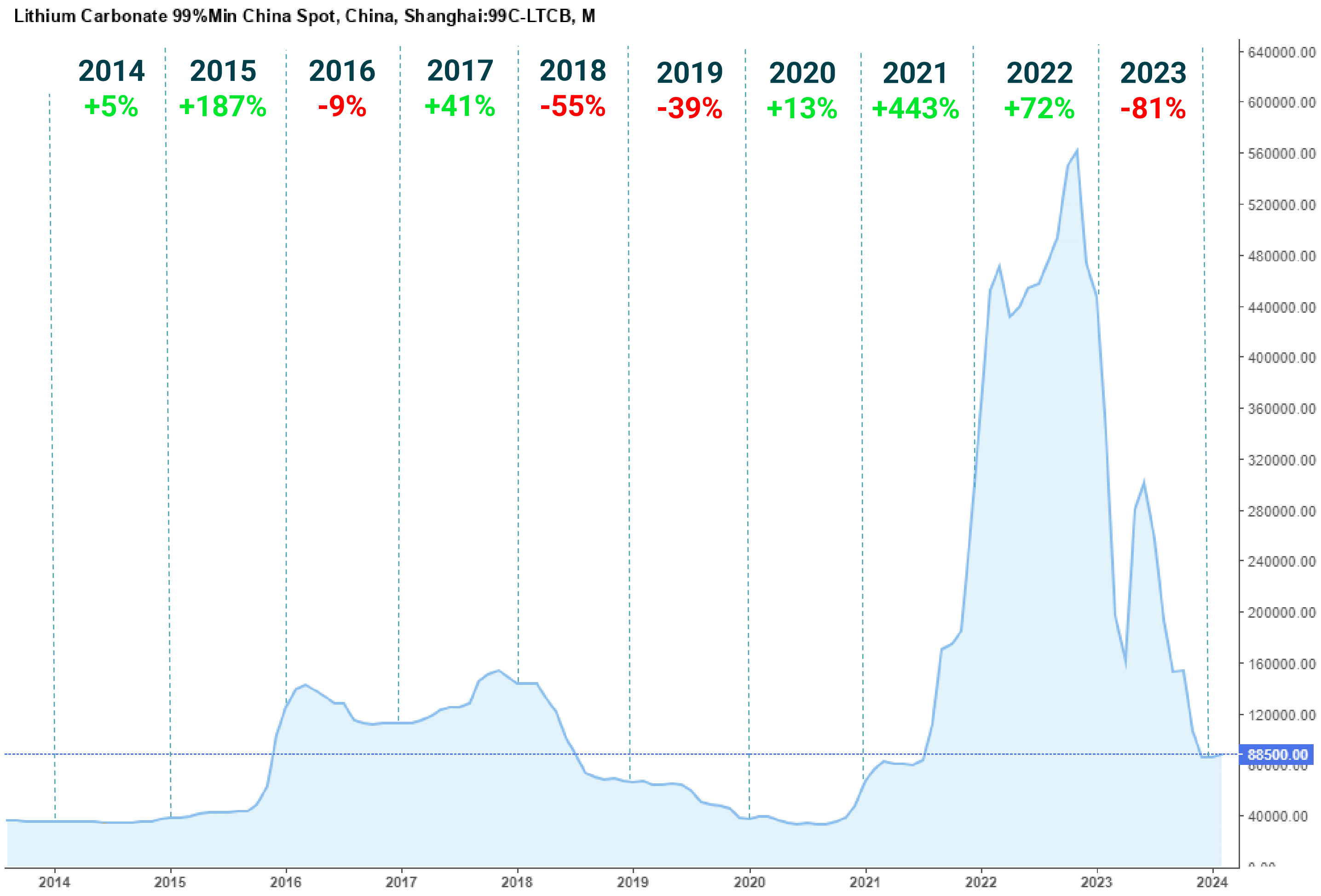
10-year price performance

2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
11.35% Pd	187.05% Li	103.67%	56.25% Pd	18.59% Pd	54.20% Pd	47.89% Ag	442.80% Li	72.49% Li	13.10% Au
6.91% Ni	-2.50% Pb	60.59% Zn	40.51% Li	17.86%	34.46%	26.02% Cu	160.61%	43.13% Ni	1.19% Cu
4.82% Li	-9.63%	59.35%	32.39% Al	6.91%	31.55% Ni	25.86% Pd	55.01%	19.97%	-0.17% Al
3.91% Zn	-10.42% Au	45.03%	31.19%	-0.44%	21.48% Pt	25.12% Au	46.91%	14.37%	-0.66% Ag
3.80% Al	-10.72%	20.96% Pd	30.49% Cu	-1.58% Au	18.31% Au	24.82%	42.18% Al	10.90% Pt	-7.67% Pt
-1.72% Au	-11.75% Ag	17.37% Cu	30.49% Zn	-8.53% Ag	15.21% Ag	19.73% Zn	31.53% Zn	6.71%	-9.97%
-2.24%	-17.79% Al	14.86% Ag	27.51% Ni	-14.49% Pt	11.03%	18.66% Ni	26.14% Ni	2.77% Ag	-10.73%
-5.52%	-19.11%	13.58% Al	24.27% Pb	-16.54% Ni	3.40%	15.99%	25.70% Cu	2.76%	-12.10% Zn
-11.79% Pt	-20.31%	13.49% Ni	13.09% Au	-17.43% Al	3.36% Cu	14.63%	22.57%	-0.05% Pb	-12.93% Pd
-14.00% Cu	-26.07% Pt	11.27% Pb	12.47%	-17.46% Cu	-4.38% Al	13.15% Li	20.34%	-0.28% Au	-20.71%
-15.51%	-26.10% Cu	8.56% Au	6.42% Ag	-19.23% Pb	-4.66% Pb	10.92% Pt	18.32% Pb	-5.89% Pd	-30.55%
-16.00% Pb	-26.50% Zn	1.16% Pt	4.66%	-22.16%	-9.49% Zn	10.80% Al	-3.64% Au	-14.13% Cu	-38.63% Pb
-19.34% Ag	-29.43% Pd	-1.88%	2.99% Pt	-24.54% Zn	-18.02%	3.25% Pb	-9.64% Pt	-16.27% Al	-43.82%
-31.21%	-30.47%	-8.63% Li	-0.63%	-24.84%	-25.54%	-1.29%	-11.72% Ag	-16.34% Zn	-45.21% Ni
-45.58%	-41.75% Ni	-13.19%	-20.70%	-54.70% Li	-38.50% Li	-20.54%	-22.21% Pd	-48.34%	-81.43% Li

Performance

Legend: Coal, Copper, Crude Oil, Natural Gas, Wheat, Aluminum, Corn, Gold, Lithium, Zinc, Lead, Palladium, Silver, Nickel, Platinum

Source: Bloomberg and U.S. Global Investors



Lithium in Canada and NWT

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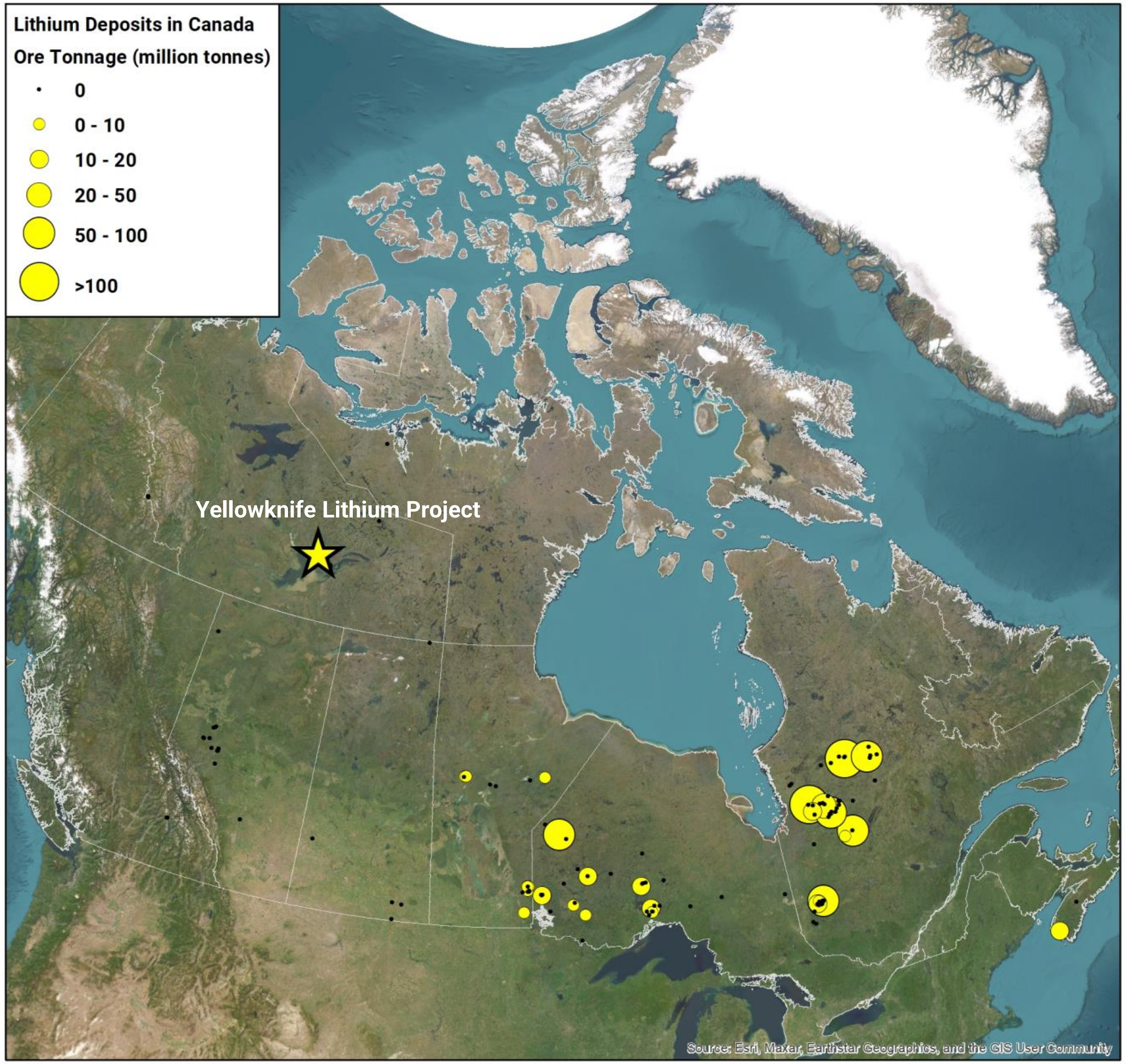
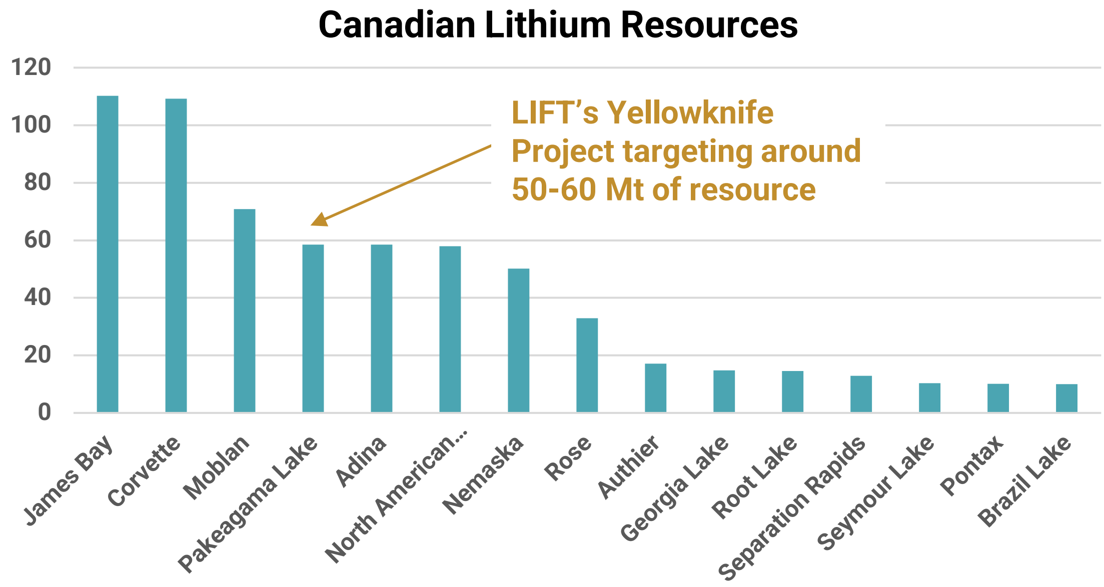
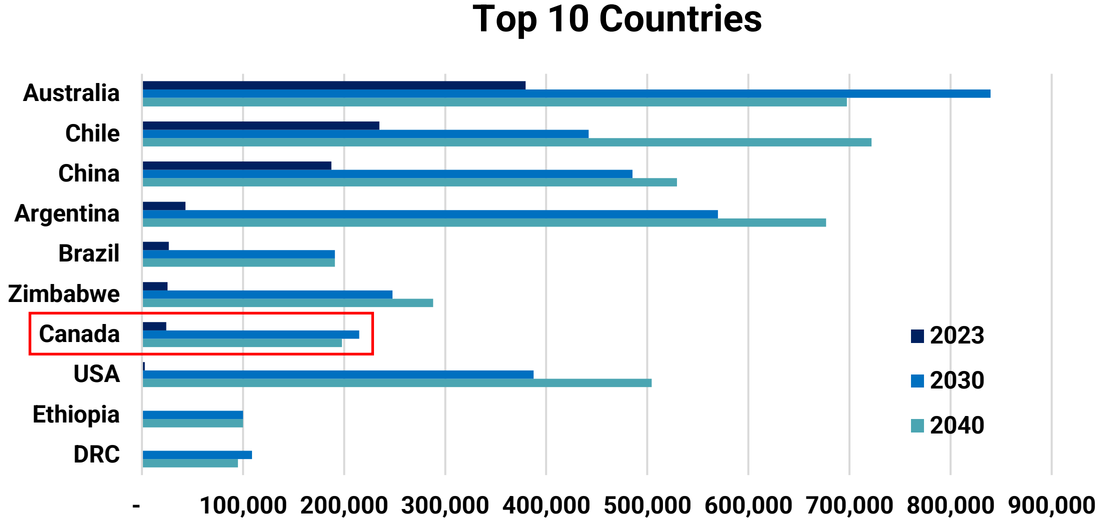


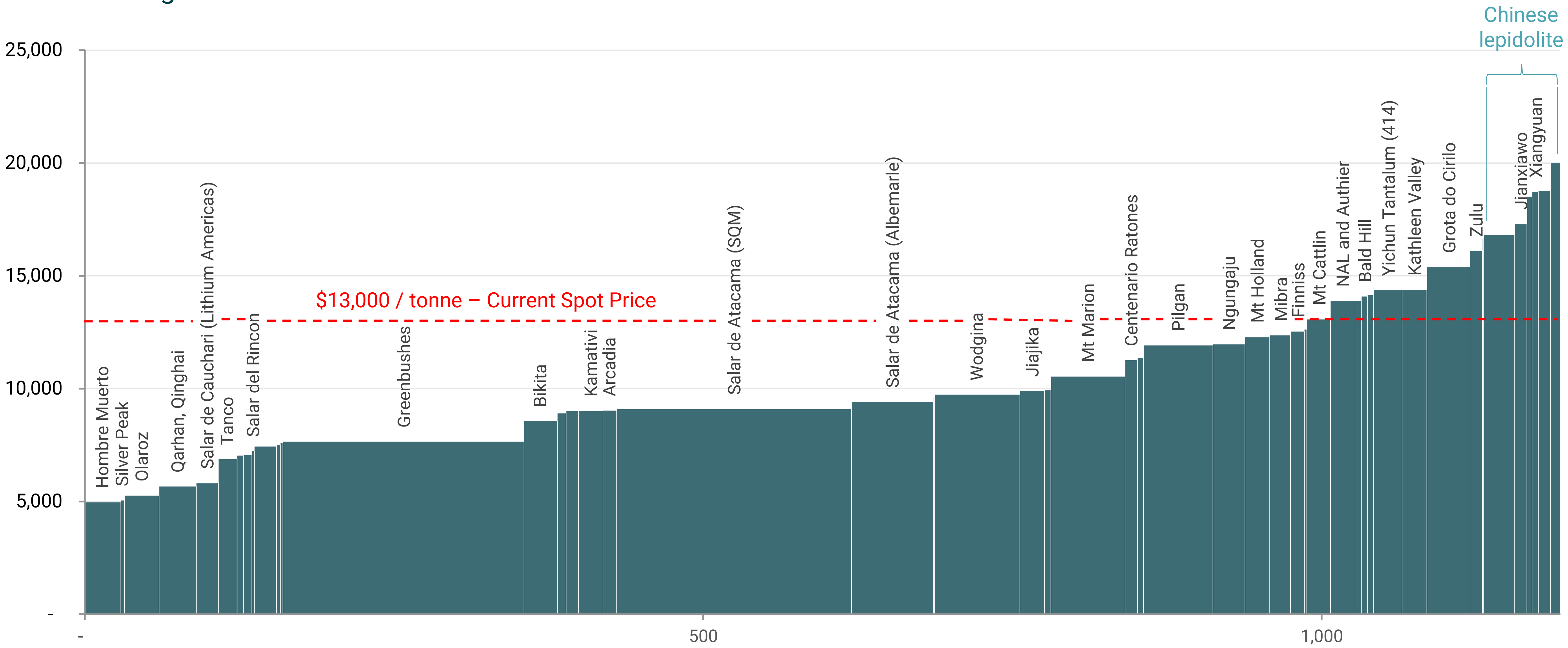




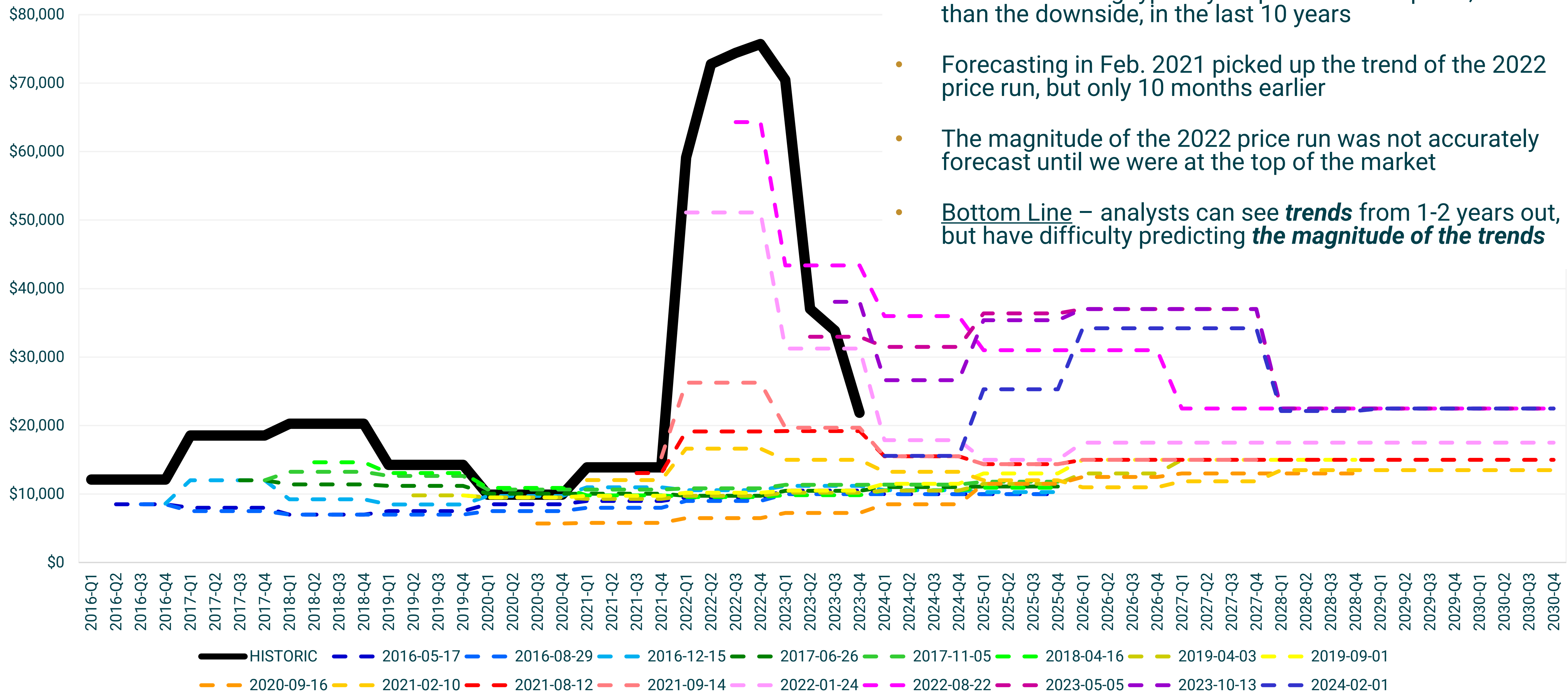
	DRC	Ethiopia	USA	Canada	Zimbabwe	Brazil	Argentina	China	Chile	Australia
2023	-	-	3,000	24,000	25,500	26,500	43,000	187,500	235,000	379,500
2030	109,000	100,000	387,400	215,000	248,000	191,000	569,800	485,400	442,000	839,500
2040	95,000	100,000	504,400	198,000	288,000	191,000	676,800	529,400	722,000	697,500

Lithium Carbonate Cost Model

- ~12% of the world's supply of lithium carbonate production is currently being produced at a cost above current spot price
- How long can this last for?



Price Forecasting vs Actual Price



- Price forecasting typically surprises to the upside, rather than the downside, in the last 10 years
- Forecasting in Feb. 2021 picked up the trend of the 2022 price run, but only 10 months earlier
- The magnitude of the 2022 price run was not accurately forecast until we were at the top of the market
- Bottom Line – analysts can see ***trends*** from 1-2 years out, but have difficulty predicting ***the magnitude of the trends***

Source: Analyst reports from well-regarded brokerage firm

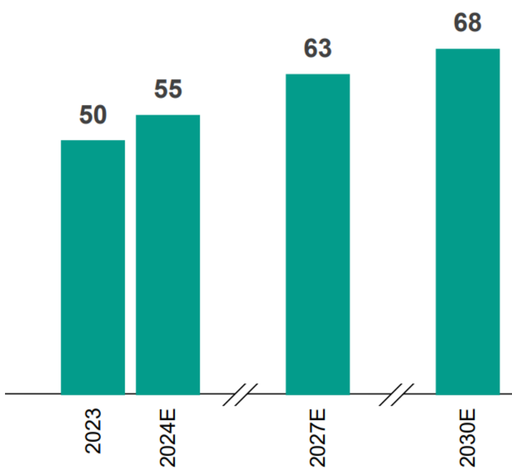
Demand

Li-FT POWER

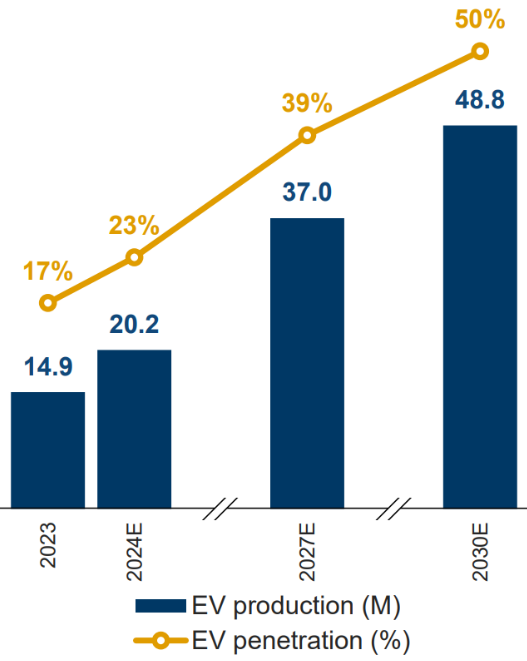
Lithium Market Demand Outlook: 2.5x Growth 2024-2030

Global EV Outlook

Battery Size (Global EV Average)[1]
(kWh per EV)

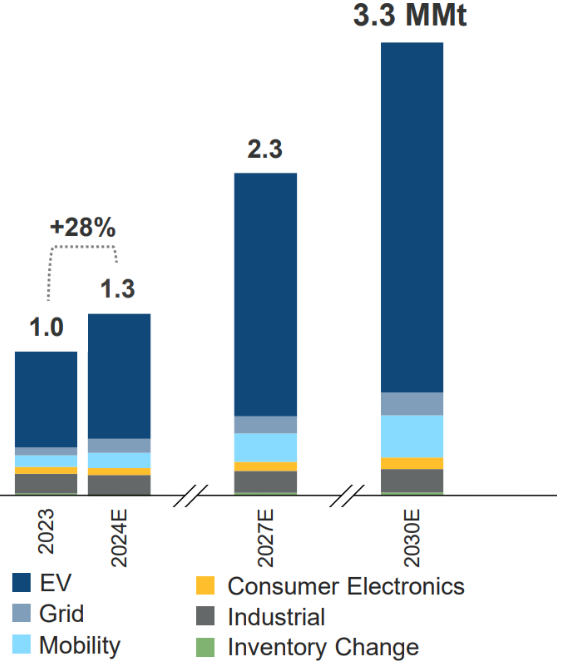


Production / Market Penetration[1]
2024-2030
CAGR: 15-20%



Lithium Demand

by Application[2]
(MMt LCE)
2024-2030
CAGR: 15-20%

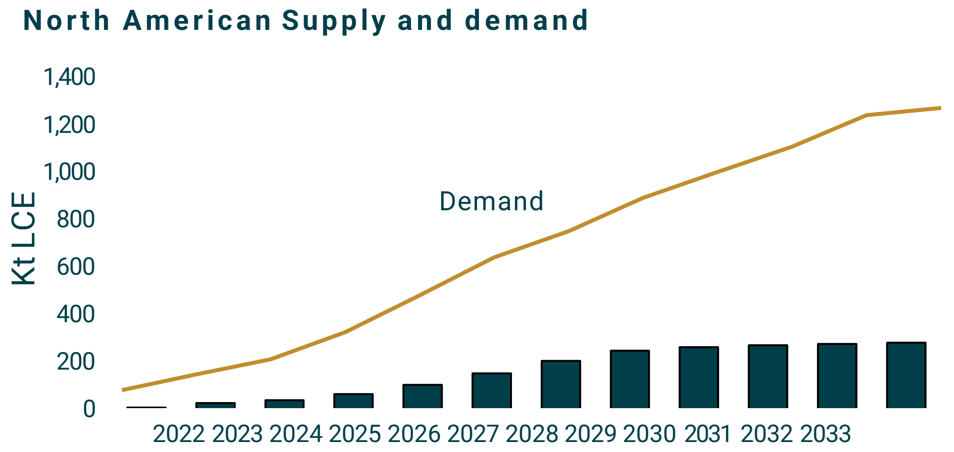


- Current market sentiment has turned negative, but long-term demand growth still intact (est. 15-20% CAGR in 2024 vs. 33% in 2023)
- Demand lead by China; non-North American growth expected to outperform this decade

NEV penetration rate in Chinese market is forecasted to reach 50% in 2025

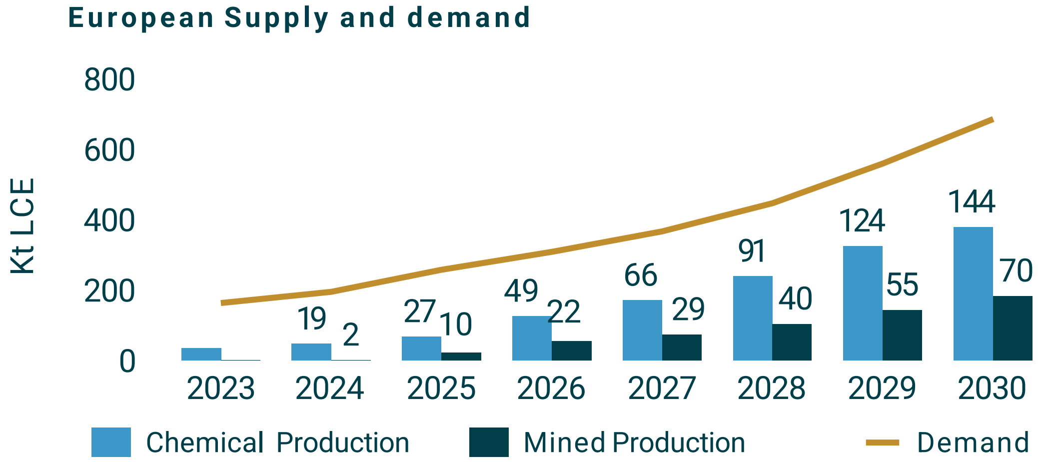
By Global Times
Published: Dec 04, 2023 07:46 PM

Lithium Supply/Demand in North America & EU



2023 3 Operating Lithium Mines
3 Lithium Chemical Producers

2033 34 Operating Lithium Mines
35 Lithium Chemical Producers



2023 1 Operating Lithium Mine

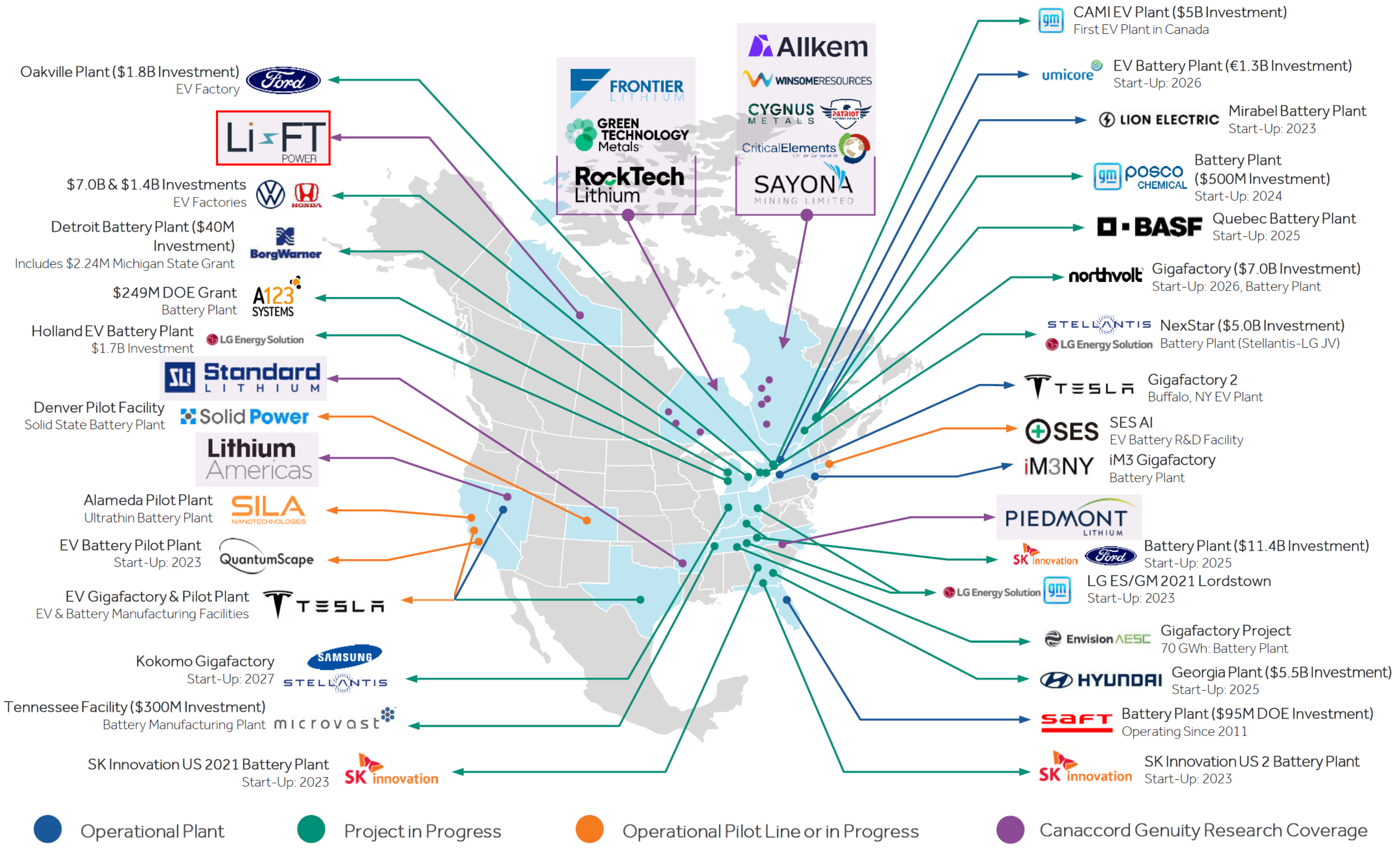
2026 5 Operating Lithium Mines
1 Lithium Chemical Producer

- 72% of refined lithium chemicals (carbonate, hydroxide) are produced in China (which only has 8% of global in-ground reserves of Li)
- Lithium is vulnerable to geopolitical shocks due to supply chain concentration
- North American demand is much higher than any conceivable supply
- Europe is slightly better, but large gaps remain
- If China ever decided to weaponize their control on refined lithium chemicals, supply shocks would hit hard in North America

Source: Benchmark Minerals Battery Database

Emerging North American Lithium Market

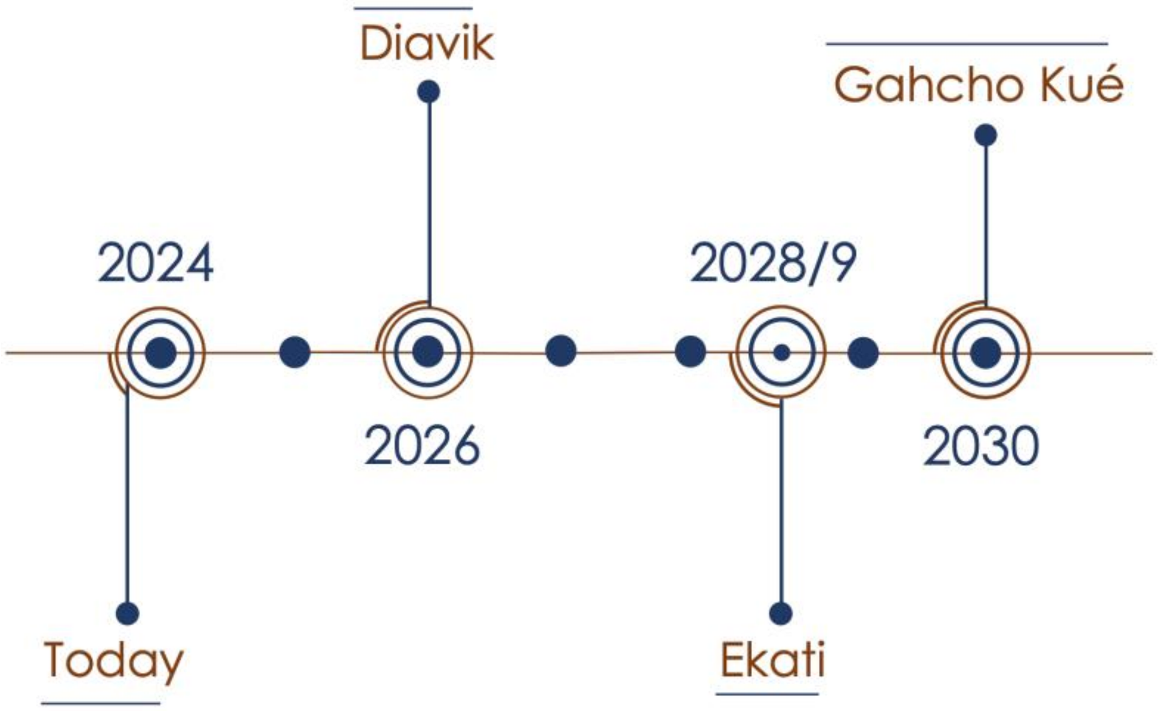
Lithium Supply Chain – Transformation Coming



- The North American Lithium supply chain is on the cusp of massive change
- >$50 B committed to date for battery and EV manufacturing facilities
- Where do the raw materials come from?
- Li-FT Power is well positioned to deliver lithium into this burgeoning marketplace

Source: S&P Capital IQ, Public Disclosure
Source – Canaccord Genuity

The Economic Future of the NWT



Current timeline for mine closures

Table 10

Relative Contribution of the Resource Sector (Direct and Indirect Employment and Income)

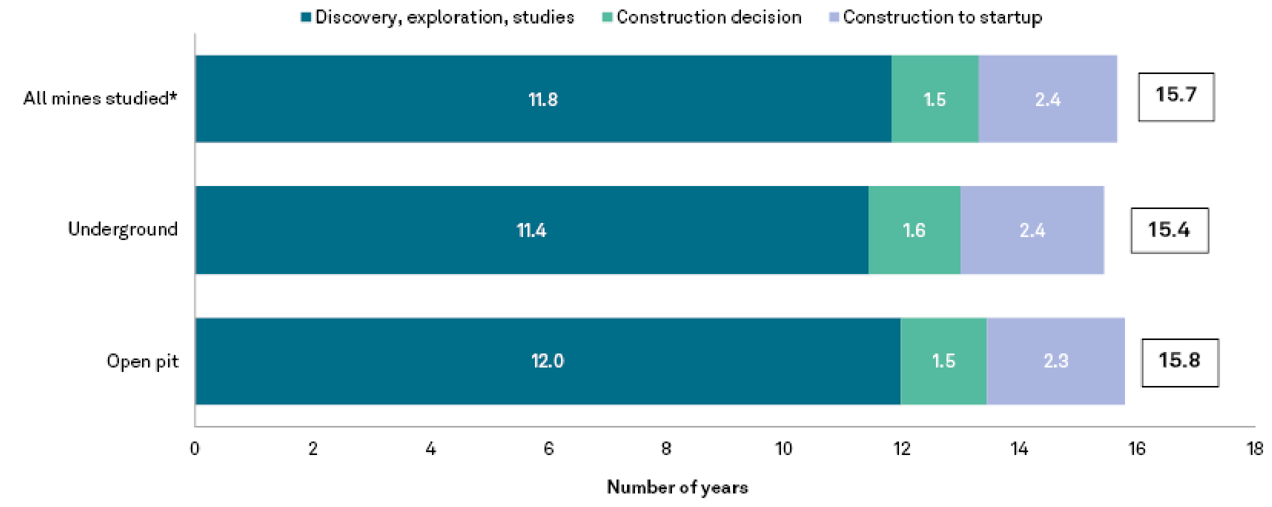
	Employment Taxfilers (%)	Employment Income (%)	Total Income (%)
Yellowknife	7.8%	15.7%	13.4%
Rest of NWT	3.9%	10.1%	7.9%
Northwest Territories	5.9%	13.5%	11.1%

- Mining has been a critical component of the NT economy for many years.
  - 27% of GDP in 2022
- Impending mine closures have the potential to change the fabric of the NWT as we know it.
- **The timelines for success in the global lithium market align with the timelines for mine closures in NWT**
  - Skilled labour force available for lithium mining just as Li-FT's projects could come online
- **We need to work together as partners to make the timing transition work.**

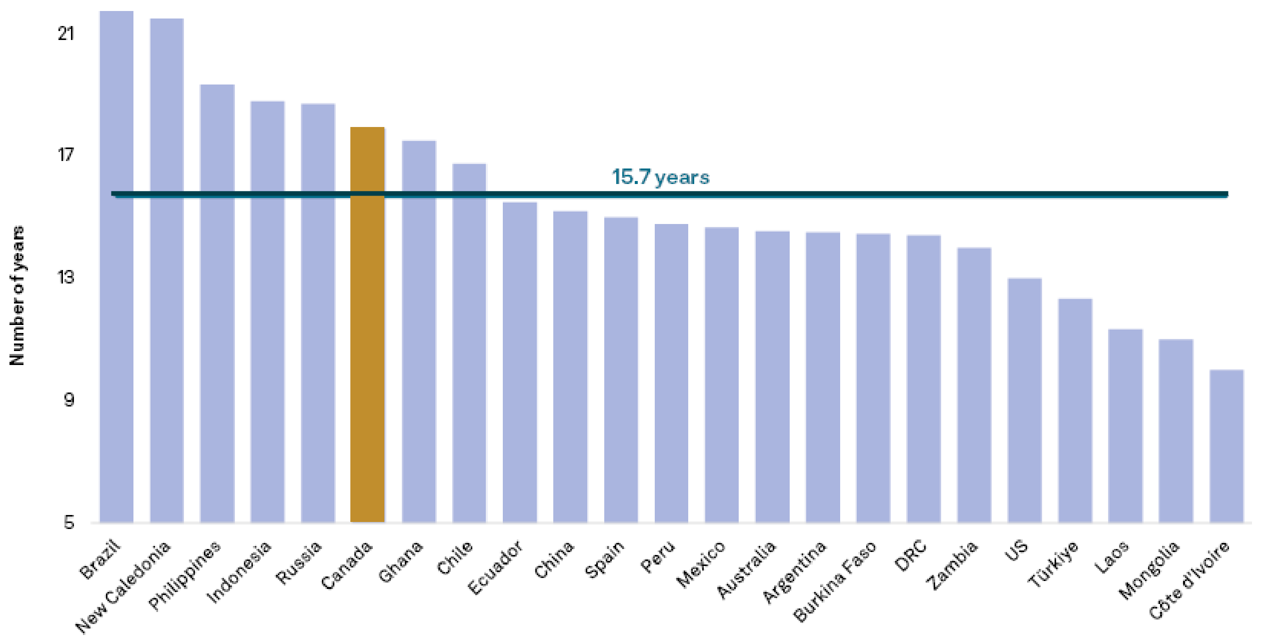
The problem is TIME

- Average timeline from discovery to production is 15 years
- We are in a GLOBAL RACE to get lithium deposits into production
- Countries in Africa are bringing resources to market within a 1-2 year permitting timeline
- Brazil also has much more favourably timelines on permitting (e.g. Groto do Cirolo-Sigma Lithium)

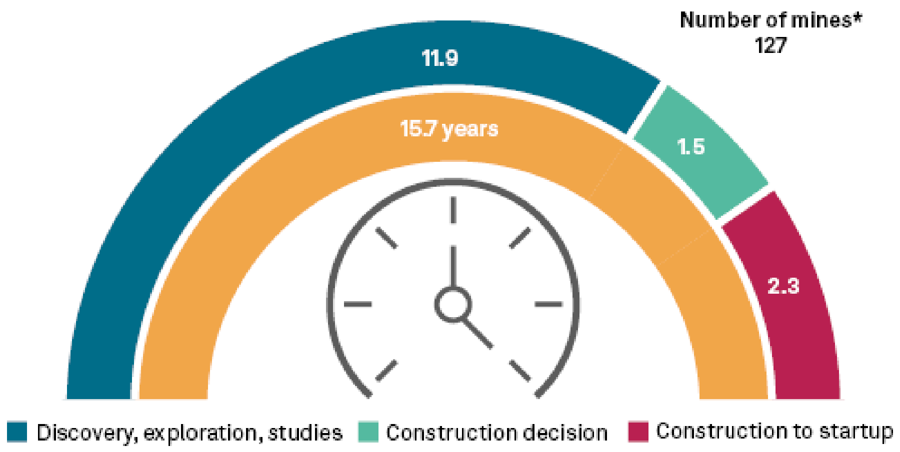
Slightly longer lead times for open pit mines*



Longer lead times in Canada, Russia, Chile increase global average



Average lead times of mines from discovery to production, 2002-2023



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Lithium Early and Advanced Exploration

Objective: Describe early and advanced lithium exploration and what this looks like on the ground.

Daniel Campbell

General Manager, Loyal Lithium

&

Mark Calderwood

Managing Director, Midas Minerals

Loyal lithium

ASX LLI

Critical Resources for Tomorrow

Mackenzie Valley Operational Dialogues

May 2024

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Loyal lithium

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The information in this report that relates to Exploration Results is based on information either compiled or reviewed by Mr Darren Allingham FAIG who is an employee of Loyal Lithium Limited. Mr Allingham is a Fellow of the Australian Institute of Geoscientists and has sufficient experience of relevance to the styles of mineralisation and types of deposits under consideration, and to the activities undertaken, to qualify as a Competent Person as defined in the 2012 Edition of the Joint Ore Reserves Committee (JORC) Australasian Code for Reporting of Exploration Results, Minerals Resources and Ore Reserves. Mr Allingham consents to the inclusion in this report of the matters based on information in the form and context in which it appears.

This presentation has been approved by the Board of Loyal Lithium Limited.

Loyal lithium

Life's better with Lithium.

North American Lithium Opportunity

The Lithium-Ion battery has the highest energy density with battery technology continuing to advance.

Over 400 million registered vehicles in North America – a percentage will transition to Electric Vehicles (EV).

Spodumene is the king of Lithium Natural Resources:

- Spodumene Concentrate represents >50% global supply
- Strong Investment support as it decouples mining from refining
- Traditional mining and processing techniques used

OUR CANADIAN-AUSTRALIAN TEAM

Loyal lithium

SHARE THE PASSION FOR LITHIUM

EXECUTIVE CHAIRMAN
Peretz Schapiro

MANAGING DIRECTOR
Adam Ritchie

NON EXECUTIVE DIRECTOR
Andrew Graham

LAND & COMMUNITY
Eileen Marlowe

COMMERCIAL MANAGER
Chris Kelly

GENERAL MANAGER
Daniel Campbell

EXPLORATION MANAGER
Darren Allingham

FINANCIAL CONTROLLER
Kevin Berry

COMPANY SECRETARY
Ian Pamensky

HIDDEN LAKE LITHIUM PROJECT

YELLOWKNIFE LITHIUM BELT

NORTHWEST TERRITORIES, CANADA

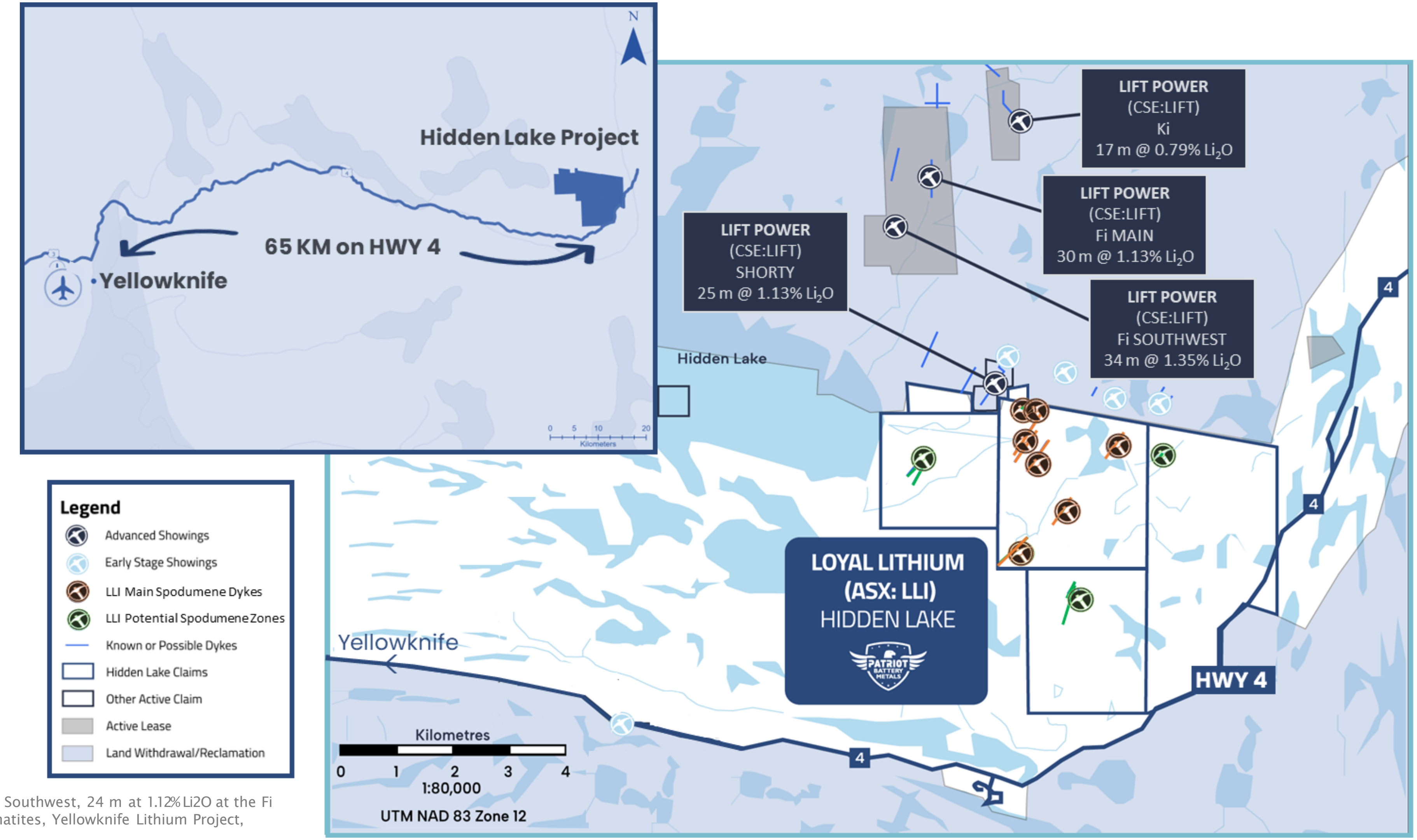
Hidden Lake Lithium Project

Loyal lithium

We Love It – Under Explored Yet Understood

"We are excited to bring fresh ambitions to this notable spodumene project alongside our joint venture partners, Patriot Battery Metals."

Adam Ritchie
Managing Director
Loyal Lithium Limited

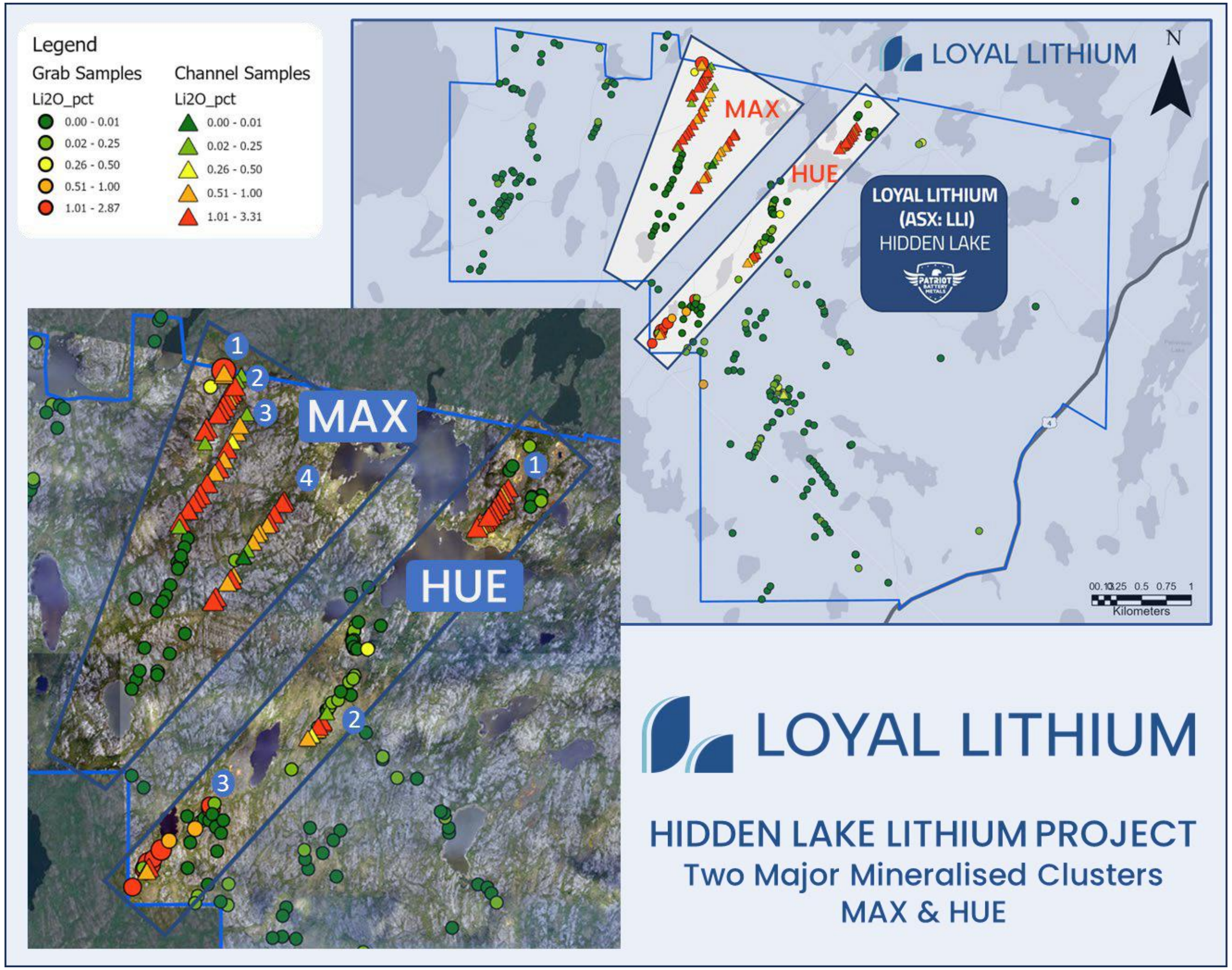


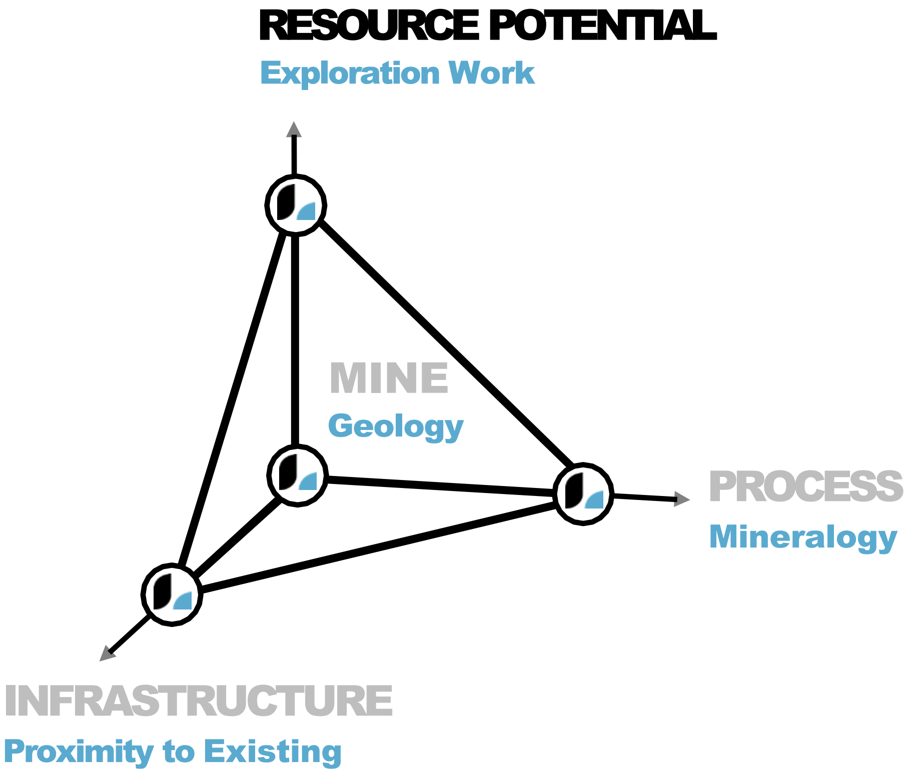
LIFT Drilling Data:

1. September 2023, LIFT Corporate Presentation
2. September 6, 2023 LIFT Intersects 22 m at 1.46% Li2O at the Fi Southwest, 24 m at 1.12% Li2O at the Fi Main, and reports first results from BIG East and Shorty Pegmatites, Yellowknife Lithium Project, NWTIntercepts of up to 1.6% Li2O over 9.2 metres.
3. November 7, 2023, LIFT intersects 21m at 1.40% Li2O at the BIG East pegmatite and 19m at 1.16% Li2O at the Shorty pegmatite, Yellowknife Lithium Project, NWT.

Hidden Lake Lithium Project

Why We Love It – Resource Potential



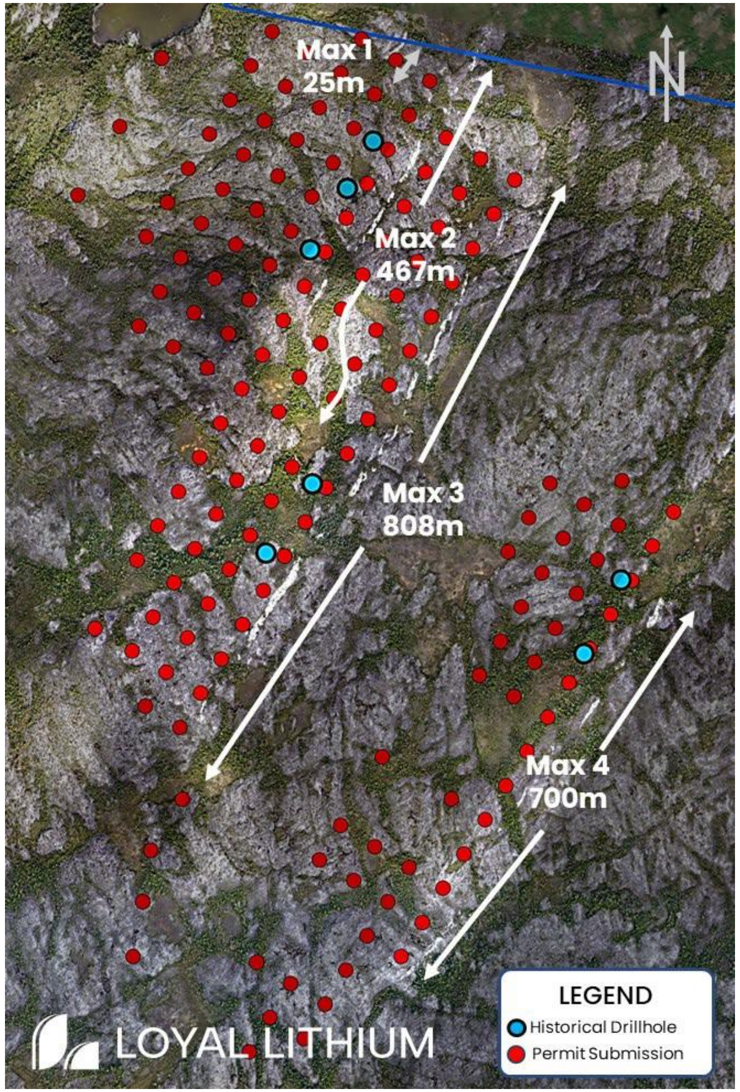


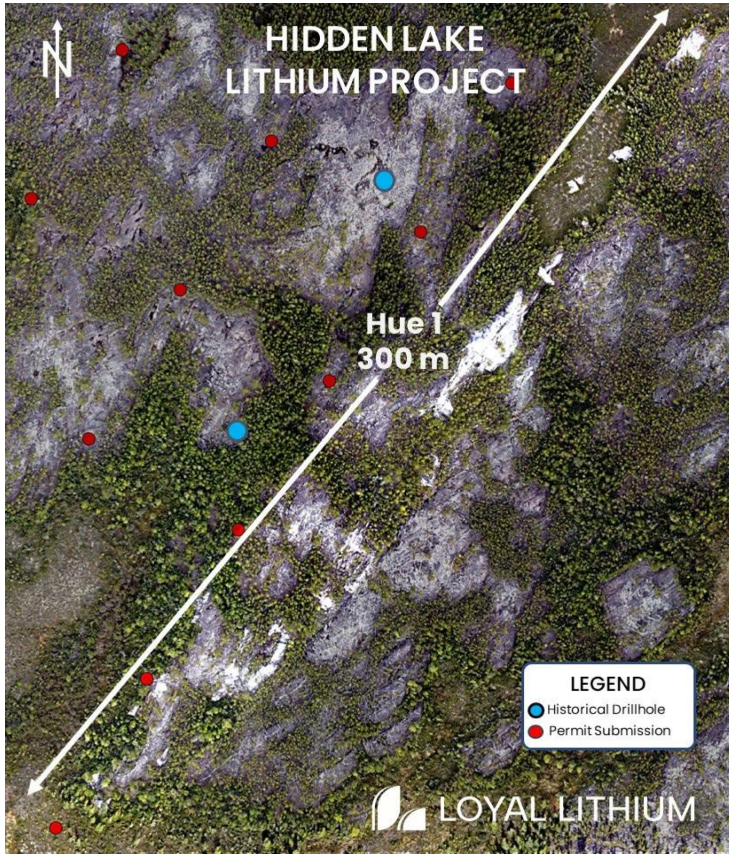
Extensive spodumene bearing pegmatite outcrops identified – 3,250m of Strike Length:

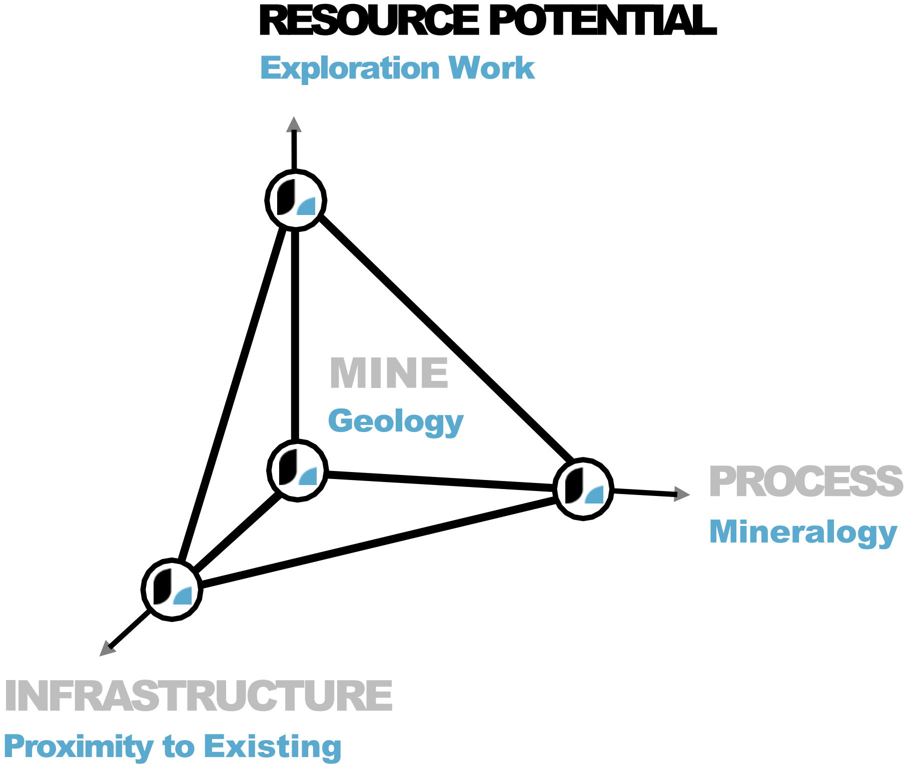
- 2 major mineralized clusters – MAX & HUE
- 4 main spodumene bearing dykes drill tested
- 3 additional spodumene dykes discovered

Hidden Lake Lithium Project

Why We Love It – Resource Potential







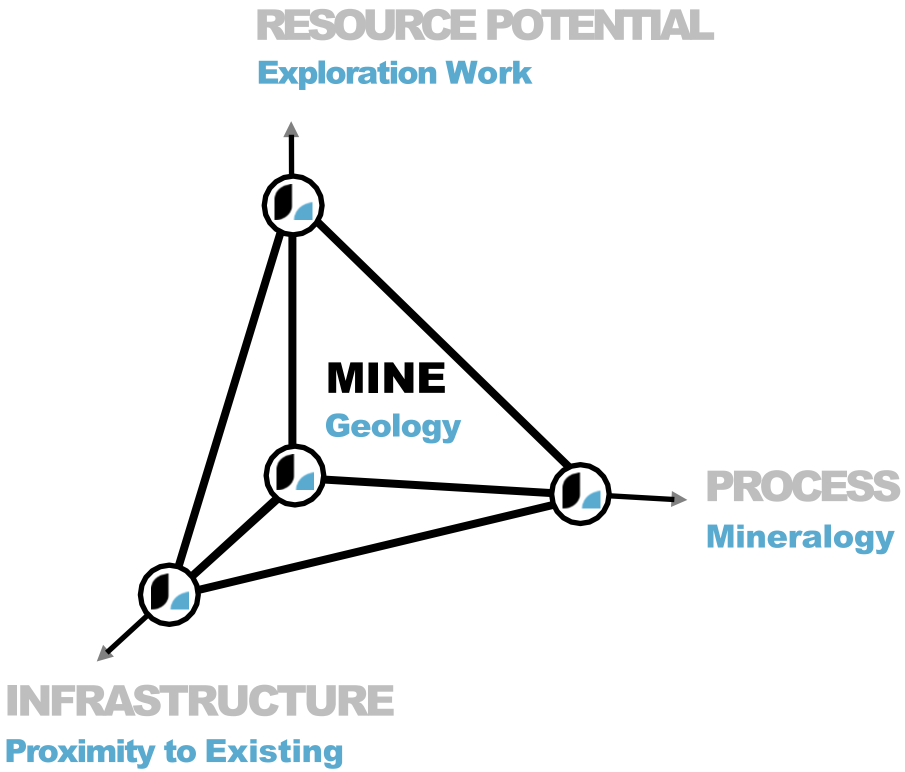
All dykes are clearly visible from surface with the 4 historical Dykes drill tested

- 10 drill holes conducted to 30–50 m vertical confirming mineralisation with grades up to 1.81% Li_2O
- Open along strike and depth

Hidden Lake Lithium Project

Loyal lithium

Why We Love It – Mineable



Prominent spodumene pegmatite outcrops have a cumulative strike length of ~3,250 m.

Surface exposures and drill intercepts imply favourable mining geometries for both open cut and underground operations.

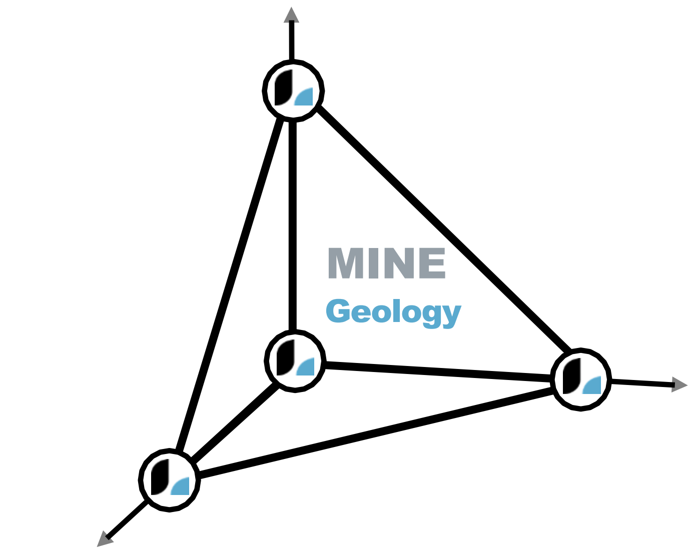
Hidden Lake Lithium Project

Why We Love It – Processing Simplicity

Mineralogy & Metallurgy fundamentals understood

Mineralogy is simple and consistent with low impurities

- Spodumene
  + Quartz
  + Feldspars
- <0.25% FeO



Metallurgy supports DMS concentration

- DMS concentrate via pilot plant
- Highly liberated
- 50%+ mass rejection <0.2% Li_2O loss

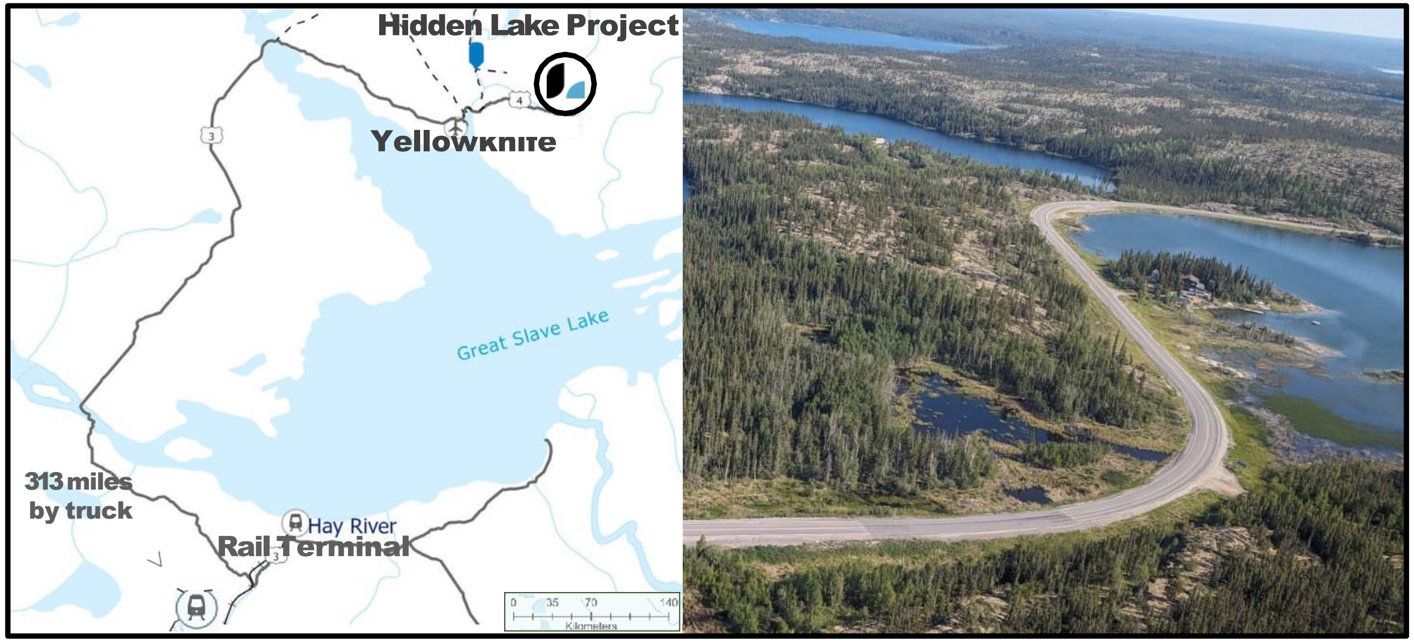
Hidden Lake Lithium Project

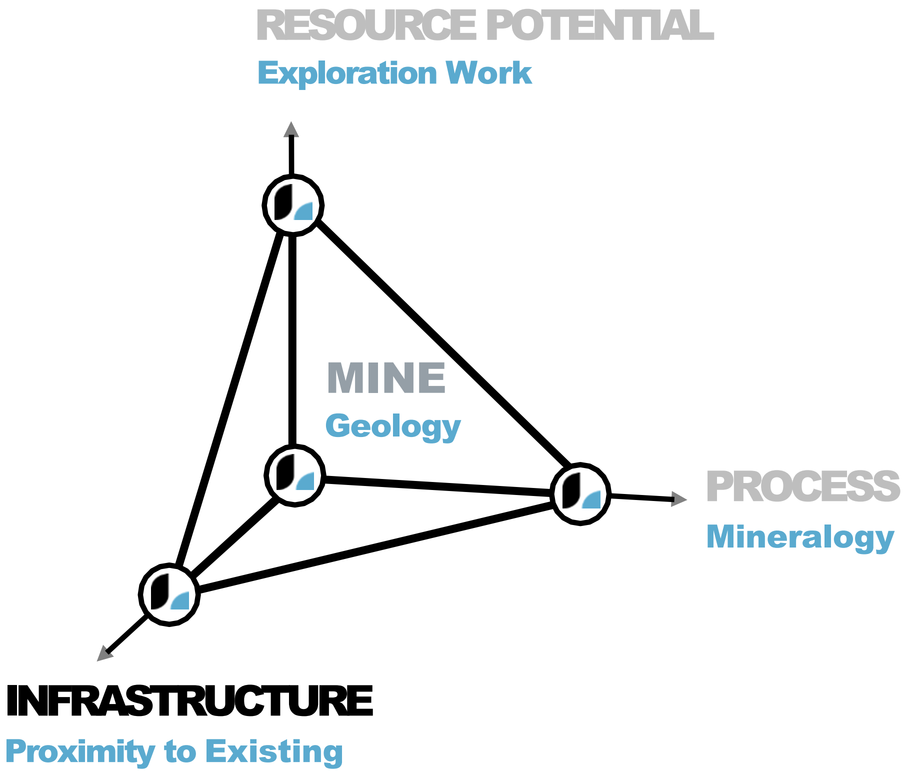
Why We Love It – Existing Infrastructure

65km drive Highway 4 – Hidden Lake to Yellowknife

Yellowknife – Capital of NWT population of ~20,000

- Well established workforce and support services
- Domestic Airport – daily connections to Canadian cities
- All-weather roads – south to Alberta and British Colombia
- Hydroelectric power – 2030 plans for the Lithium Belt





Hay River Rail Terminal – CN Rail
Canada & United States of America

- Significant backhaul capacity

Hidden Lake Lithium Project

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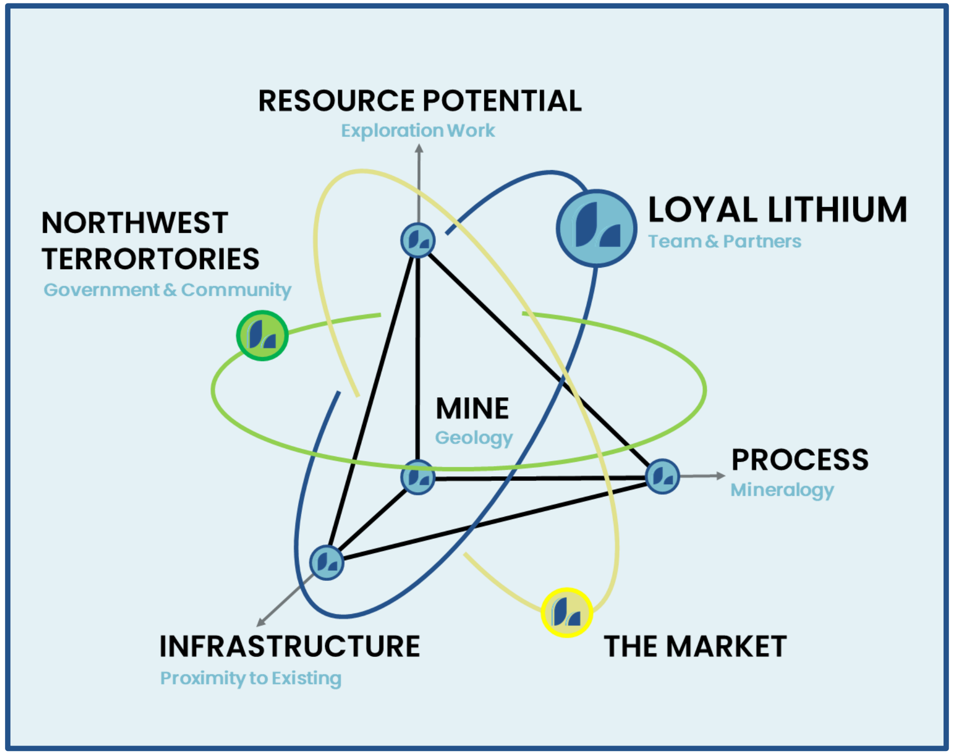
Why We Love It – Existing Infrastructure

2023 | 2024

LAND & COMMUNITY

- First Nations Engagement
- Yellowknife Community Engagement
- Government & Regulators
- Environmental & Cultural Surveys



Completed Work Programs

- Field mapping extends mineralized strike length to 3,250m
- 2 major mineralized clusters identified – MAX & HUE
- Land Use Permit (exploration permit) obtained
- Mapping, channel samples, LiDAR, and ortho photos
- Geologic interp & Phase 1geophysical survey (airborne)

Ongoing and Planned

- Metallurgical testing and analysis
- Conceptual mining studies
- Phase 2 geophysical survey (airborne)
- Geologic interpretation update
- Scout drill program of tier 1targets

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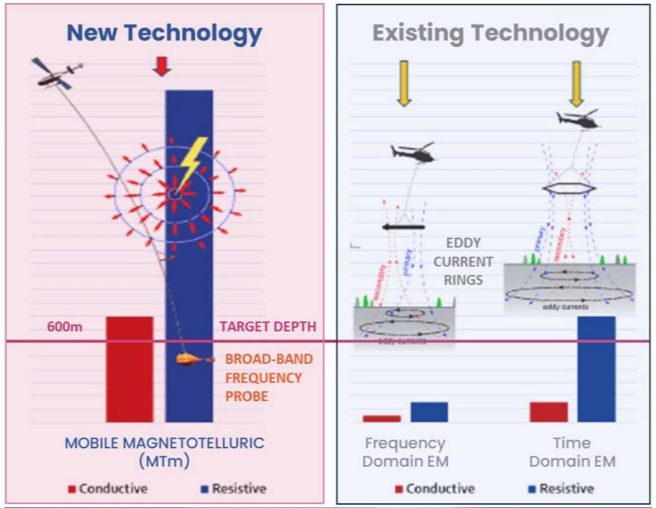
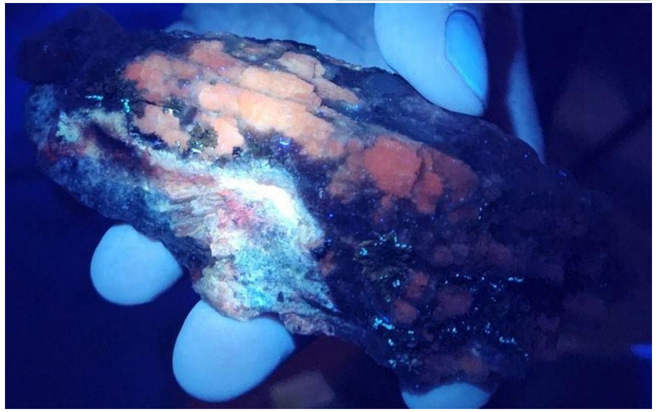
Exploration Pathway

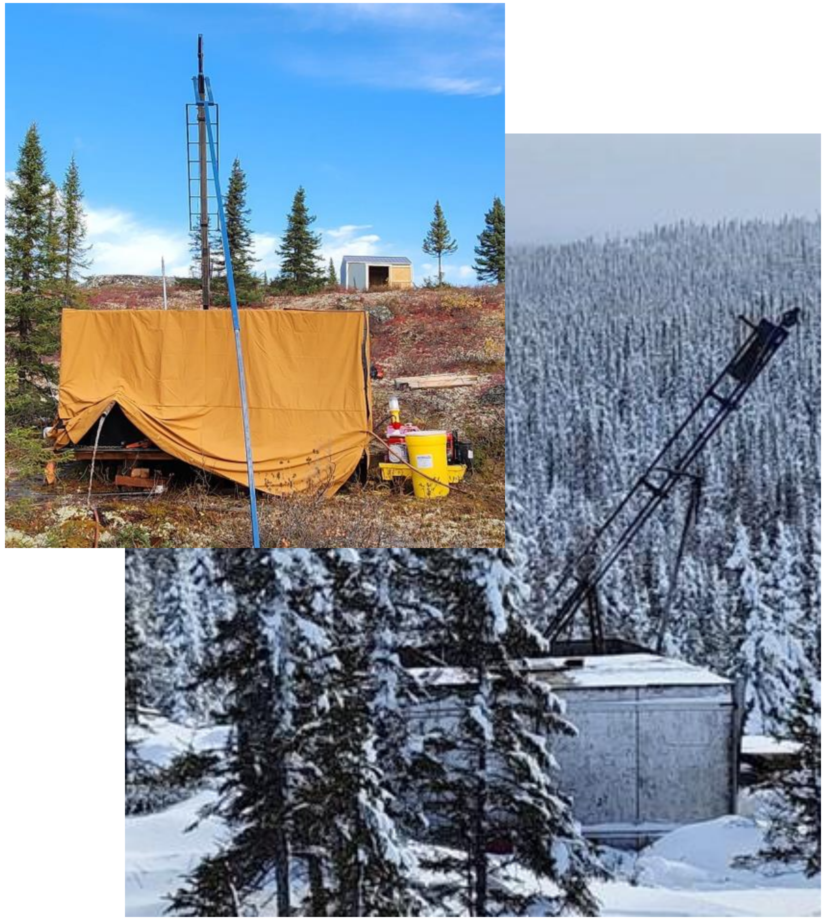
DONE

DOING





NEXT



Hidden Lake Lithium Project

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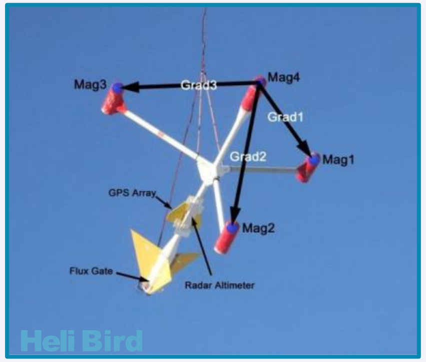
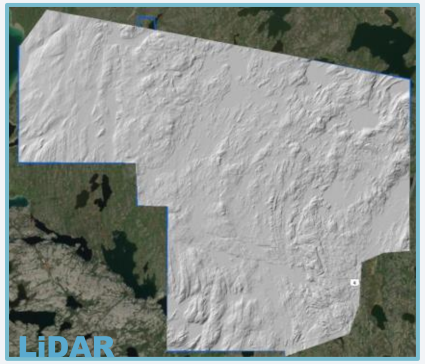
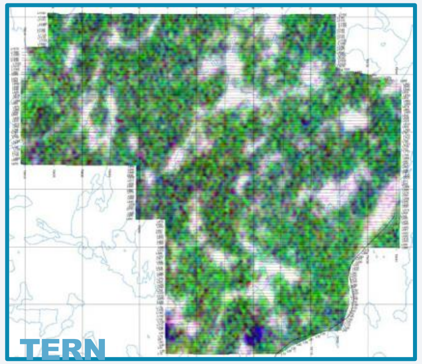
Technology to Reduce Drilling (Phase 1)

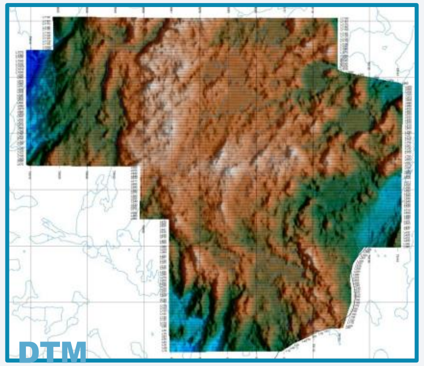
The Heli-GT bird is towed 25 m below the helicopter. The basic orthogonal magnetic gradients G1, G2 and G3 are measured on 3 meter baselines. A radar altimeter and 4 GPS antennae are mounted on the towed bird. In the helicopter a touch screen computer tablet logs the data and directs navigation.



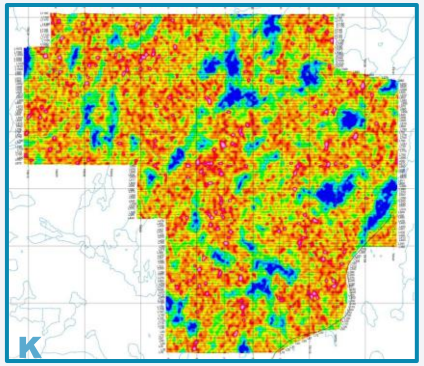
Ground features are analysed to further understand regional and local geologic structures that can also host pegmatites within them and along trend of the structures.

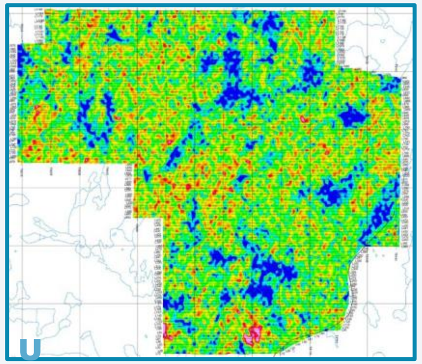


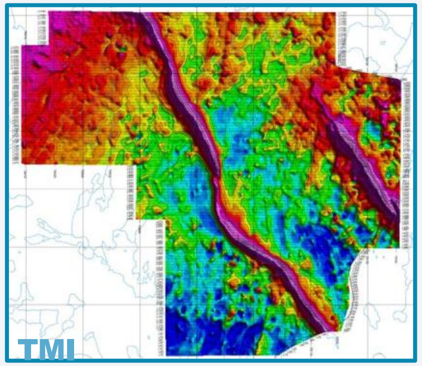




Phase 1 Airborne Geophysics generated a wide variety of outputs that can be integrated into geologic interpretations to inform further field work and drilling preparations.



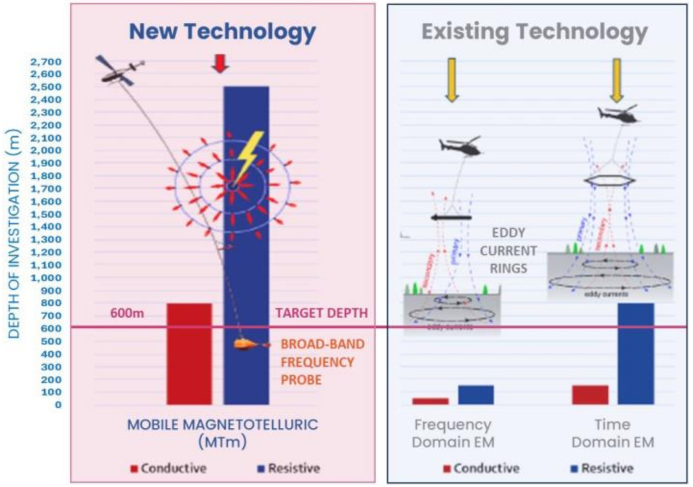


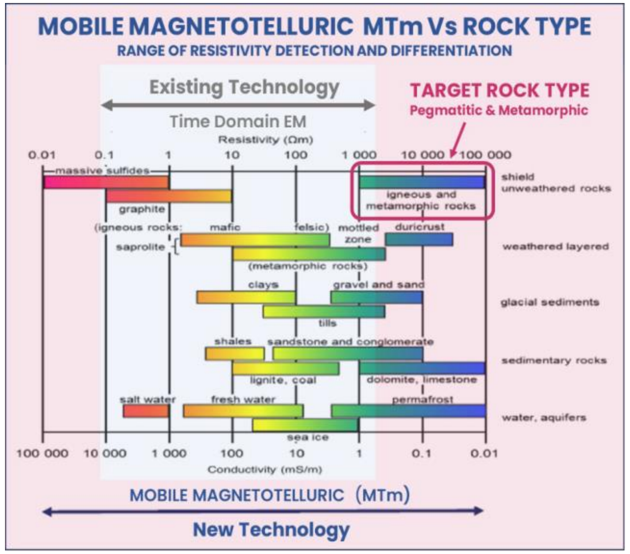


Hidden Lake Lithium Project

Technology to Reduce Drilling (Phase 2)

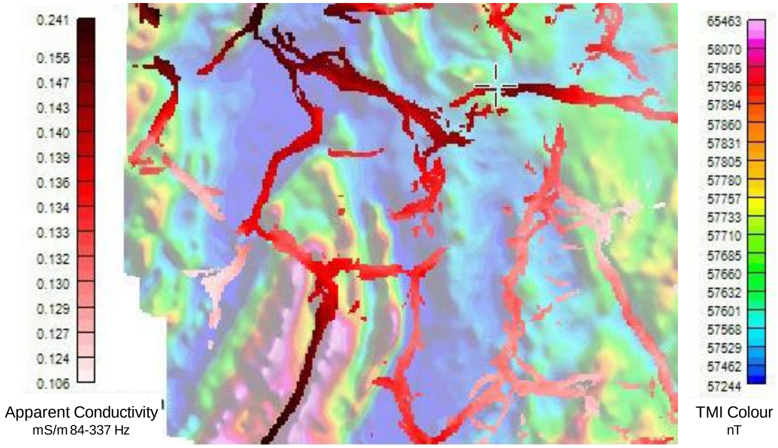
MOBILE MTm DIFFERENCE





REAL WORLD EXAMPLES

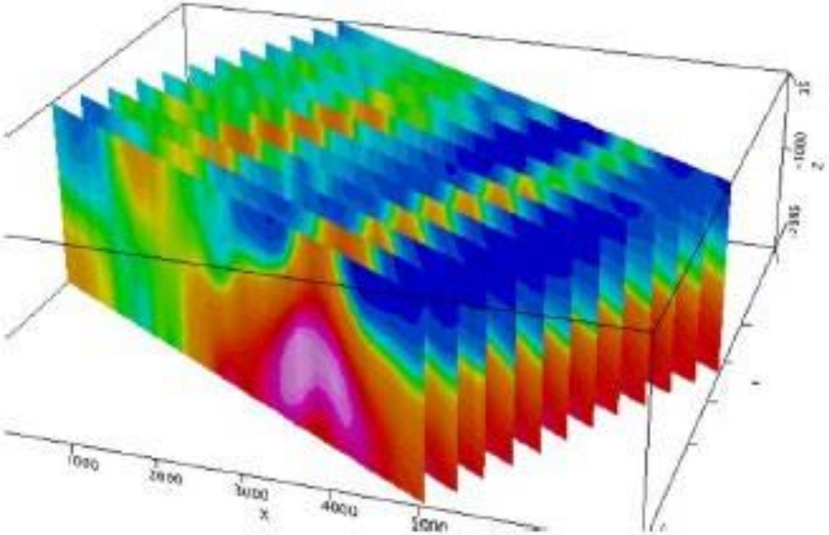
Conductive Structural Features Revealed Within Magnetic Signature



The geophysical survey is expected to reveal conductive and contrasting structural features within the projects unique geology, in which the two prominent spodumene bearing pegmatite dyke swarms have been discovered.

Rock Type Resistivity Discrimination

Multi sensor data analysis is anticipated to generate a detailed 3D model that will generate surface and subsurface drilling targets to complement the existing high-grade lithium assays from completed drill holes.



Hidden Lake Lithium Project

Loyal lithium

Permit Conditions to Protect the Environment

Land Use Permit (Exploration Permit) has 101 Permit Conditions to Protect the Public and Environment

- Regulatory notifications prior to work commencing which includes pre-site work site inspections in proposed areas
- Equipment size restrictions to mitigate environmental impacts, including ground pressure and noise
- Drilling operations require a 100m setback from a watercourse (flowing, standing, or any area occupied by water during part of the year)
- Winter roads require a minimum of 10cm of packed snow or ice to mitigate impacts to vegetation with mandatory work stoppages at the first sign of rutting.
- Progressive reclamation through operational programs to mitigate risks to stakeholders and regulators
- Indigenous and community engagement integrated through the process to accommodate concerns and focus on transparency and communication

MINE DEVELOPMENT – TYPICAL TIMEFRAMES

THE ROAD AHEAD PROVIDES CLEAR SOCIAL AND ECONOMIC BENEFITS

READINESS
???? years

- Community Engagement
- Exploration
- Test work
- Enviro Studies
- Resource Modelling
- Strategy
- Community Agreements
- Engineering & Design
- Estimating & Scheduling
- Economics
- Optimisation
- Feasibility Studies
- Permits & Approvals

CONSTRUCTION
2 – 3 years

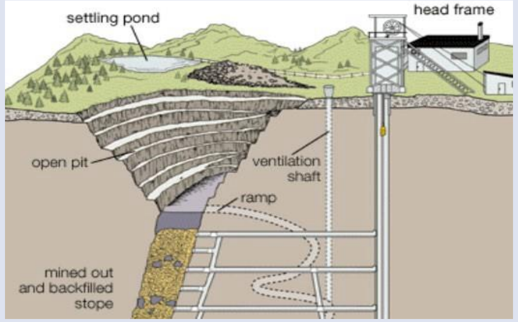
- Early Works
- Infrastructure
- Process Plant
- Project Management
- Project Controls
- Procurement
- Contracts Administration
- Contractor Management
- Construction Management.
- Engineering: Environment, Mining, Civil, Mechanical, Electrical, Comms
- Health & Safety

COMPLETIONS
1 year

- Testing
- Certifying
- Modification
- Dry Commissioning
- Wet Commissioning
- Load Test
- Ramp up
- Performance Test
- Defects
- Optimisation
- Improvements
- Nameplate
- Handover to Ops

OPERATIONS
10 – 20 years

- Environmental Monitoring
- Mining
- Infrastructure
- Camp & Catering
- Process Plant
- Laboratory & Qual. Control
- Logistics
- Sales & Marketing
- Major Shutdowns
- Sustaining Capital
- Expansion planning
- Reclamation
- Closure



Example: Open Cut to Underground Mining Concept

Example: Construction of Modular Process Plant

Example: Early Operations of a Crushing Circuit

Rio Tinto: Diavik Diamond Mine

LITHIUM SUPPLY CHAIN - SPODUMENE

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A TECHNICAL MINERAL TO A SPECIALTY CHEMICAL

MINE → CONCENTRATE → LOGISTICS → EXTRACT → PURIFY → LOGISTICS → CREATE → BATTERY MANUFACTURING PLANT

MINE

A defined lithium (spodumene) resource(s) >1% Li_2O and a sufficient Life of Mine (LOM) and mining rate to justify the development of a multi-train refinery. Traditional mining and concentrator methods are utilised and are in close proximity.

District Scale Target Metrics:

- Spodumene resource(s) >100 mt and > 1% Li_2O
- Life of Mine (LOM) >20 years
- Spodumene Con. production rate of >500 ktpa at ~6% Li_2O (SC6)

LARGE CAPITAL INTENSITY
(less than CAD$1.0B)

REFINE

A refinery requires a defined lithium (spodumene) resource(s) accessible via cost-effective transport modes like road, rail, or sea. Optimal locations are major industrial hubs, providing skilled labour, affordable utilities, and waste rock management.

One primary advantage of spodumene lithium supply chains is the ability to geographically separate the mining and refining processes, although this may be hindered by logistical constraints.

Refineries are technically complex and typically involve two main processes: extraction and purification, which is tailored to customer needs. The final product, typically Lithium Hydroxide, is a specialty chemical that undergoes strict qualifications before sale.

A traditional refinery would ideally have a minimum of four (4) process lines to justify common plant and infrastructure requirements.

HIGH CAPITAL INTENSITY
(greater than CAD$2.0B)

CATHODE

ACTIVE MATERIAL (CAM)

The prequalified Lithium Hydroxide product is processed and combined with other cathode precursor materials in defined battery chemistry ratios to create the active material in a battery cathode (CAM). While CAM plants can be integrated within battery manufacturing plants, commonly known as Gigafactories, their location can be independent. This is driven by scale and specialty labour and chemistry processes involved.

LARGE CAPITAL INTENSITY
(scale dependant)

LITHIUM FROM NWT IS URGENT

SUPPORTIVE ACTION REQUIRED

1. Why Lithium

A sustainable future hinges on renewable energy and energy storage solutions.

The lithium-ion battery stands as the global frontrunner in energy storage technology, driving advancements in communication, transportation, and energy sectors.

2. Why NWT

The availability of raw materials, particularly lithium, is a critical factor in battery production.

Spodumene, a lithium rich mineral, is globally recognised as a superior natural source of lithium and abundantly present in the NWT. Spodumene currently supplies over 50% of the world's lithium demand. It enjoys robust investment support and offers the distinct advantage of physically separating the mining and refining processes.

Strategically positioned, the NWT could serve as a hub for Spodumene supply to the emerging North American lithium supply chain.

3. Why the Urgency

While lithium is an abundant naturally occurring element, Spodumene, is not as prevalent.

Development plans for alternative lithium sources, including brines, clays, and other hard rock deposits, in various regions and provinces are rapidly advancing. **Without urgent supportive action to facilitate exploration activities and substantiate a critical mass, along with demonstrating sustainable extraction of NWT Spodumene, there is a risk of global funding being redirected to alternative sources and jurisdictions.** This scenario could result in missed opportunities for the development of NWT lithium.

LOYAL LITHIUM

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Land & Community Manager
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NWT Lithium Exploration Model

Mark Calderwood

Phase 1 - Targeting

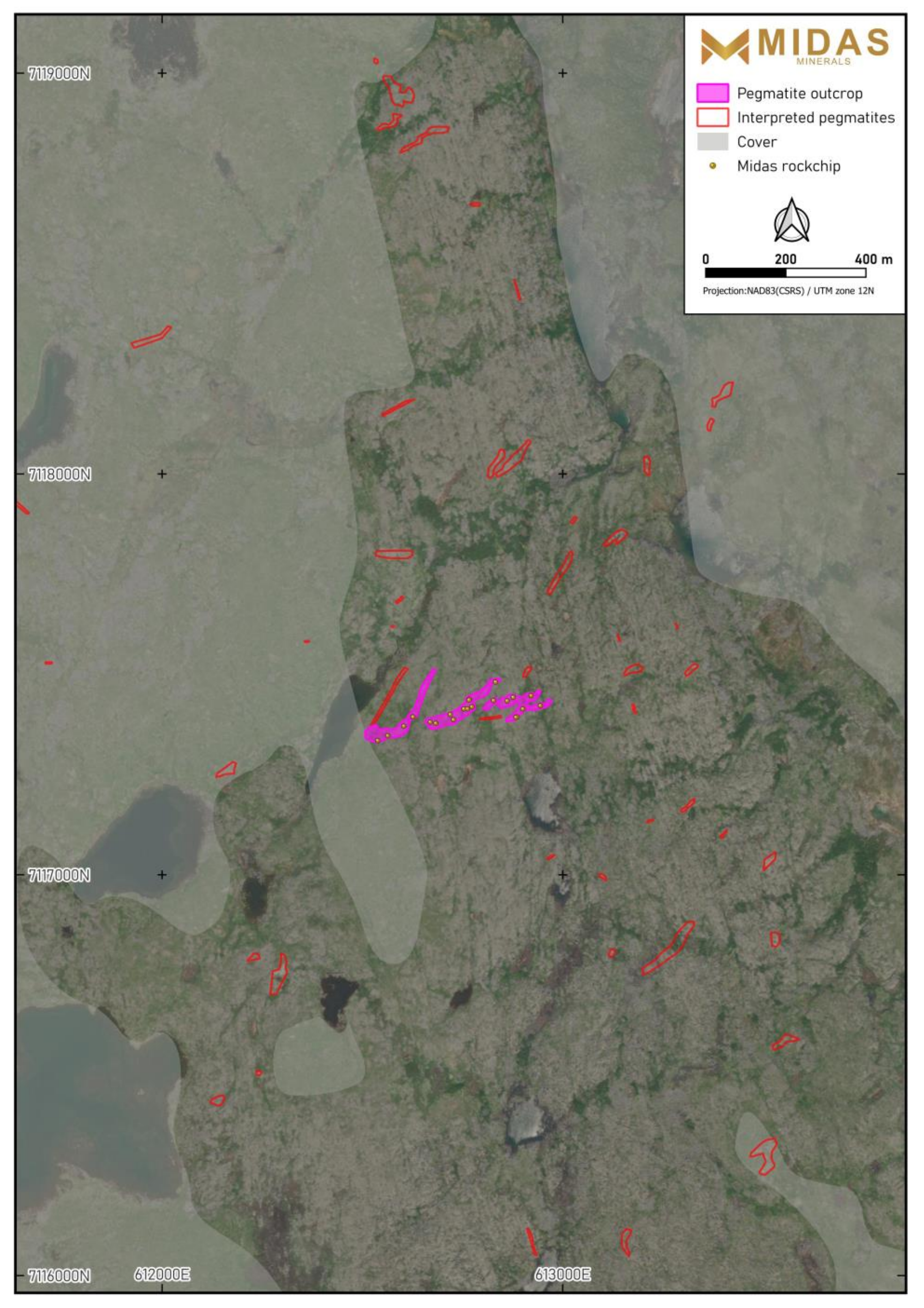
- Research prior exploration
- Review available geophysics
- Pegmatites targets identified from satellite or aerial imagery
- Remote sensing

Early years of lithium exploration success will most likely be the result of discovery of outcropping spodumene (lithium) pegmatites.

Some of these found by prospectors in the 1960’s

A conceptual project of say 100km^2

Perhaps 50km^2 will be targeted for prospecting

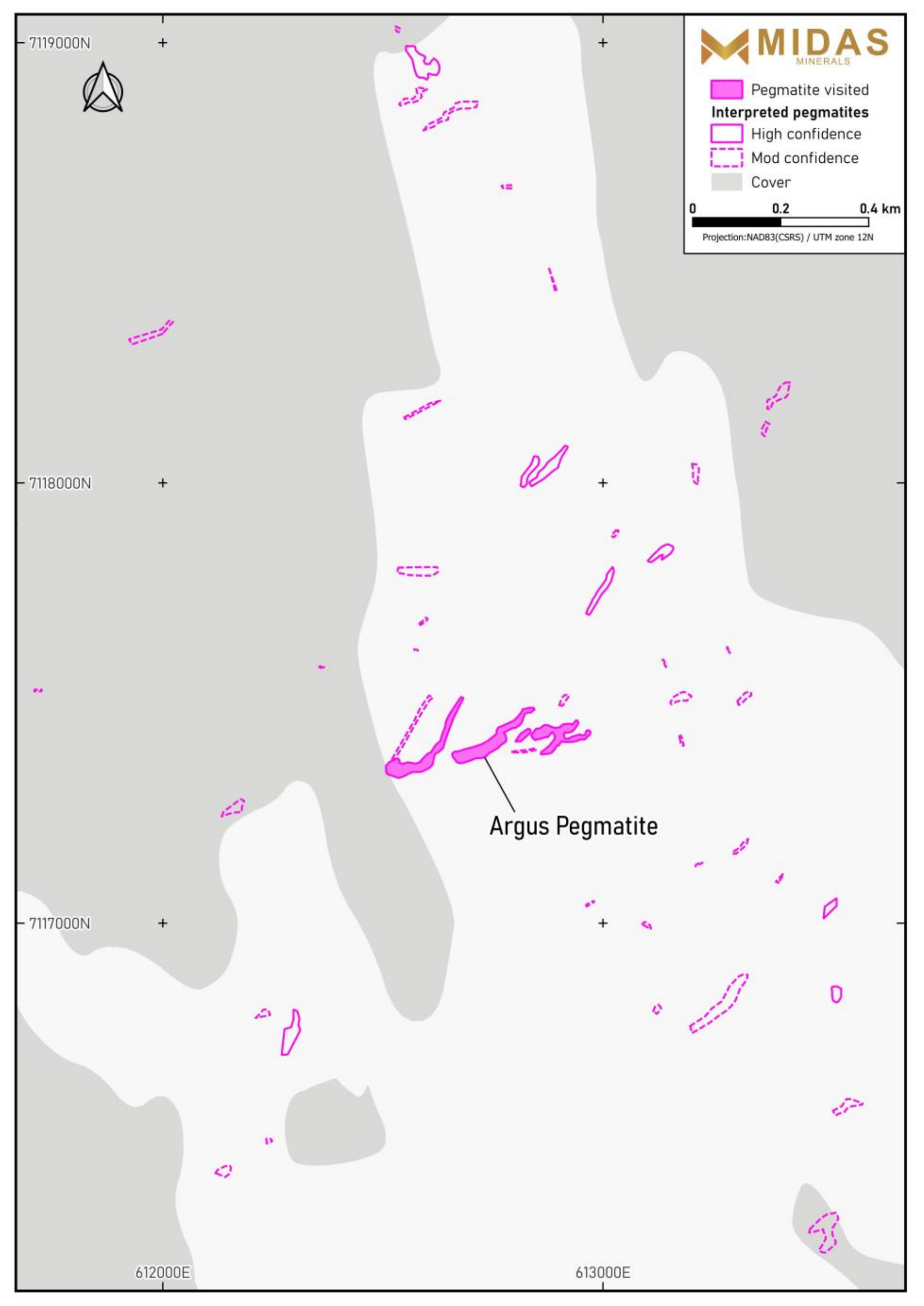


Phase 2 - Prospecting

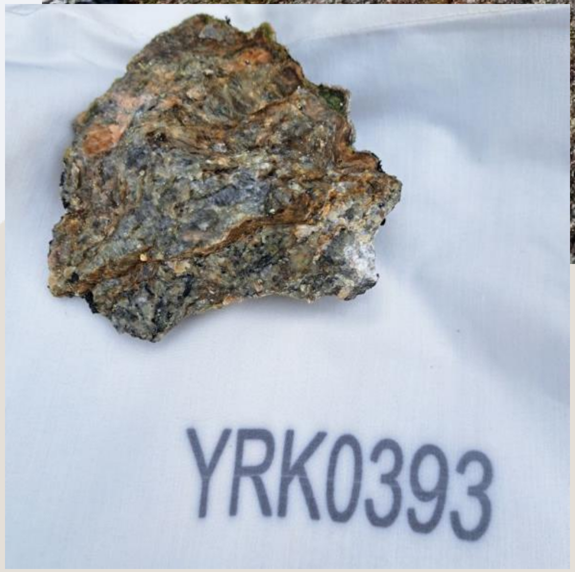
- Helicopter assisted prospecting
- Walking traverses to inspect pegmatite targets
- Looking for visual evidence of spodumene
- Taking small pegmatite samples – assays can be used to tell us if we are getting closer to spodumene pegmatite

Prospecting is done on a rapid basis, very low impact however need to be aware of not disturbing migrating wildlife

Of the 50km² prospected, perhaps 10km² will be targeted for further mapping and sampling



Phase 2 - Prospecting



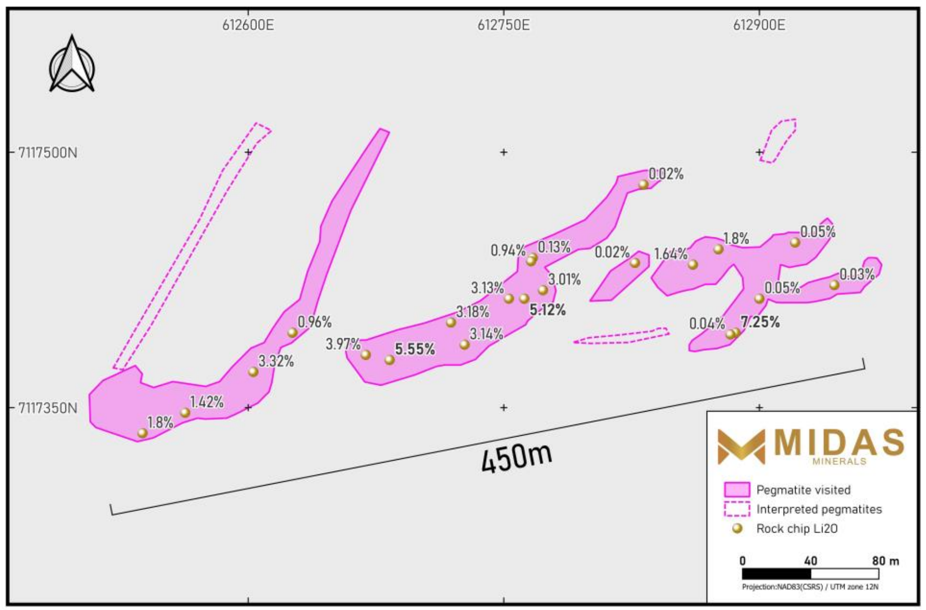
Phase 3 – Mapping and Sampling

- Detailed mapping and sampling of interesting pegmatites
- Aim is to find a pegmatite worthy of drilling
- Finding drill targets under cover, significantly more difficult. Till sampling may prove useful

Low impact exploration, many of the pegmatites will prove to be too small or low grade to justify expensive drilling.

Of the 10km² Mapped in detail, perhaps <2km² will be targeted for drilling, perhaps in two or three locations.

The odds of a project making it to drilling stage is probably 25% or less. Sometimes the first explorer is not successful however a later group is.



Phase 4 – Initial Drilling

- Initially a small number of holes drilled winter or summer
- Helicopter assisted, temporary on-site camp

Potential regular noise impact from rig and helicopters over a radius of 1-3km. Impact for initial drilling likely only for a few weeks. Water use minimal.

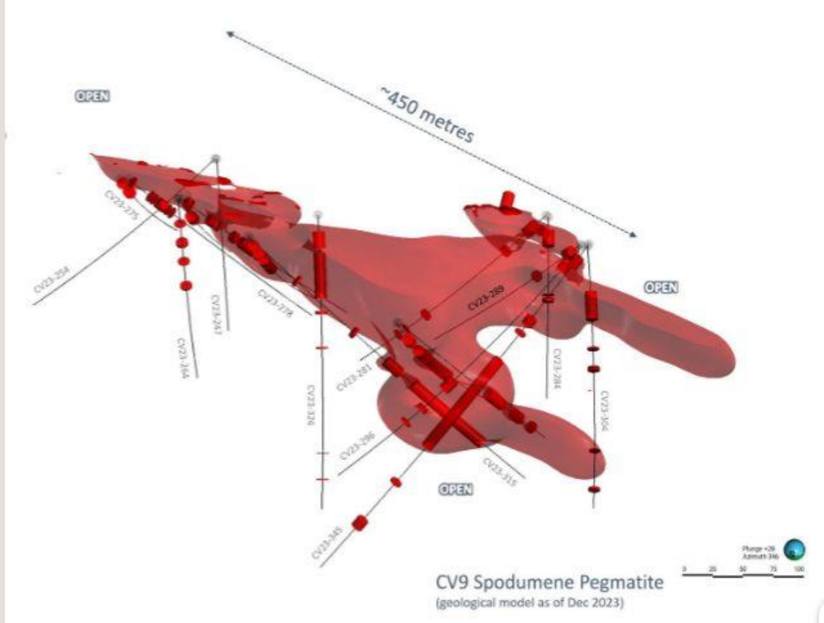
Of the several areas drilled over 2km^2, perhaps 1-2km^2 will be targeted for resource drilling.

The odds of a project making it to resource drilling stage is probably 6%.

Phase 5 – Resource Drilling

- More intensive pattern drilling of potentially economic deposit
- Helicopter assisted, multiple rigs, medium term camp +/- 20 people
- Perhaps 50 to 200 drill holes

Potential regular noise impact from rig and helicopters for several months at a time. in multiple years. Water use will depend on location

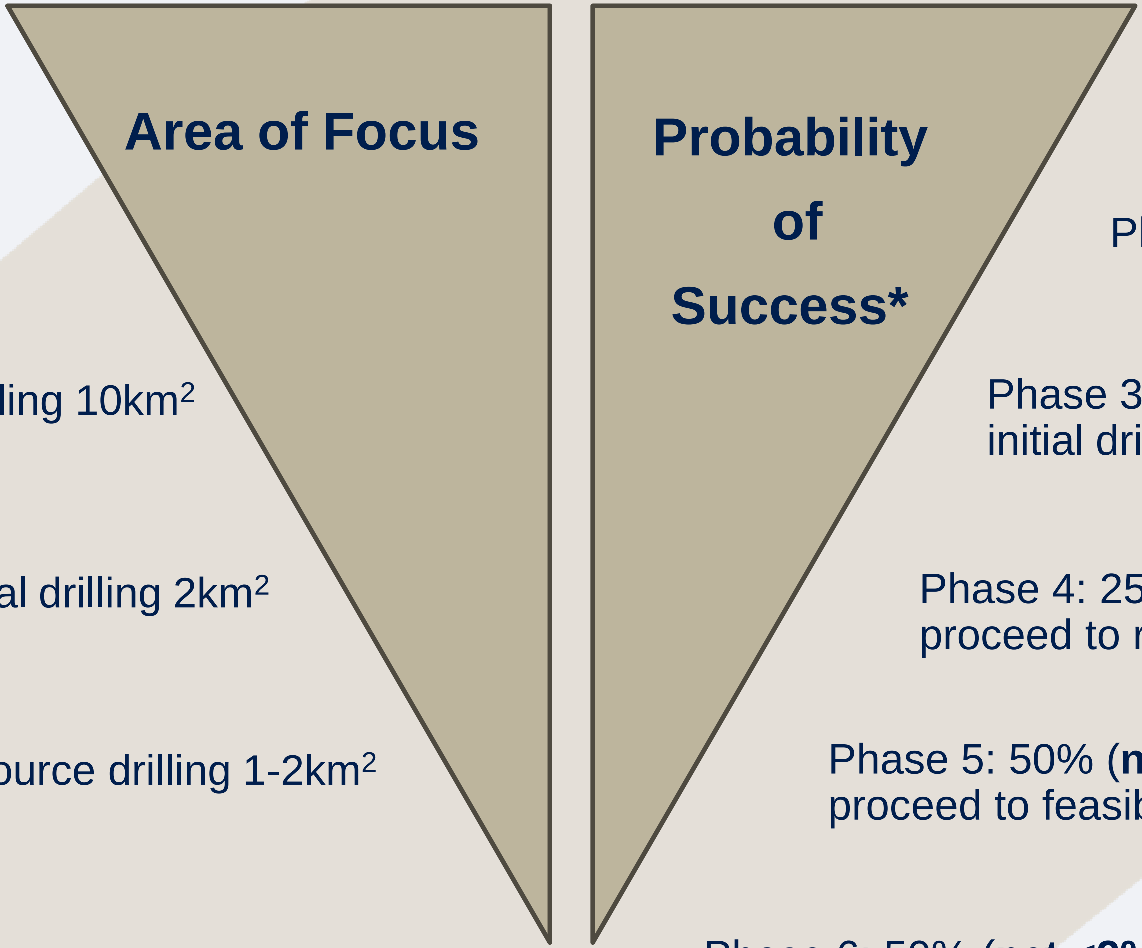


Only the very best projects will be considered for mining.

The odds of a project making it from resource drilling stage to feasibility is 3%.

At this stage environmental impact studies will commence

Schematic Exploration Model



Phase 1: targeting 100km^2

Phase 2: prospecting 50km^2

Phase 3: mapping and sampling 10km^2

Phase 4: initial drilling 2km^2

Phase 5: resource drilling 1-2km^2

Phase 6: feasibility study

Phase 1: **100%**

Phase 2: 50% **(net 50%)**

Phase 3: 50% **(net 25%)** to proceed to initial drilling

Phase 4: 25% (**net 6%**) to proceed to resource drilling

Phase 5: 50% (**net 3%**) sufficient to proceed to feasibility

Phase 6: 50% (**net <2%**) of advancing to mining approvals consideration

** chance of success higher if prior known deposit*

Thankyou

Masi

From Lithium Exploration to Mining & Processing

Objective: Provide an overview of lithium projects and processing methods.

Hendrik Falck

Manager of Geology and Resource Royalty Policy, GNWT

&

Dr. Charlotte Gibson

Assistant Professor, Queens University

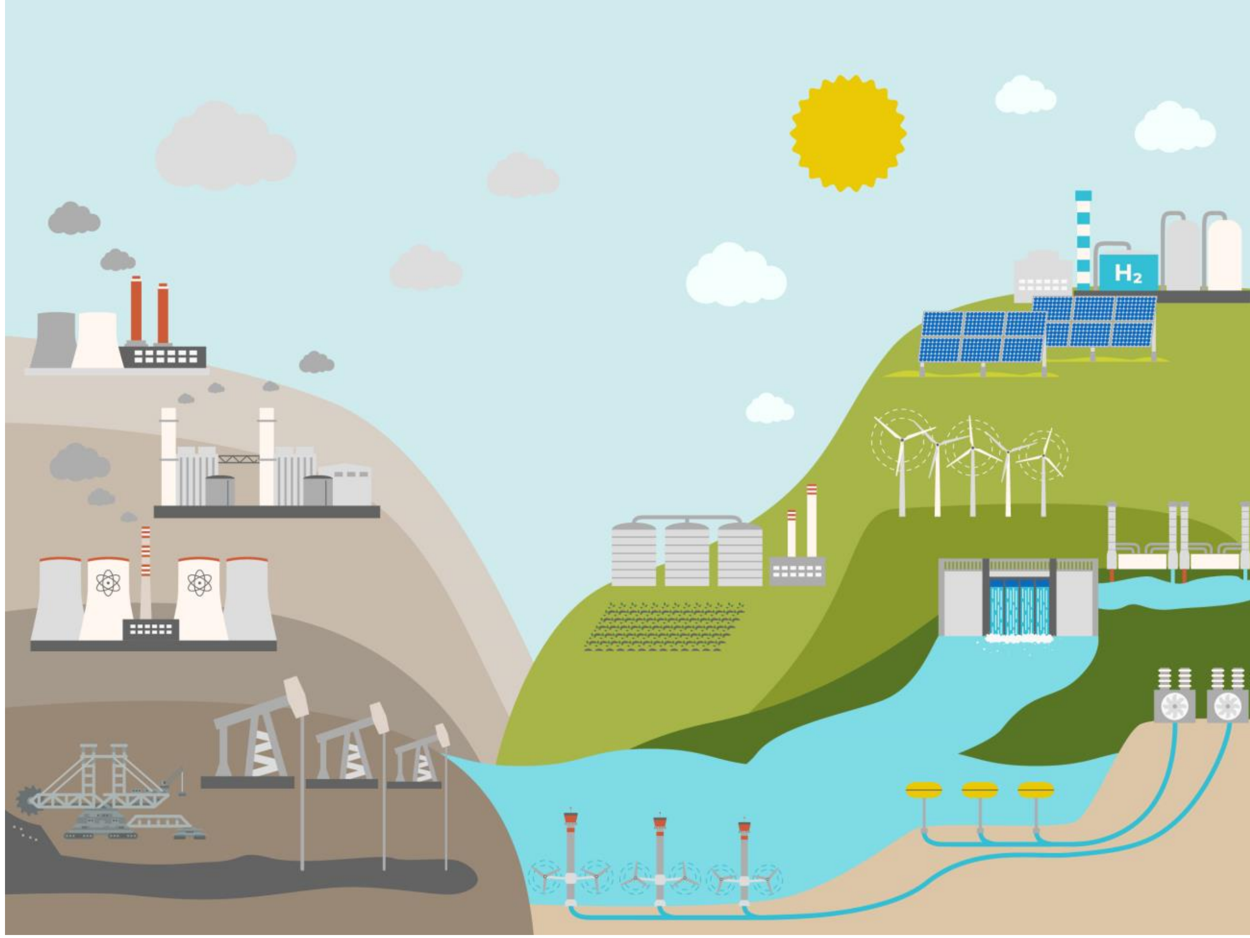
&

Brian Cook

PhD Candidate, Queens University

Classifying the production of lithium, cesium and tantalum from the Tanco mine, Manitoba, Canada, according to UNFC – A Case Study

Tania Martins
Claude Deveau
Hendrik Falck



RESOURCE MANAGEMENT WEEK
2024

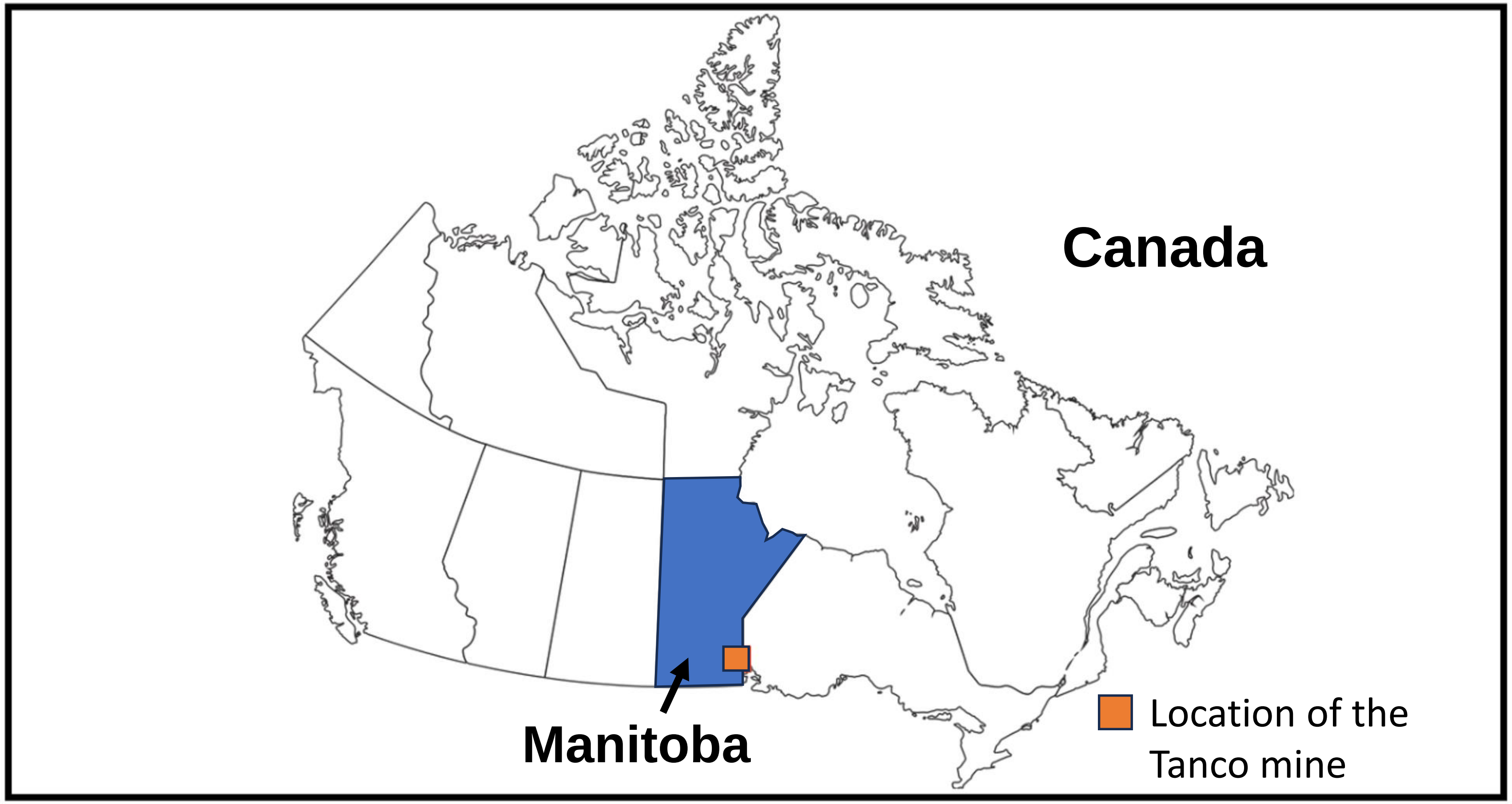
UNECE

UNFC Case Study: Tanco mine

- Why make a case study of the Tanco mine?
  - Active operation of critical minerals;
  - Multicommodity;
  - Very well studied deposit (geology);
  - Not a lot of information on the resource estimation;
- Demonstrates the challenges of the classification of multiproduct mines.
- Example of application of the United Nations Framework Classification (UNFC) for Resources.

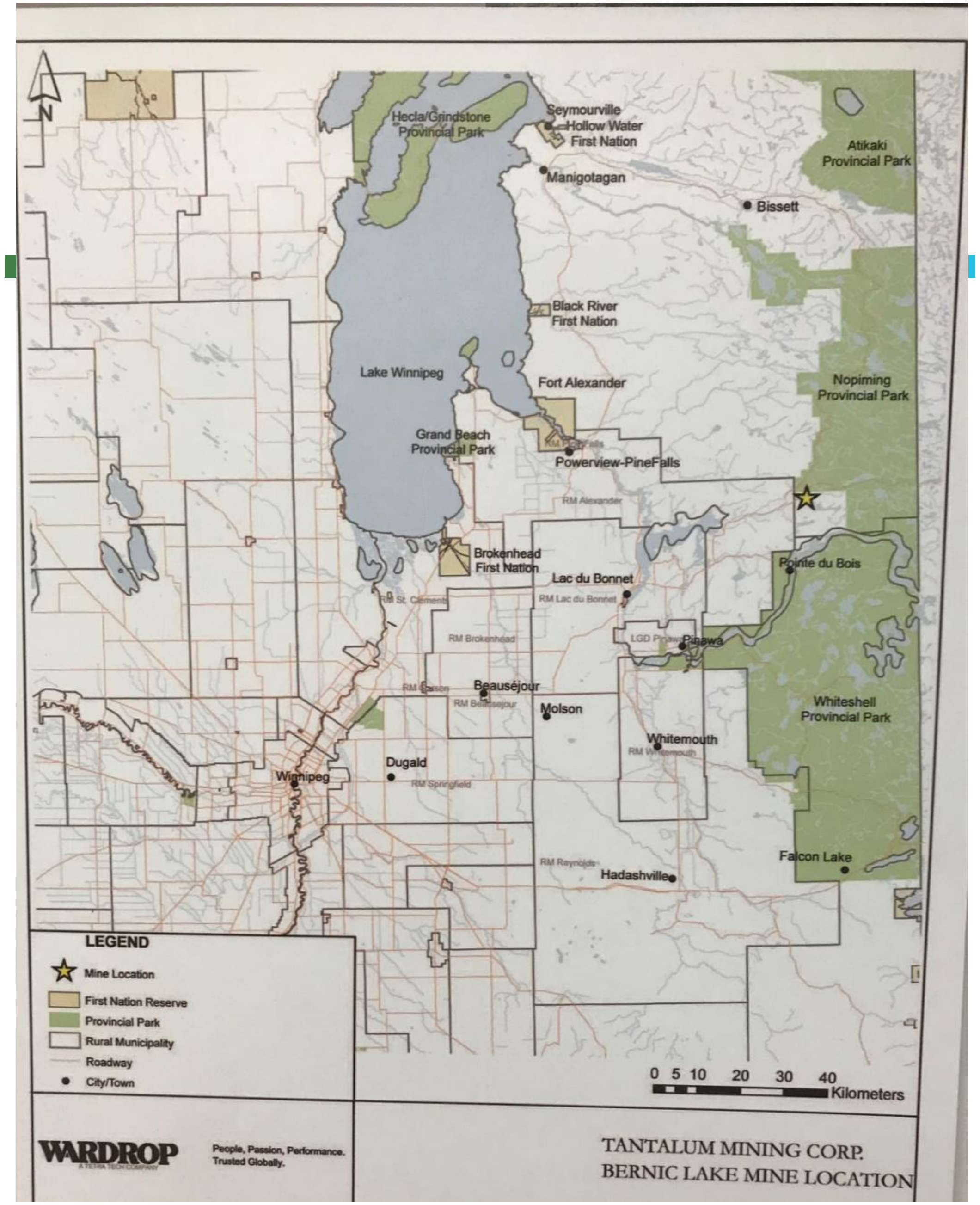
The Tanco Mine

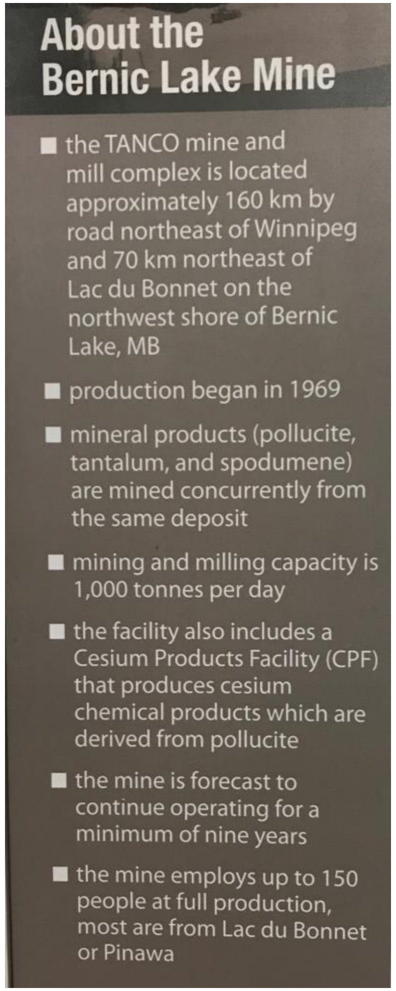
Location



The Tanco Mine

Location

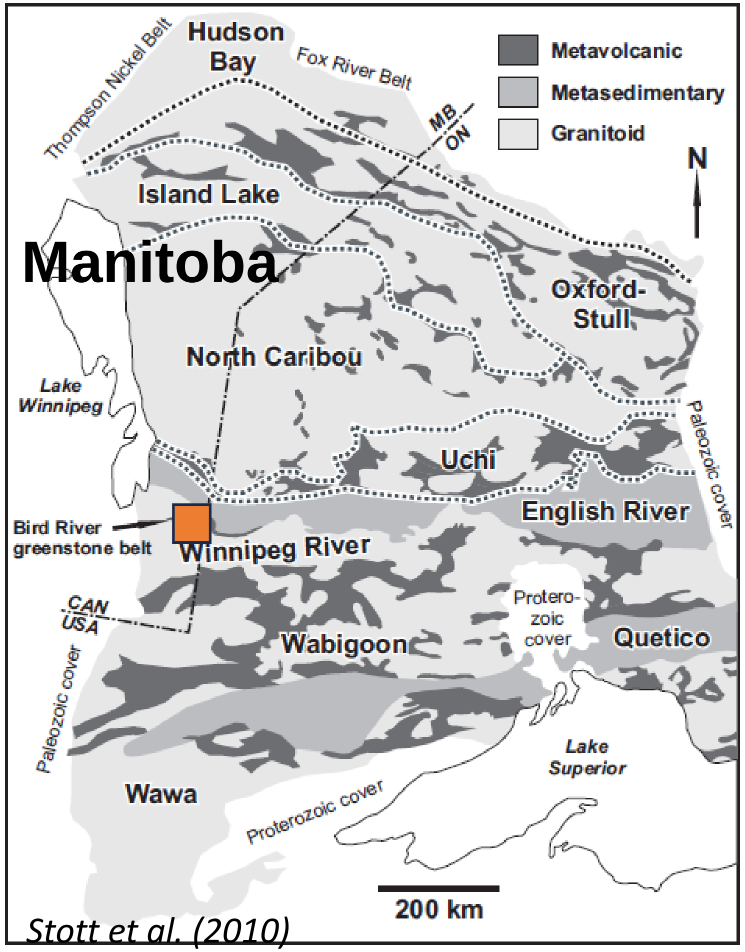




The Tanco Mine

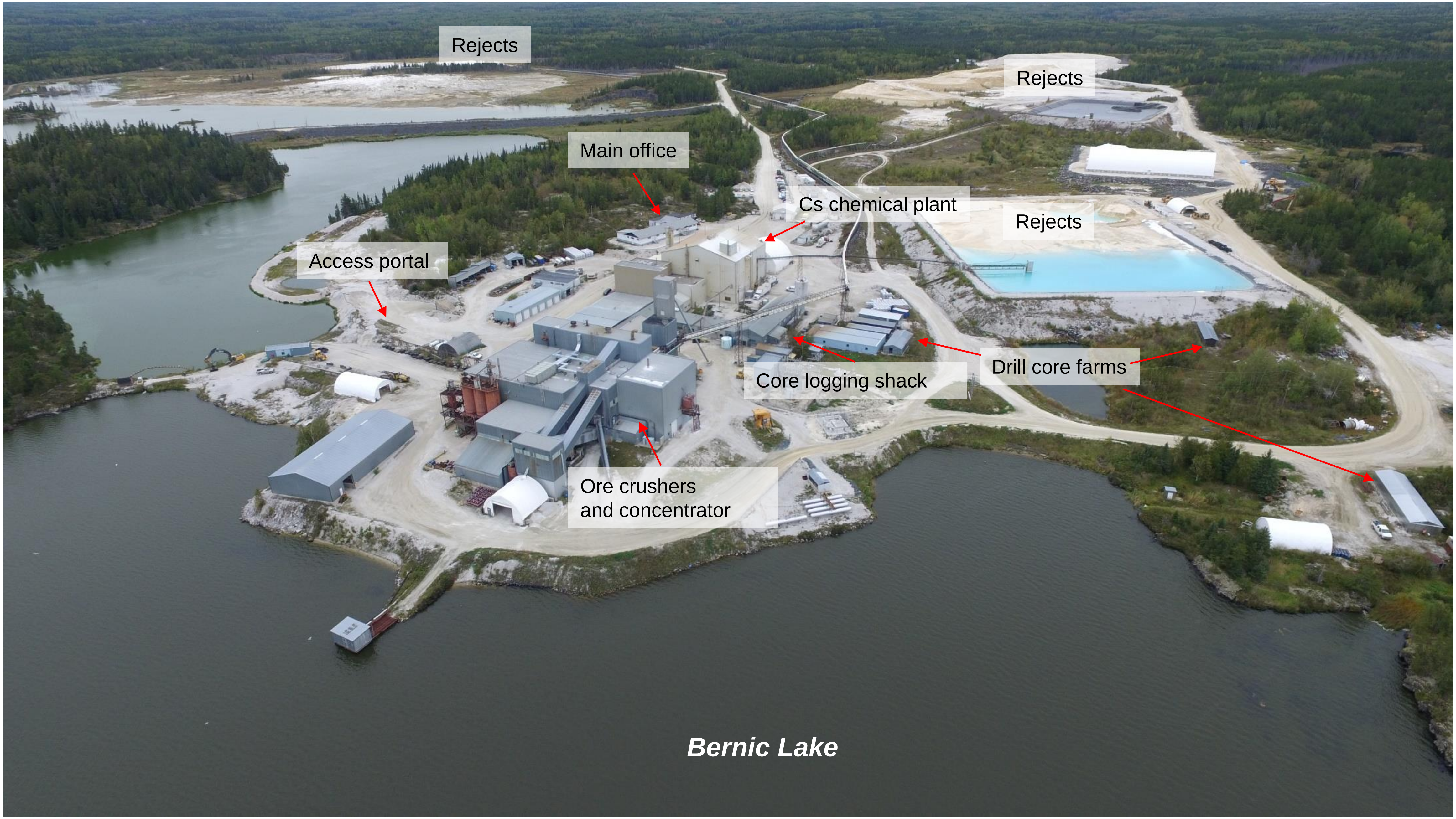
Location

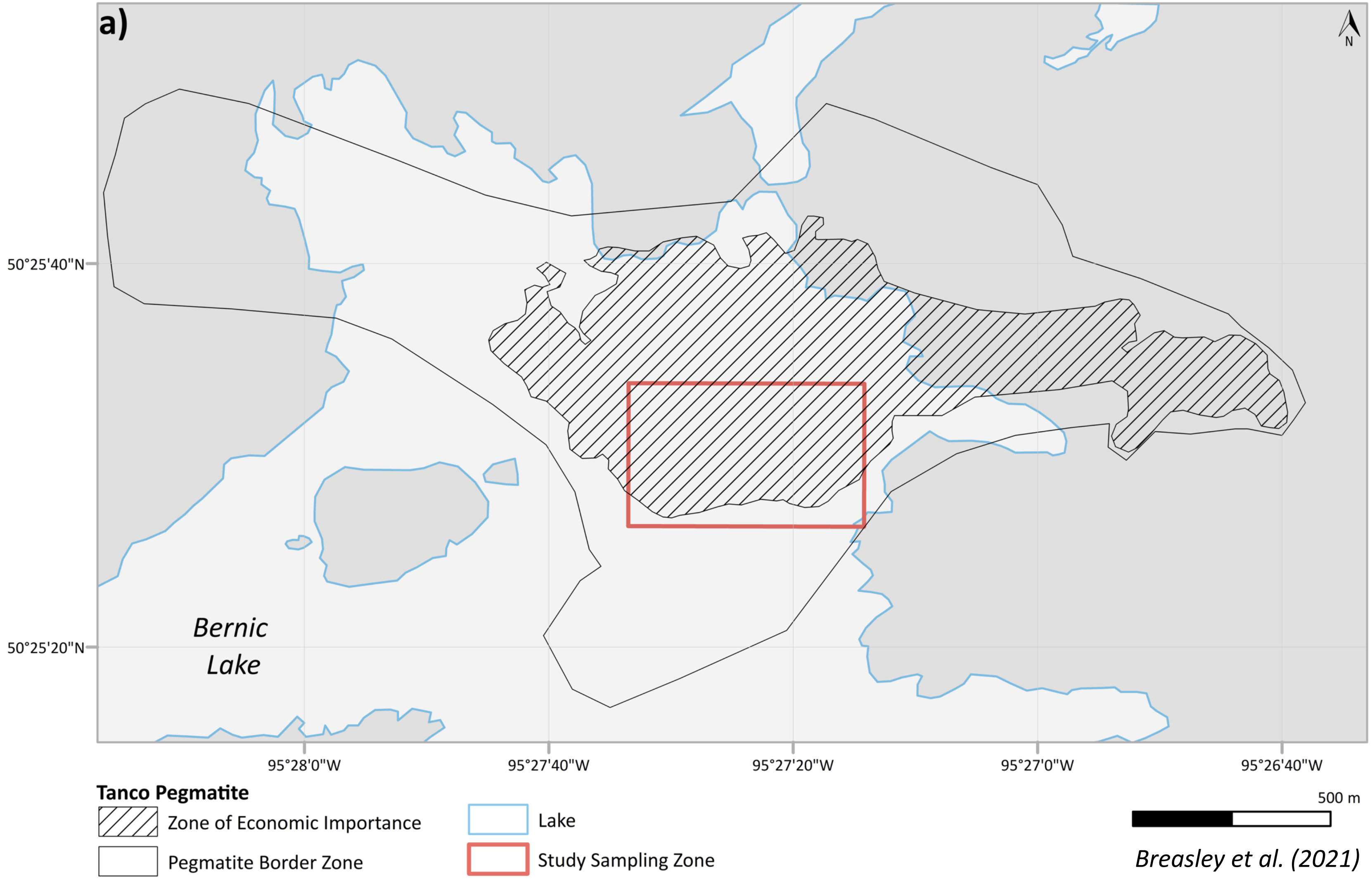
Location of the Tanco mine



Stott et al. (2010)

- The Tanco pegmatite is part of the Winnipeg River-Cat Lake pegmatite field;
- Part of the Bernic Lake pegmatite group;
- Located in the Bird River greenstone belt, which is part of the Archean Superior Province;
- The Bird River greenstone belt has been subdivided into two distinct (northern and southern) panels, both of which are composed of ca. 2.75-2.72 Ga juvenile, arc-type metavolcanic and associated metasedimentary rocks.


Rejects
Rejects
Main office
Cs chemical plant
Rejects
Access portal
Drill core farms
Core logging shack
Ore crushers
and concentrator
Bernic Lake



Tanco pegmatite

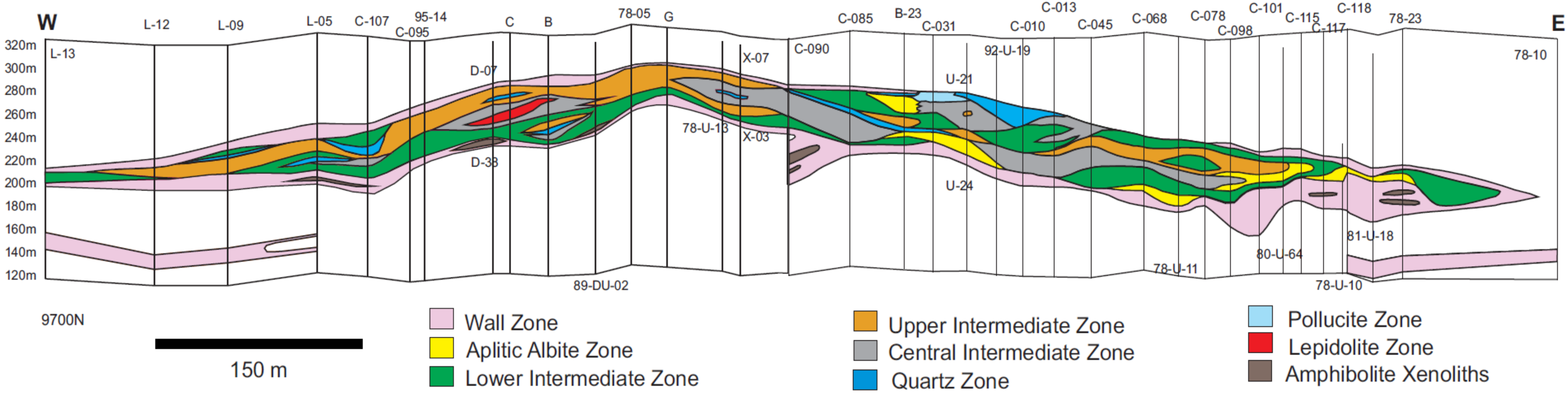
Characteristics

- Known maximum lateral dimensions: 1060 m (N–S); 1520 m (E–W); up to 100 m thick (E–W) through its center; ~ 40 m thick on average;
- Pegmatite is subhorizontal; intruded metamorphic rocks: amphibolite and gabbro;

- Age: approximately 2631 ± 12 Ma (Camacho et al., 2012);
- ~ 2627 drill holes (above and underground); ~ 172 km of recovered core;

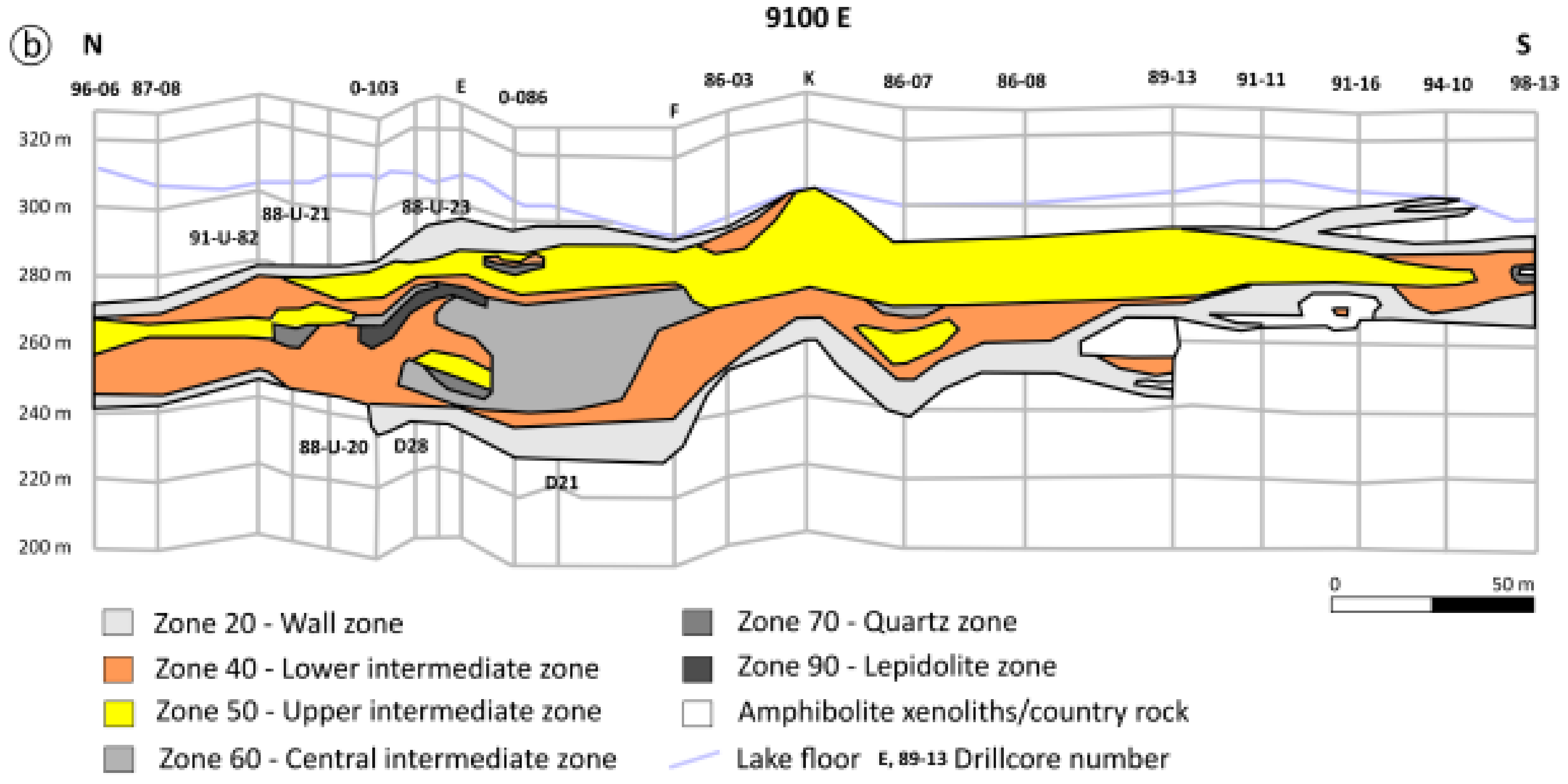
The Tanco pegmatite

Zonation



The Tanco pegmatite

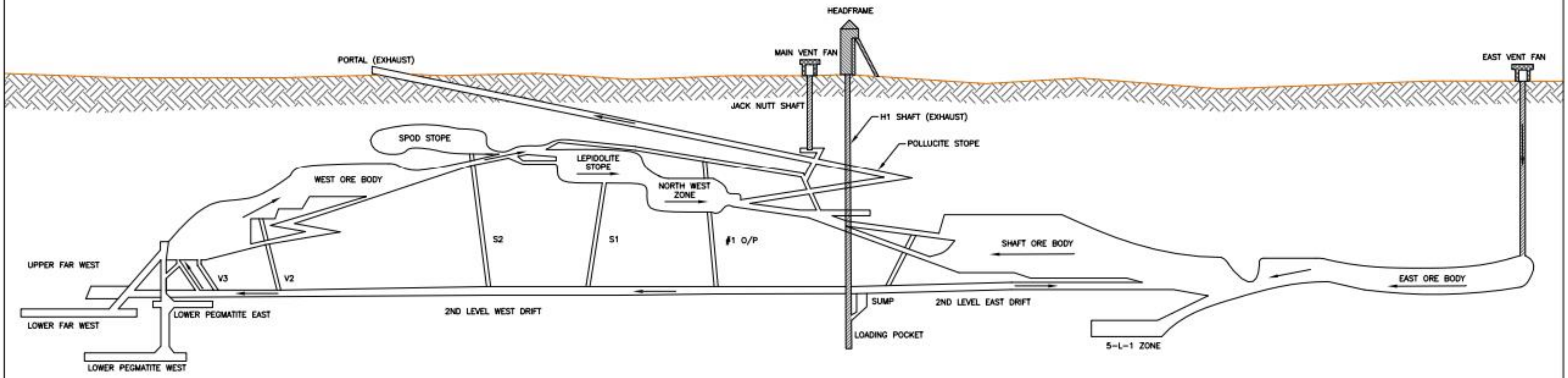
Zonation



Cross-section of zones in the Li active fronts based on drillcore data (Breasley et al. (2022).

The Tanco pegmatite

Idealized mine cross-section



Cross-section of the Tanco mine looking southwest (from Tetratech, 2013).

The Tanco pegmatite

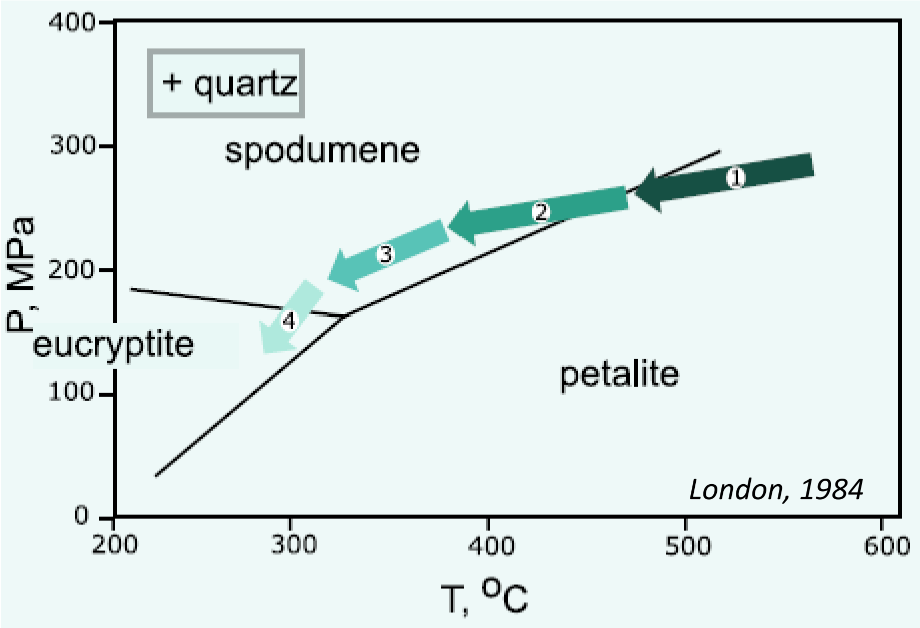
Mineralogy/Geochemistry

- Extensive list of minerals (more than 100 minerals listed in the literature);
- Home of new mineral discoveries: černýte, tancoite, diomignite, titanowodginite, ercitite and groatite;
- Bulk geochemistry of Tanco (based on 102 km of 1355 drill-hole intersections, underground observations, measured and estimated mineral modes of the zones, zone-specific compositions and mineral densities, and ore grades):
    - composition of a muscovite granite (peraluminous, moderately silicic, high-phosphorus, Na>K granite);
    - 8 wt.% petalite, 2.8 wt.% lithian micas, and 1 wt.% primary spodumene;
    - accessory silicates and phosphates are only in tenths of 1 wt.%;
    - very high degree of fractionation: K/Rb 4.7, K/Cs 9.3, Rb/Cs 2.0, Rb/Tl 137, Fe/Mn 0.63, Mg/Li 0.02, Al/Ga 917, Zr/Hf 2.6, Zr/Sn 0.21 and Nb/Ta 0.19.

The Tanco pegmatite

Mineralogy/Geochemistry

- Spodumene is the main targeted ore at the deposit and is typically found as spodumene and quartz intergrowths (SQUI);
- SQUI is typically thought to have formed via the breakdown of parental petalite;
- Evidence of variable spodumene to quartz ratios, iron-enriched spodumene in SQUI, and the notable lack of significant preserved petalite at Tanco: not sufficient to explain all SQUI origins seen in the deposit;

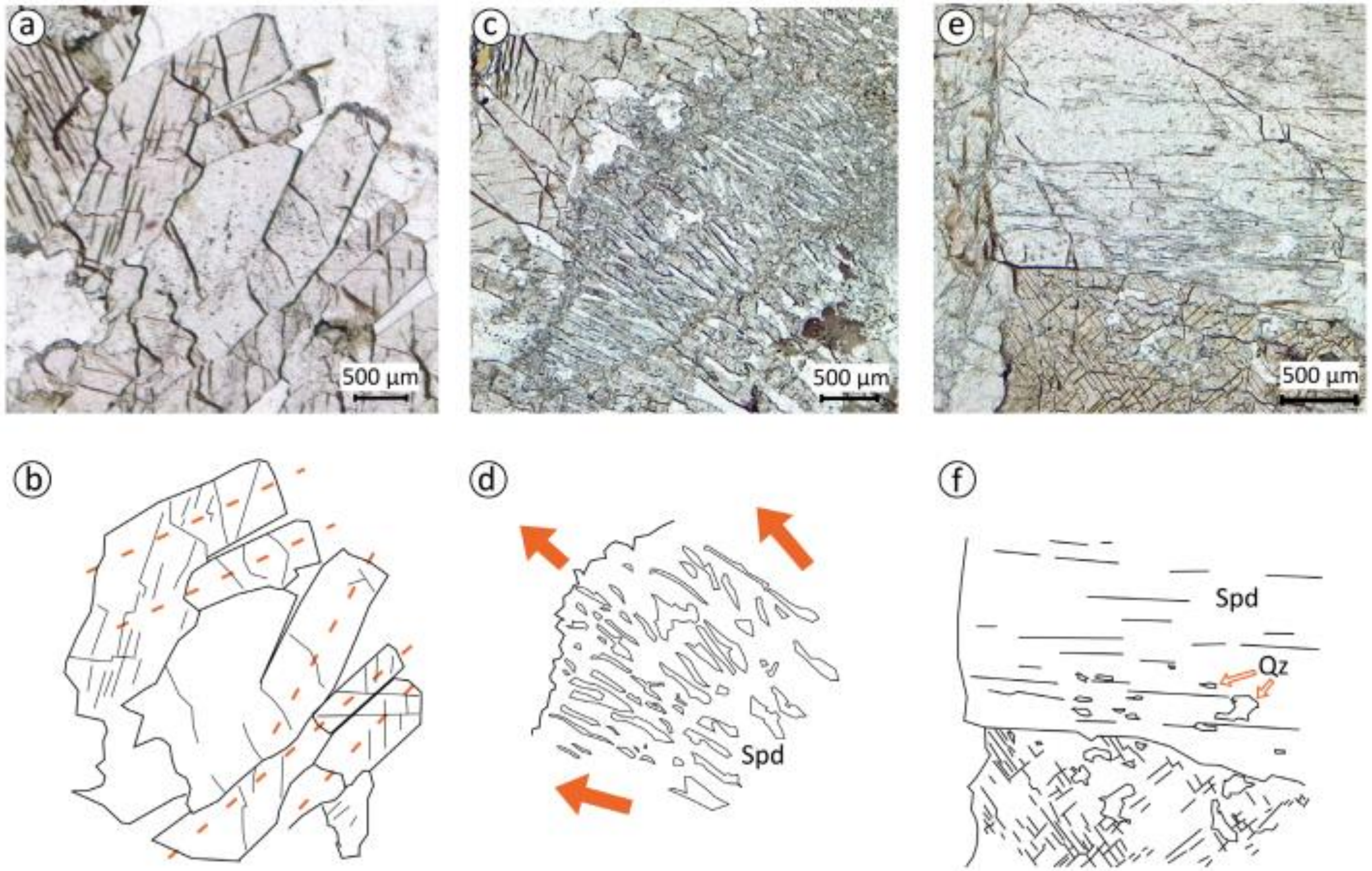


- Assessing the origins of SQUI using: petrography, cathodoluminescence (CL), scanning electron microscopy (SEM), laser ablation inductively coupled mass spectrometry (LA-ICP-MS), X-ray computed tomography (micro-CT), and electron backscatter diffraction (EBSD).

The Tanco pegmatite

Mineralogy/Geochemistry

- Five distinct textural groups of spodumene:
  - **a), b)** classic SQUI (the most abundant textural variety in the deposit) as shown by elongated unidirectional texture;
  - **c), d)**
    micro SQUI with symplectic radial texture, replacing the classic SQUI;



The Tanco mine

Production

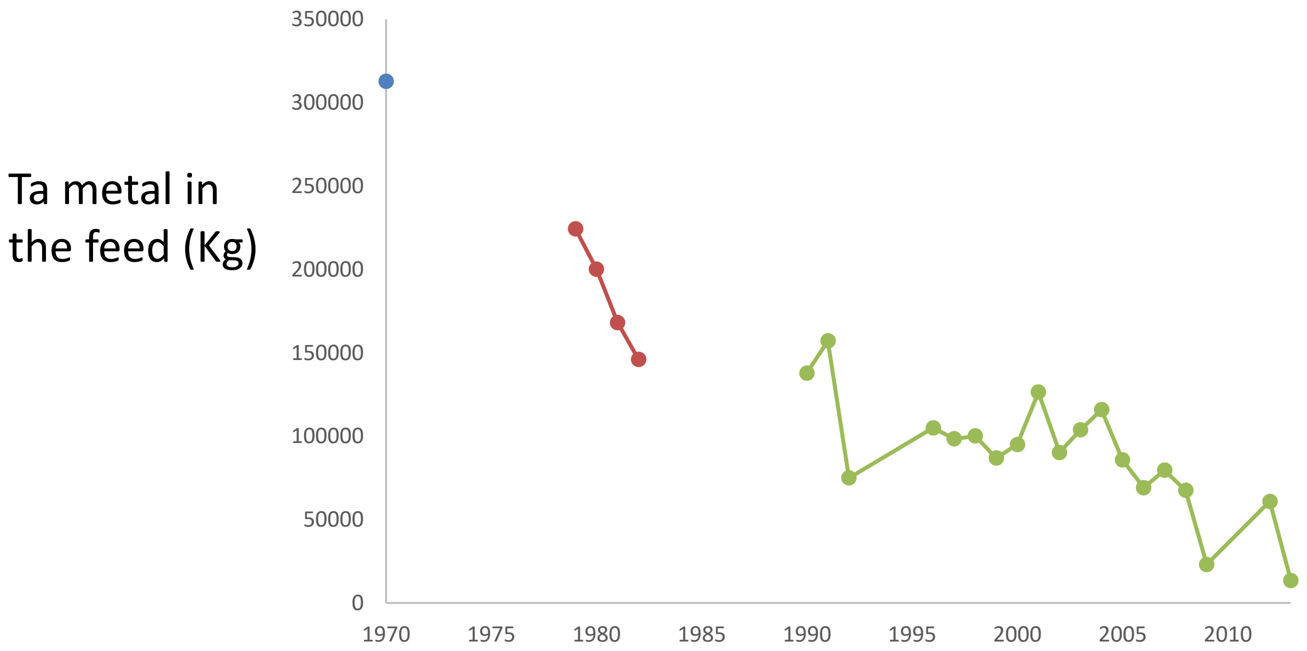
- Produced tantalum (Ta) ore (***tantalite***) since 1967 (off and on); cesium (Cs) ore (***pollucite***) and lithium (Li) ore (***spodumene***);

- The cesium formate pilot plant was designed, built and commissioned in 1996/97.
- The original plant was designed to produce 500 barrels/month of 2.3 g/cm^3 specific gravity cesium formate.
- In 1999, expansion of the plant allowed for the production of 700 barrels/month.
- In 2001, the plant underwent a further expansion in order to accommodate the manufacturing of conventional cesium chemicals.

The Tanco mine

Production

- Produced tantalum (Ta) ore (***tantalite***) since 1967 (off and on); cesium (Cs) ore (***pollucite***) and lithium (Li) ore (***spodumene***);

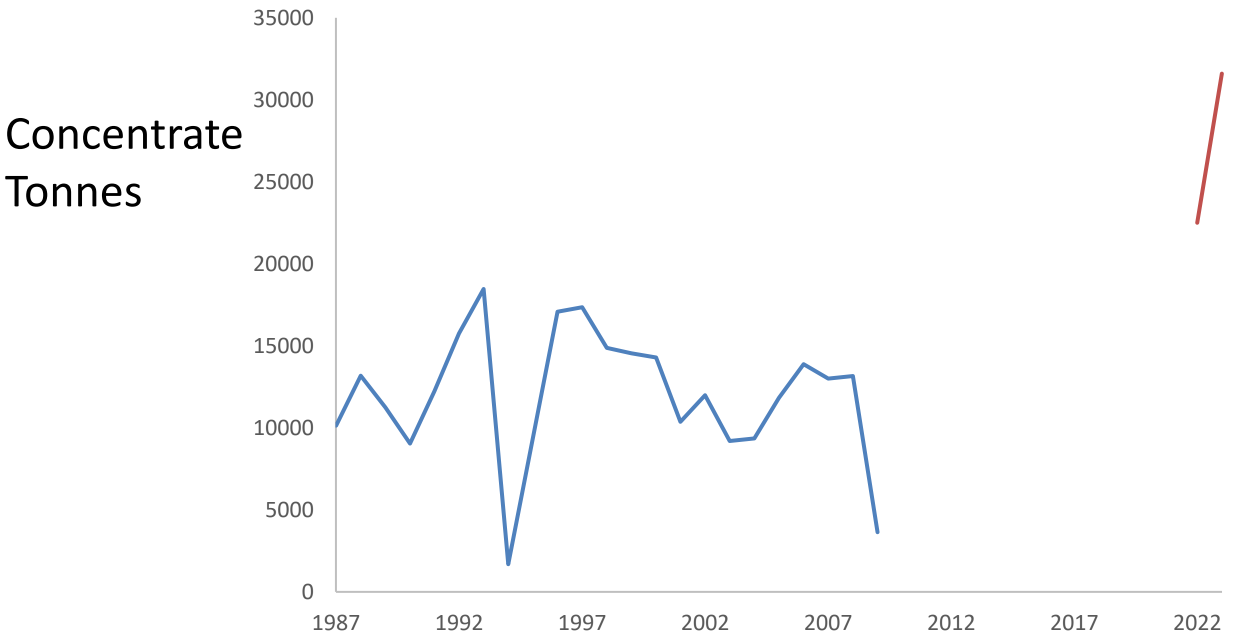


Production of contained Ta metal at the Tanco mine

The Tanco mine

Production

- Produced tantalum (Ta) ore (***tantalite***) since 1967 (off and on); cesium (Cs) ore (***pollucite***) and lithium (Li) ore (***spodumene***);



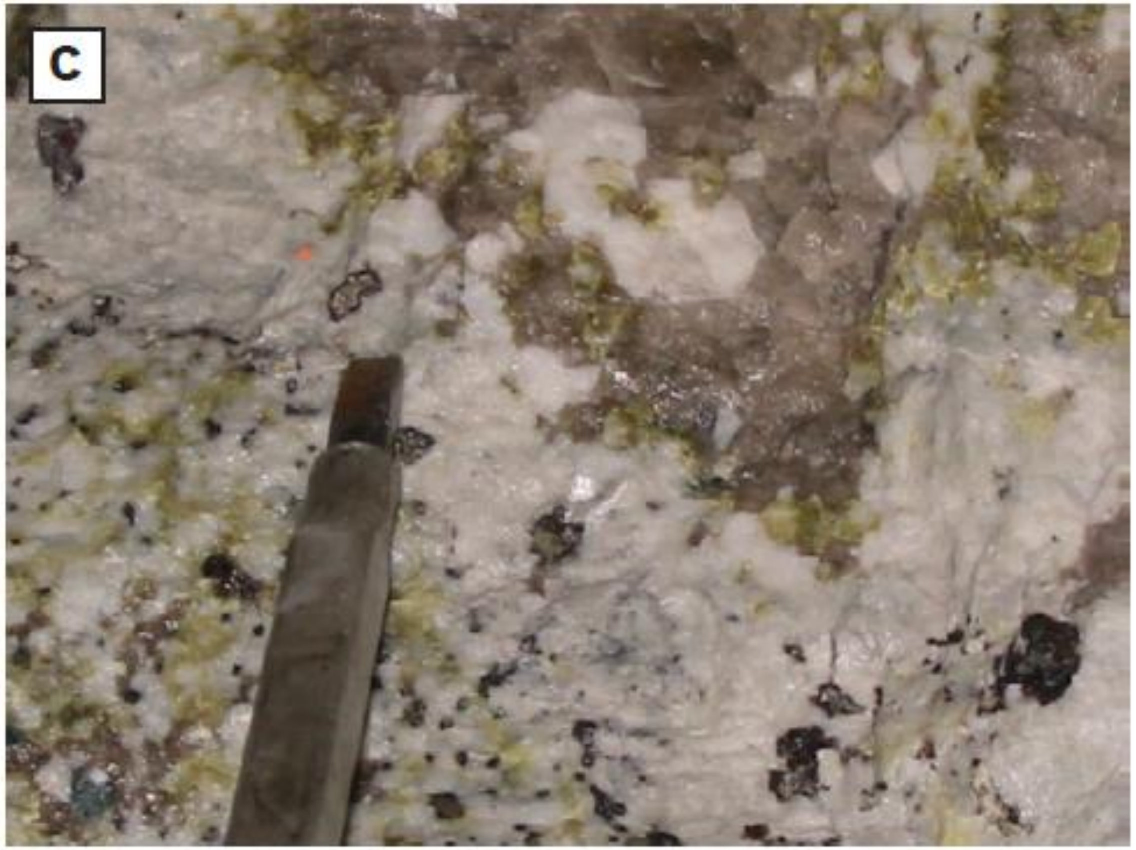
Production of Lithium Concentrate at the Tanco mine

Year	Li_2O Conc. grade	Conc. tonnes
1987	7.32	10141
1988	7.29	13179
1989	7.29	11244
1990	7.26	9045
1991	7.23	12233
1992	7.30	15762
1993	7.30	18473
1994	7.31	1701
1996	7.24	17094
1997	7.20	17360
1998	7.24	14879
1999	7.21	14547
2000	7.19	14298
2001	7.16	10366
2002	7.19	11997
2003	7.18	9200
2004	7.16	9357
2005	7.17	11835
2006	7.19	13879
2007	7.08	13013
2008	7.11	13161
2009	7.03	3647
2022	5.00	22500
2023	4.82	31598

The Tanco pegmatite

Mineralogy

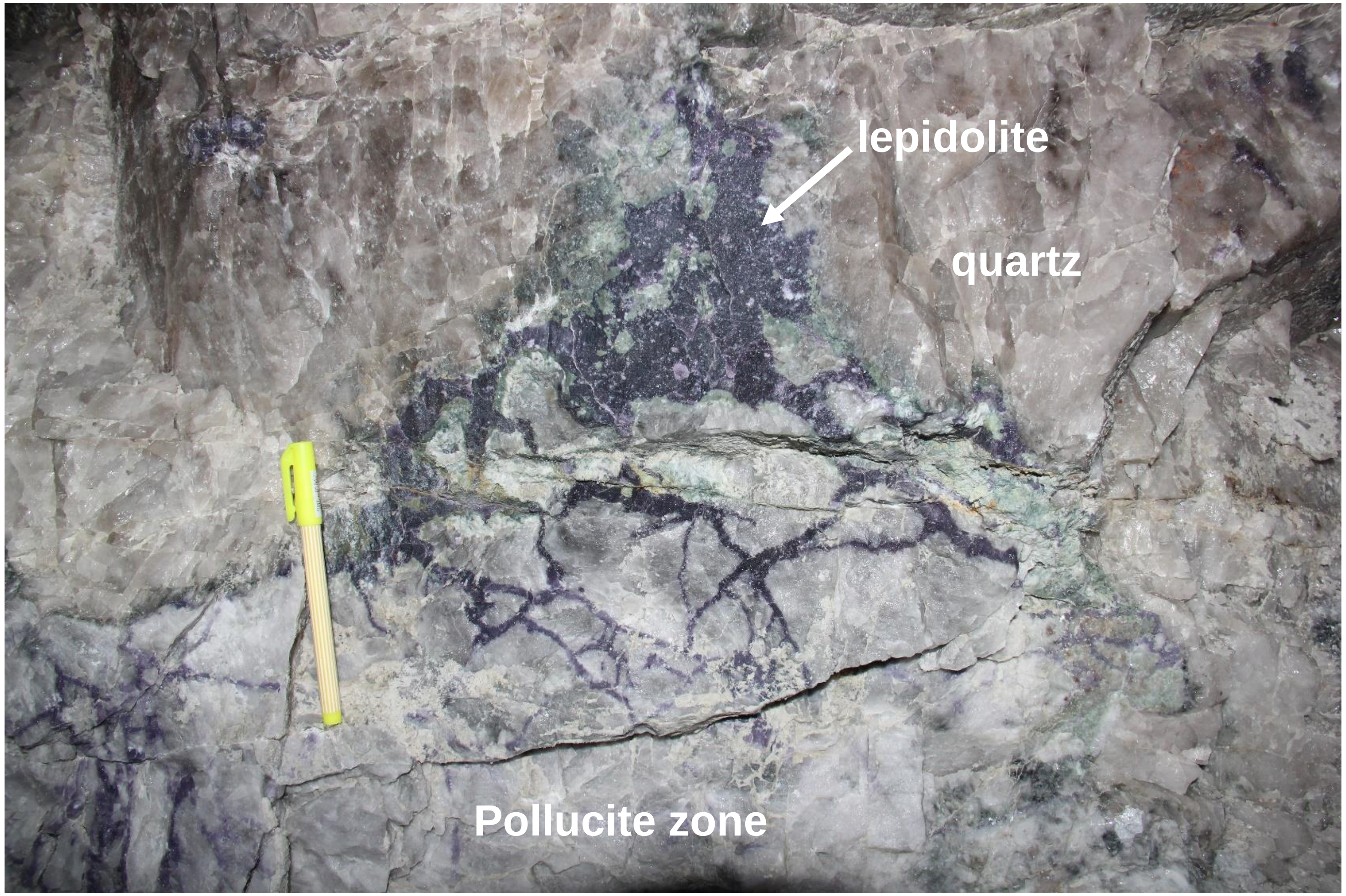
Contact with albite-quartz assemblage; green colour is due to the presence of the green mica.

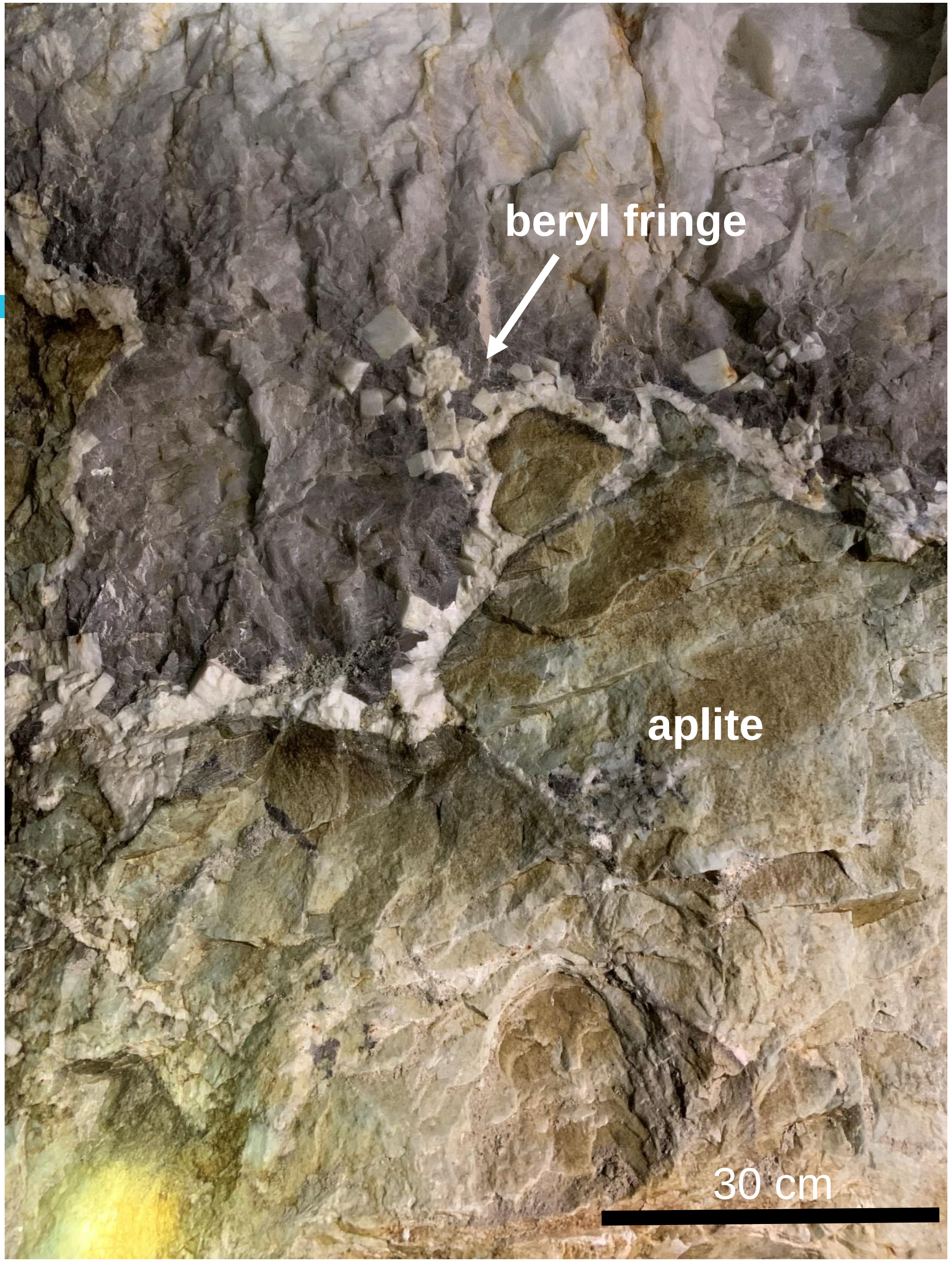


Tantalum mineralization in an albite-beryl-mica assemblage; scaling bar chisel end is 25.5 cm.

The Tanco pegmatite

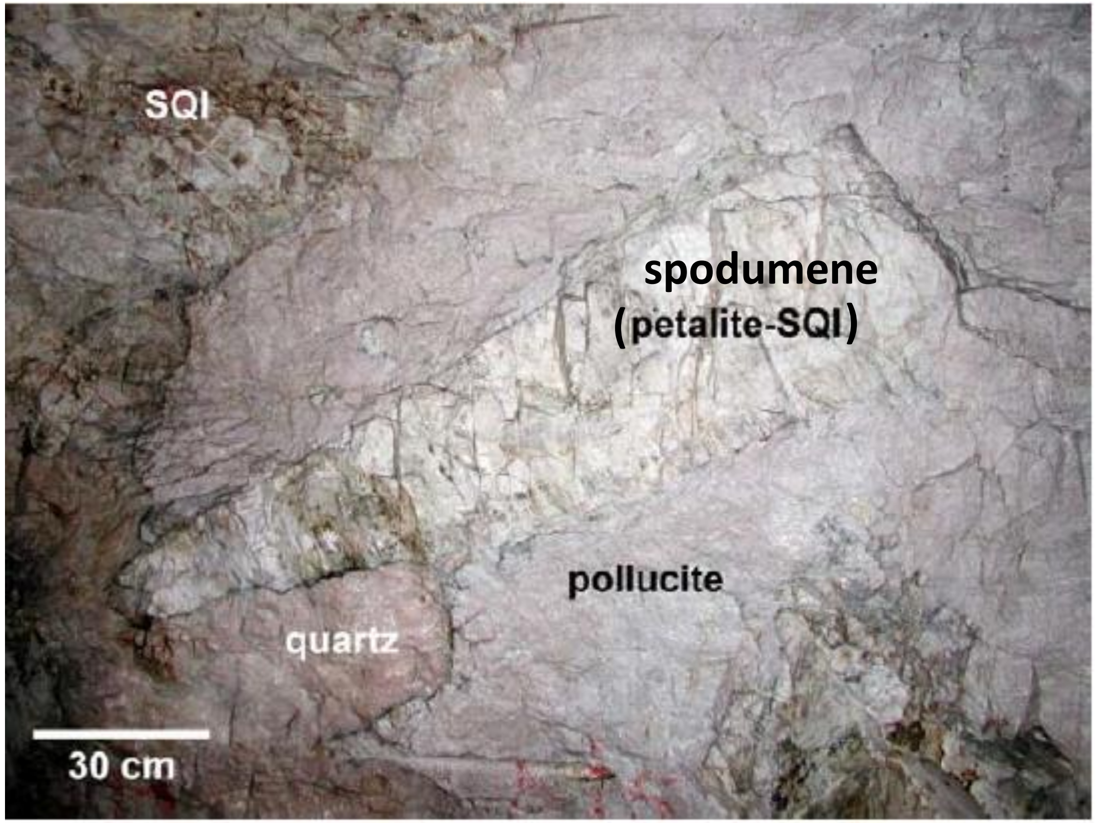
Mineralogy



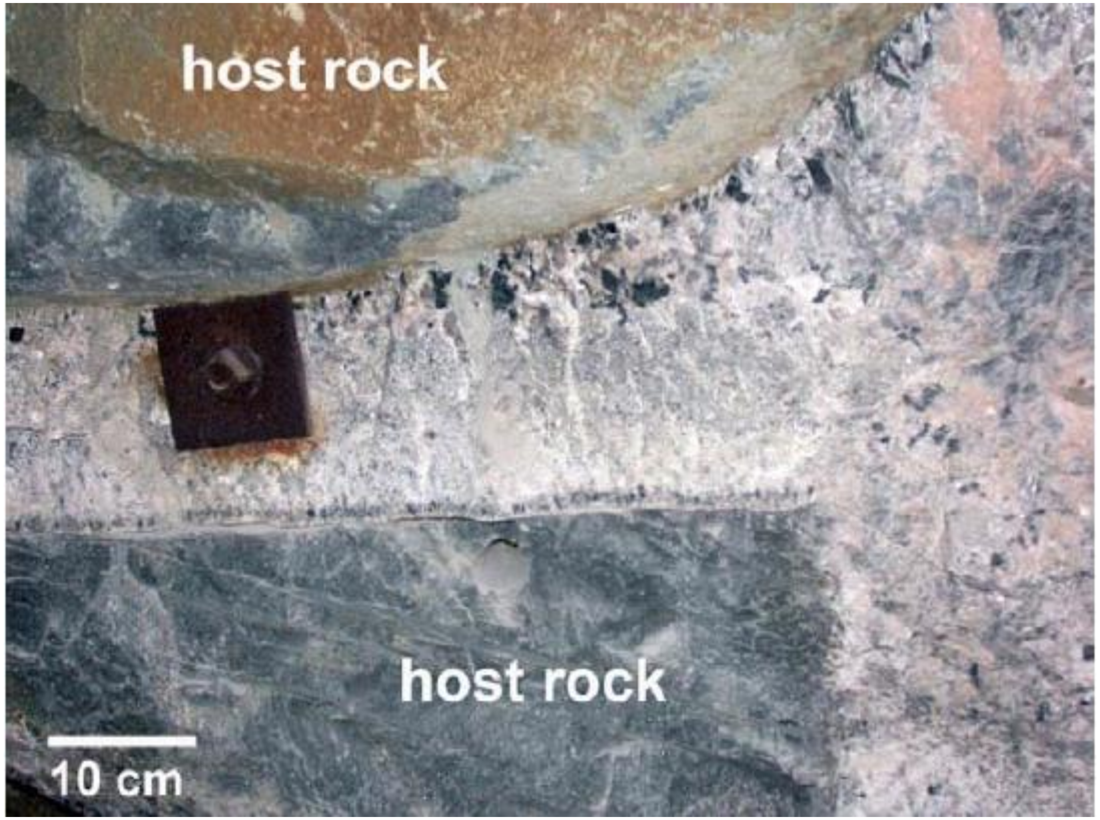


The Tanco pegmatite

Mineralogy



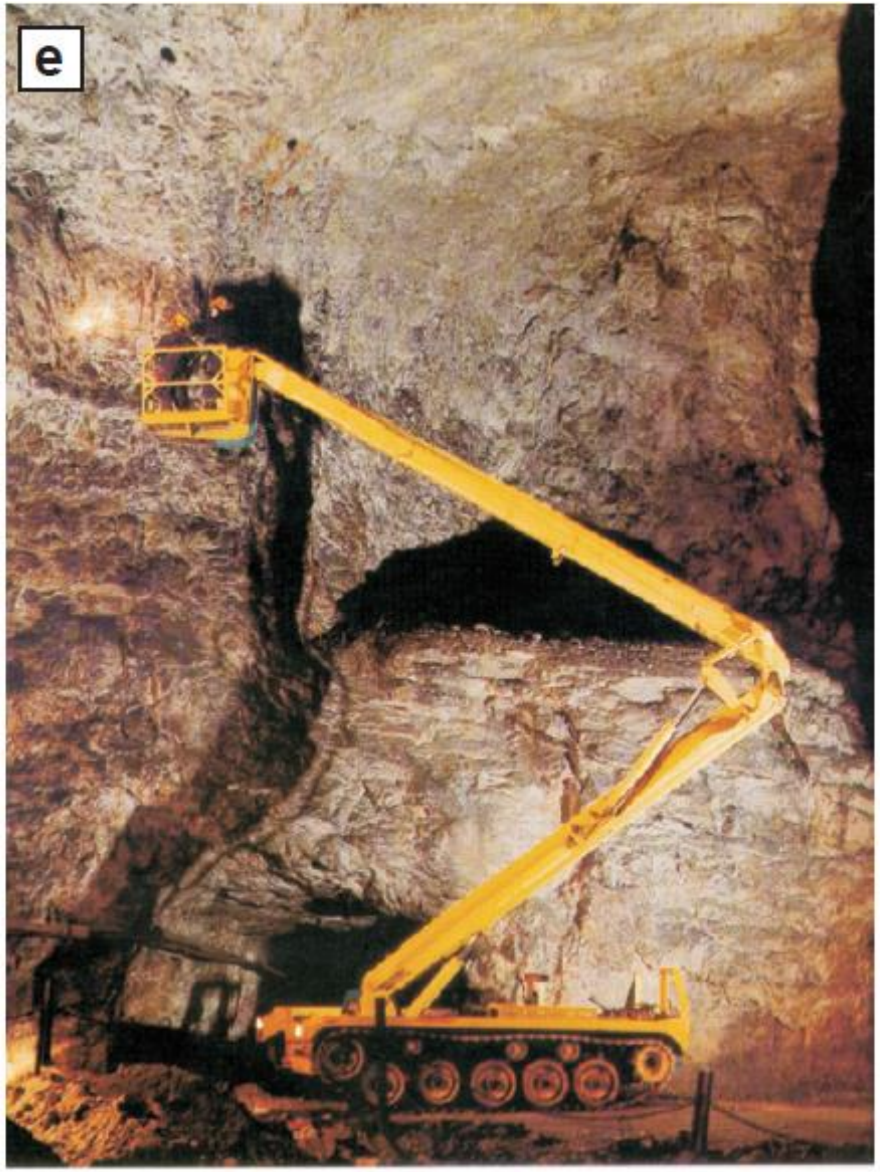
Spodumene – quartz intergrowth (SQI) pseudomorph of petalite, which grew toward pollucite



Lower border zone contact; black tourmaline crystals grew inward from the walls of the dike, and fine-grained tourmaline pervasively dots the rock.

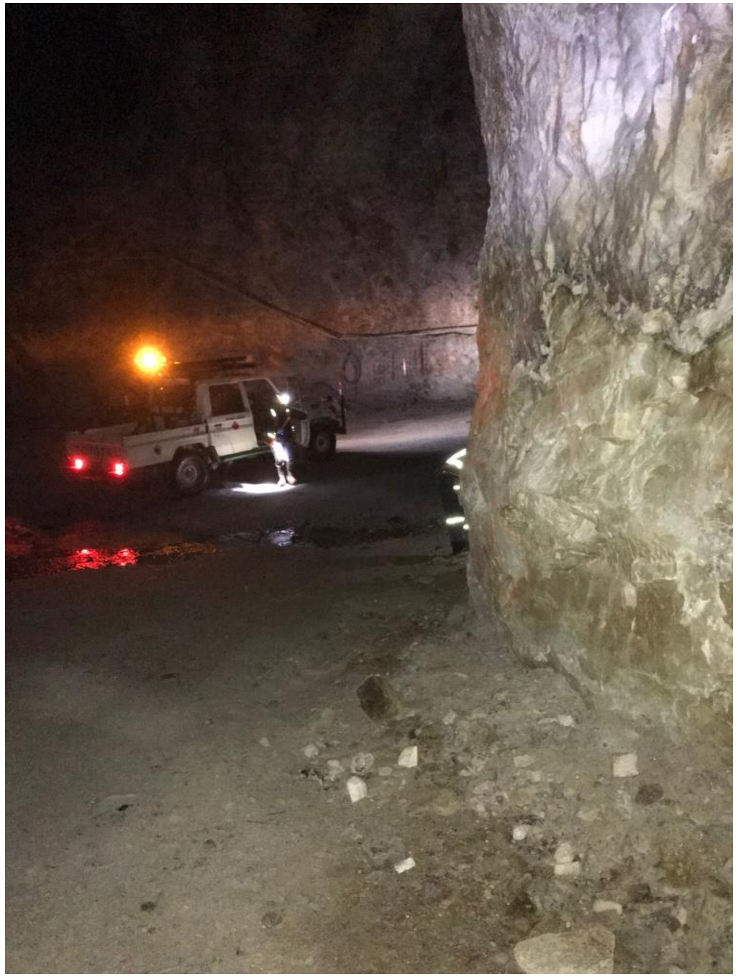
The Tanco pegmatite: underground

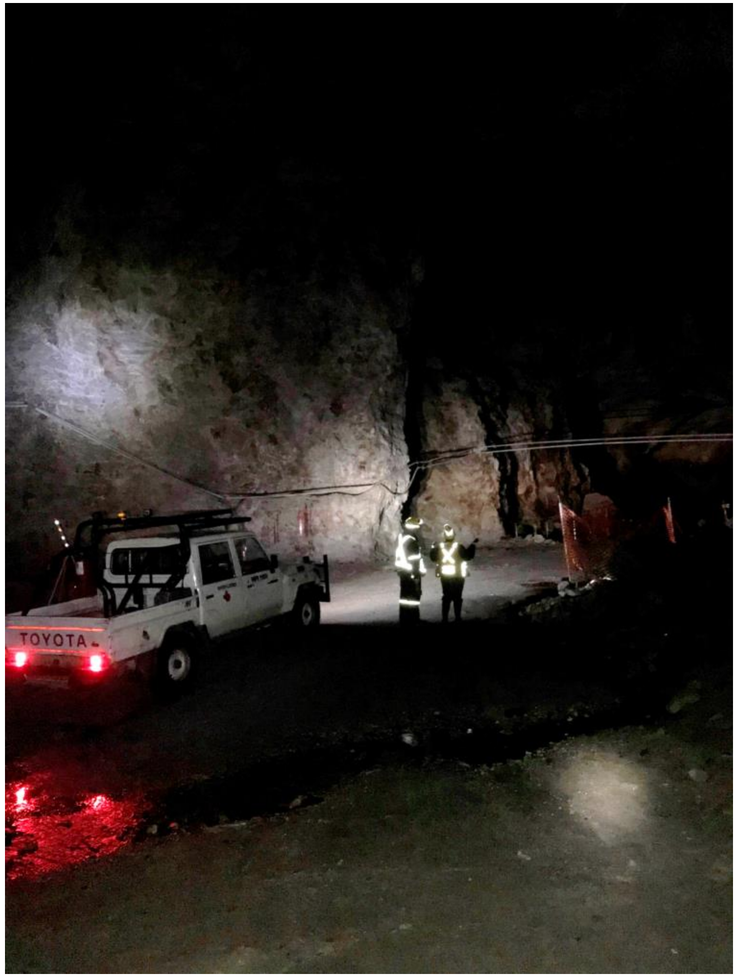
Scoop tram close to one of the spodumene zone pillars illustrating the room and pillar method used at Tanco.



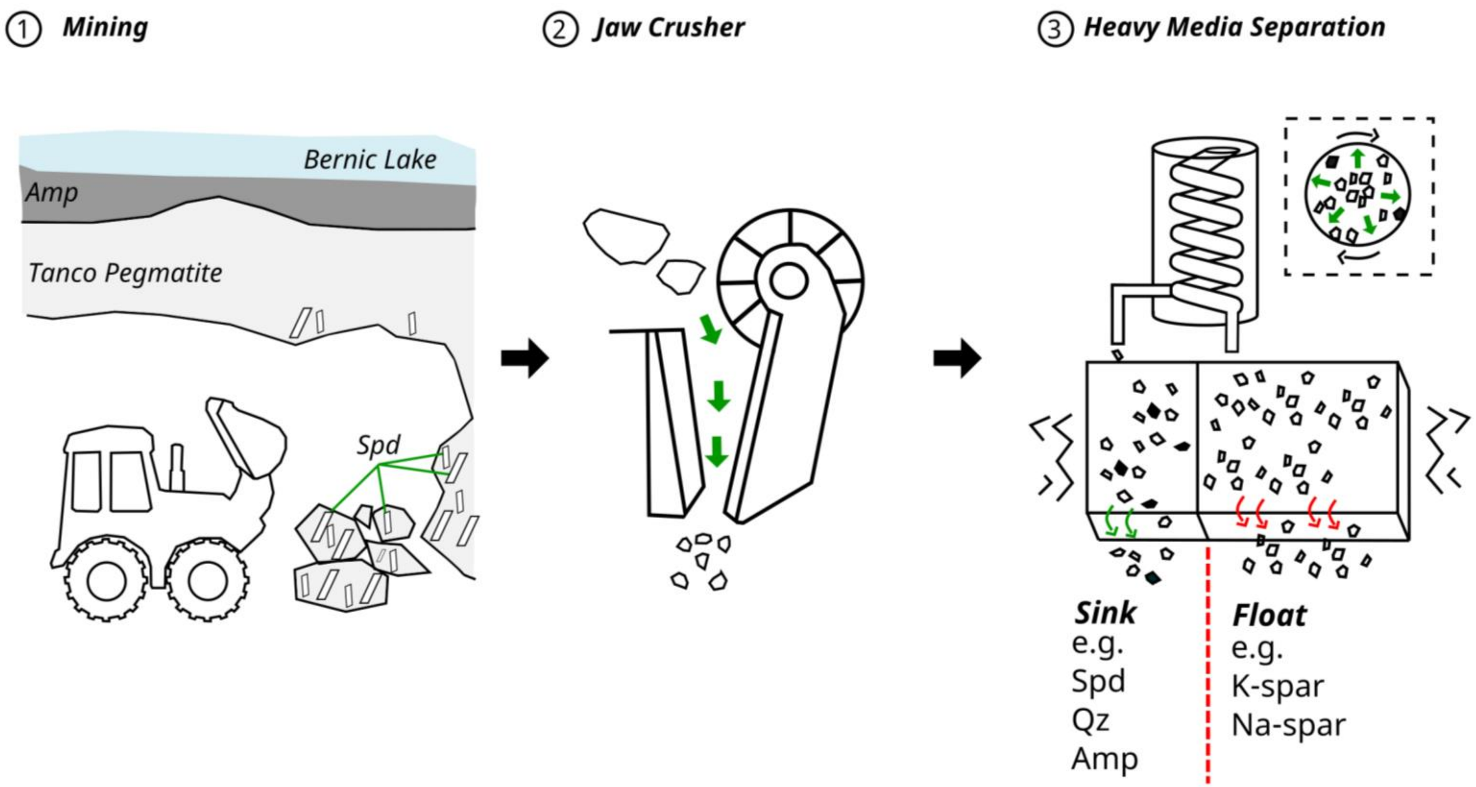
Custom designed aerial lifts ("giraffe").

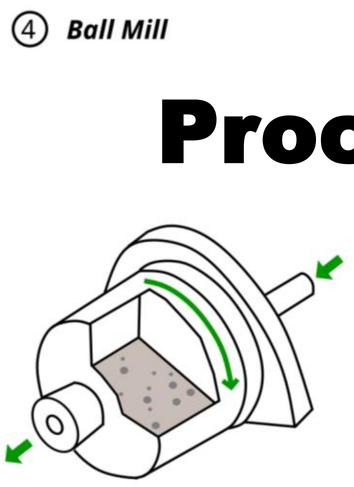
The Tanco pegmatite: underground





Processing-Li

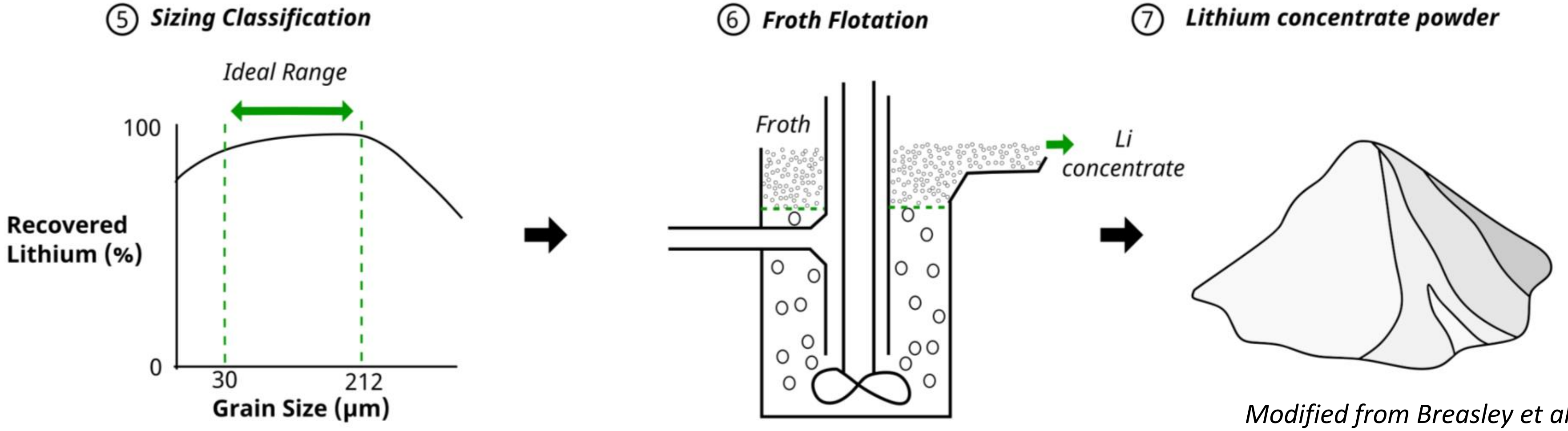




Specific Gravity of Spodumene= 3.15 gm/cc

Specific Gravity of Petalite= 2.43 gm/cc

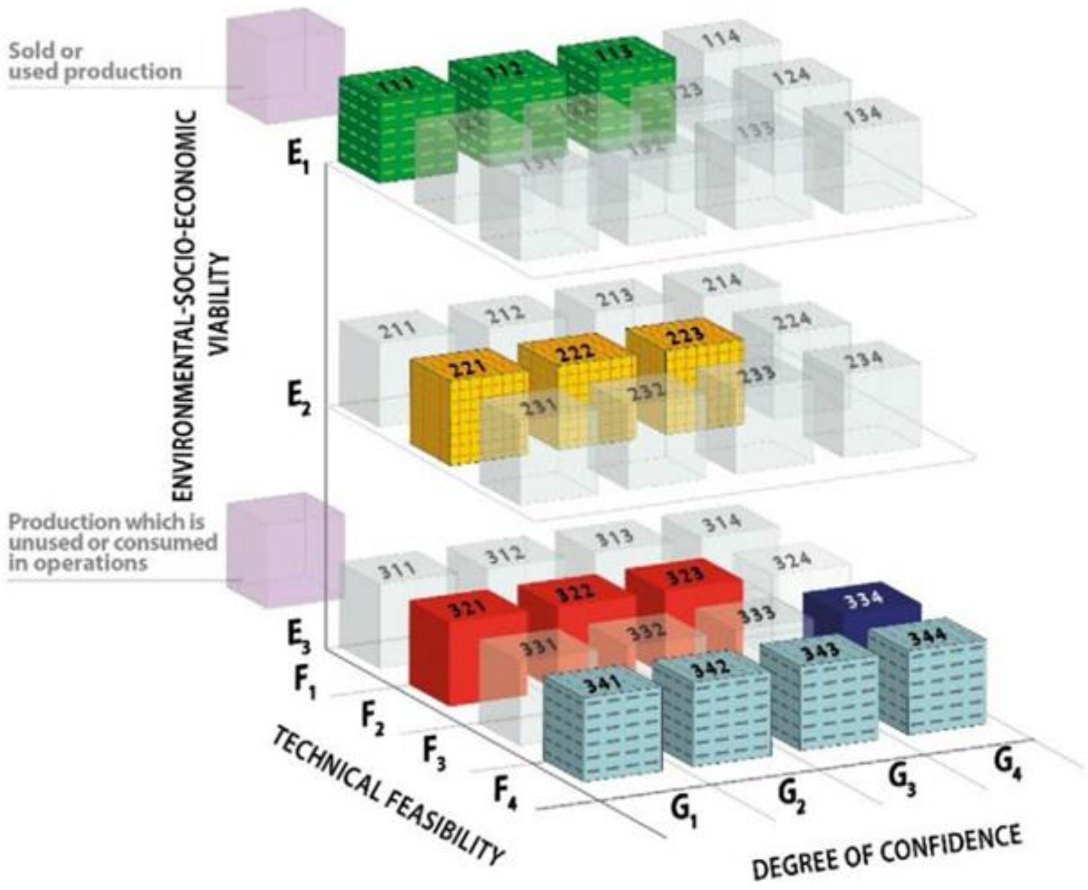
Specific Gravity of Quartz= 2.65 gm/cc



Modified from Breasley et al. (2023)

UNFC Case Study: Tanco mine

Classification



- Reserve estimates (**public record**) are a variety of historical formats;
- Considered non-compliant with current Canadian National Instrument (NI43-101) requirements;
- The deposit has a mineable resource in current underground operations (amalgamated value that includes measured, indicated and inferred):
  - 2,324,400 tonnes with a Li_2O grade of 1.859% containing a Li_2O metal quantity of 43,206.78 tonnes;
  - 3,709,570 tonnes with a Ta_2O_5 grade of 0.109% containing a Ta_2O_5 metal quantity of 4,037.52 tonnes;
  - 116,400 tonnes with a Cs_2O grade of 13.83% containing a Cs_2O metal quantity of 16,100 tonnes.

UNFC Case Study: Tanco mine

Classification

- UNFC should be applied to the different commodities separately;
- E-axis (*Environmental-Socio-Economic Viability*): 1.1 for Lithium and Cesium; 3.3 for Tantalum;
- F-axis (*Technical Feasibility*): 1.1 for Lithium and Cesium; 2.3 for Tantalum;
- G-axis (*Degree of Confidence*): G3 for Lithium, Cesium and Tantalum (reserve estimates include measured, indicated and inferred).

	Classification	Type	Commodity	Quantity (tonnes)	Grade	Metal Content	Sub Class	E	F	G
Cesium										
	113	Underground	Cs_2O	116,400	13.80%	16,100	In Production	1	1.1	3
Lithium										
	113	Underground	Li_2O	2,324,400	1.86%	43,206.78	In Production	1	1.1	3
Tantalum										
	333	Underground	Ta_2O_5	3,709,570	0.10%	4,037.52	Development Not Viable	3	2.3	3

UNFC Case Study: Tanco mine

Conclusion

- Multicommodity production: can produce Lithium or Cesium without producing Tantalum;
- Not throwing the other products away, but it allows for selective mining (also include tailings reprocessing);
- Market drives what mine is producing so the classification changes through time (Tantalum classification example);
- One or two of the commodities are profitable enough, the mine can operate; if only one of the commodities is being produced and is not profitable, the mine might shut down.

Year	Type	Commodity	Quantity (tonnes)	Grade	Sub Class	E	F	G
1982	Underground	Ta_2O_5	1,047,000	0.144%	In Production	1	1.1	3
	Tailings	Ta_2O_5	647,000	0.065%		2	2.3	3
2010	Proven	Ta_2O_5	414,521	0.073%	In Production	1	1.1	1
	Indicated	Ta_2O_5	1,019,680	0.076%		2	2.2	2
	Inferred	Ta_2O_5	519,848	0.080%		3	2.3	3
2022	Underground	Ta_2O_5	3,709,570	0.10%	Development Not Viable	3	2.3	3

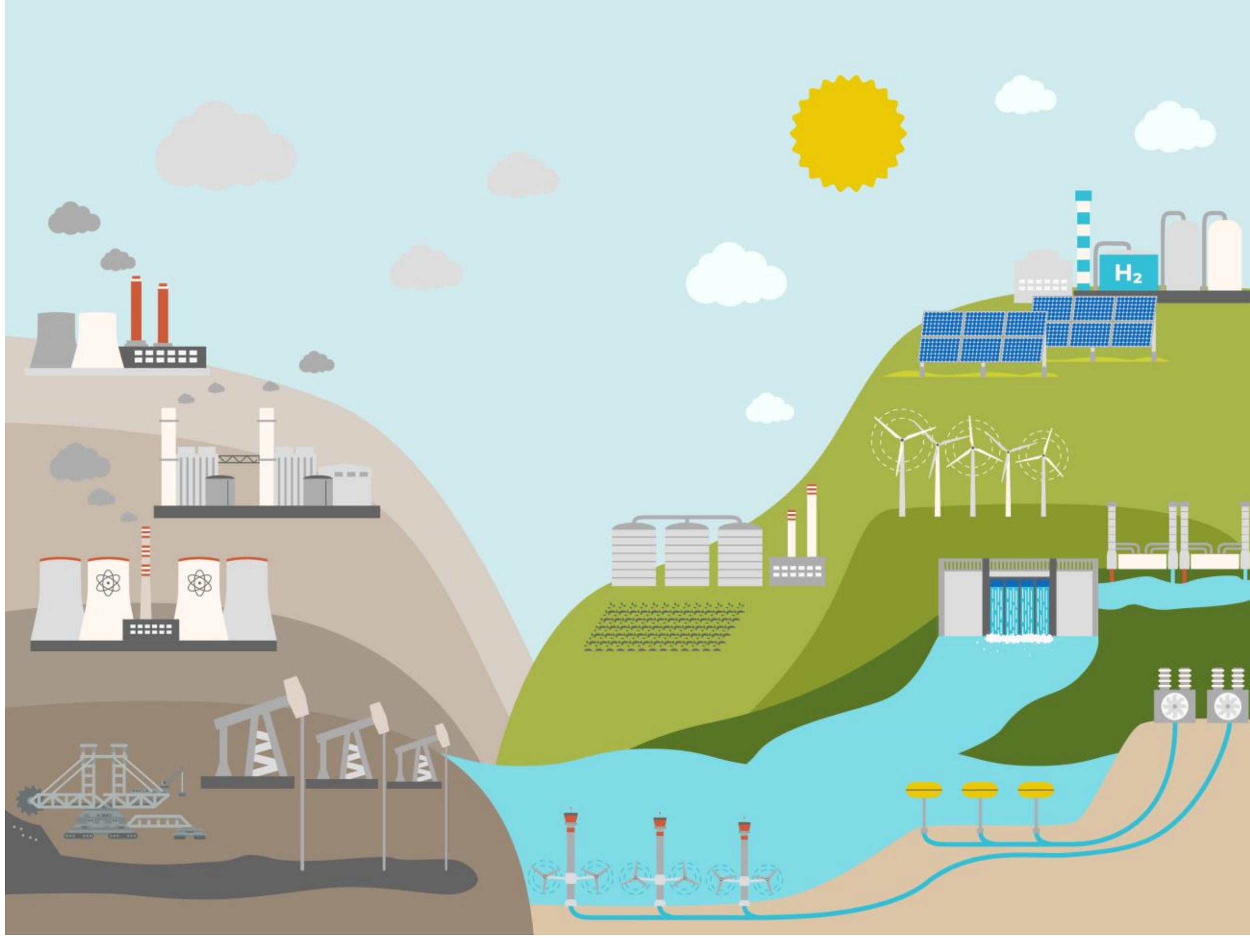
Tantalum classification

THE VIEWS EXPRESSED ARE THOSE OF Tania Martins of the Manitoba Geological Survey AND DO NOT NECESSARILY REFLECT THE VIEWS OF THE UNITED NATIONS.

Thank you!

Tania Martins
A/ Chief Geologist, Precambrian Geoscience Section, Manitoba Geological Survey

UNECE
Date 24 I 4 I 2024, Geneva



RESOURCE MANAGEMENT WEEK 2024

UNECE

Lithium and the Biophysical Environment

Objective: Explain potential impacts from lithium exploration to mining/ processing, how lithium mine waste is typically managed and deposited/handled, and regulatory frameworks.

Matthew Hudder

Environmental Scientist, CanmetMINING, NRCan

&

Charbel Atallah

Research Scientist, CanmetMINING, NRCan

&

Richard Goulet

Senior Research Scientist and Section Head, CanmetMINING

Natural Resources Canada | Ressources naturelles Canada

Recovery of Lithium from Petroleum and Geothermal Brines

Charbel Atallah, Matthew Hudder, Sanaz Mosadeghsedghi, Laleh Dashtban Kenari, MohammadAli Baghbanzadeh, Lucie Morin, Konstantin Volchek

CanmetMINING - Natural Resources Canada

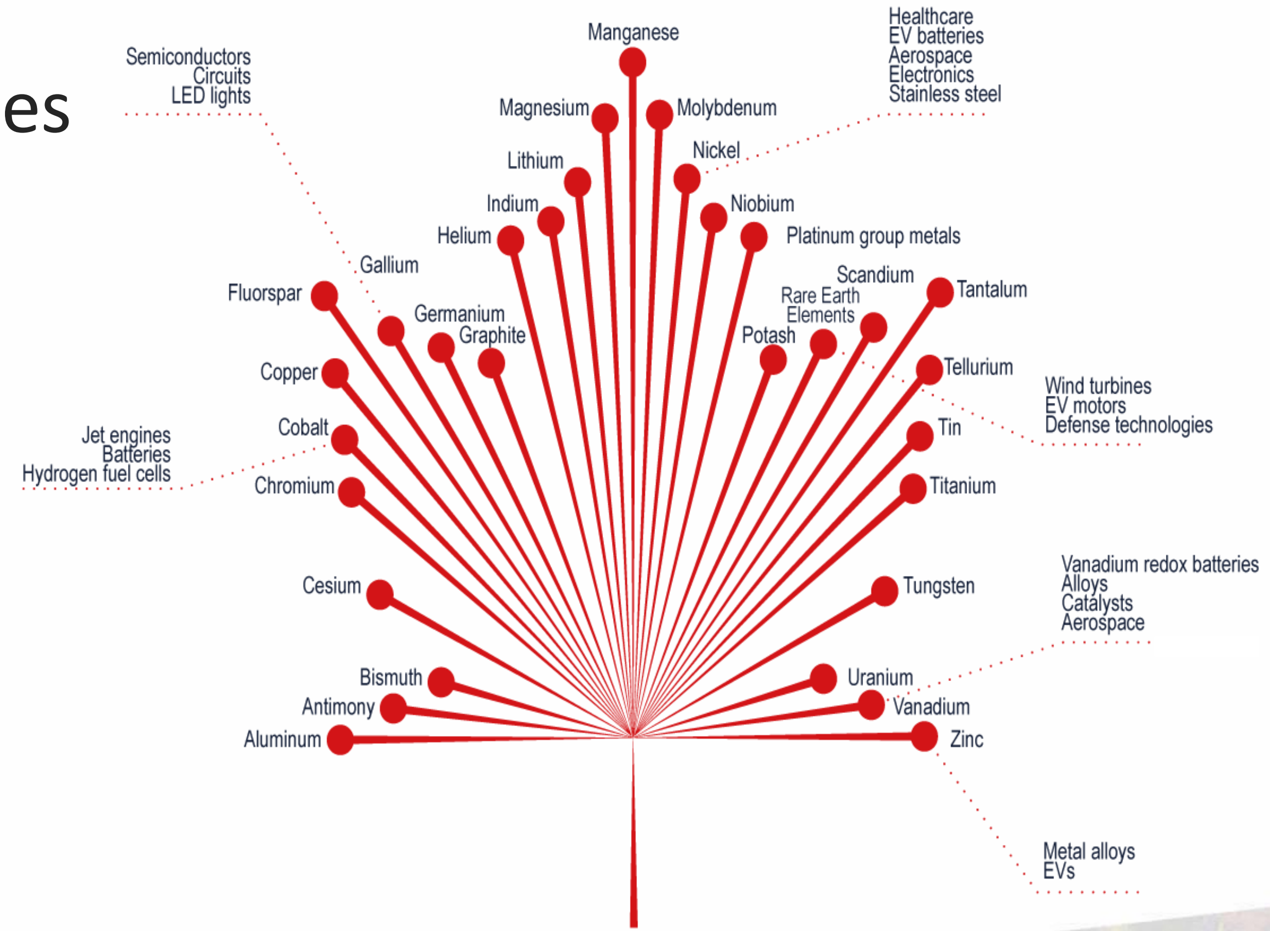
Mackenzie Valley Operational Dialogue 2024

May 29th, 2024

Canada

Presentation Outline

- Critical Minerals Research, Development and Demonstration (CMRDD) Program
- Overview of Canadian Lithium Brines
- Lithium from Brines project
  - Project roadmap
  - Flowsheet development
  - Electrochemical approach
- Technology Research
  - Electrocoagulation & Electrodialysis
  - Vacuum Membrane Distillation
- Future Work
  - Optimization
  - Scale-up



Critical Minerals Research, Development & Demonstration Program

- Unlocking the Potential of Canada's Critical Mineral Resources -

Who We Work With?

- Canadian companies with a Critical minerals resource that have a high reserve potential
- Developers of disruptive Critical mineral technologies that need to be advanced
- Canadian companies that want to recycle Critical minerals from waste and post-consumer products
- Post-secondary institution that are attracting and developing HQP

What Do We Do?

- World-class scientists with experience in Critical minerals research
- Focussed research to understand the WHYs and HOWs, offering a different perspective to conventional processes
- Actively identifying and resolving technical challenges faced by industry,
- Collaborate directly with Companies to support project advancement

How We Quantify Success? (KPI)

TRL advancements - Advance Resources to Reserves - Industry feedback

Challenge with Critical Minerals:

Aligning industry's **input** needs with Federal expertise

Understanding and working on the right gaps/ problems with the highest potential

Critical Minerals Research, Development & Demonstration Program

Vision:

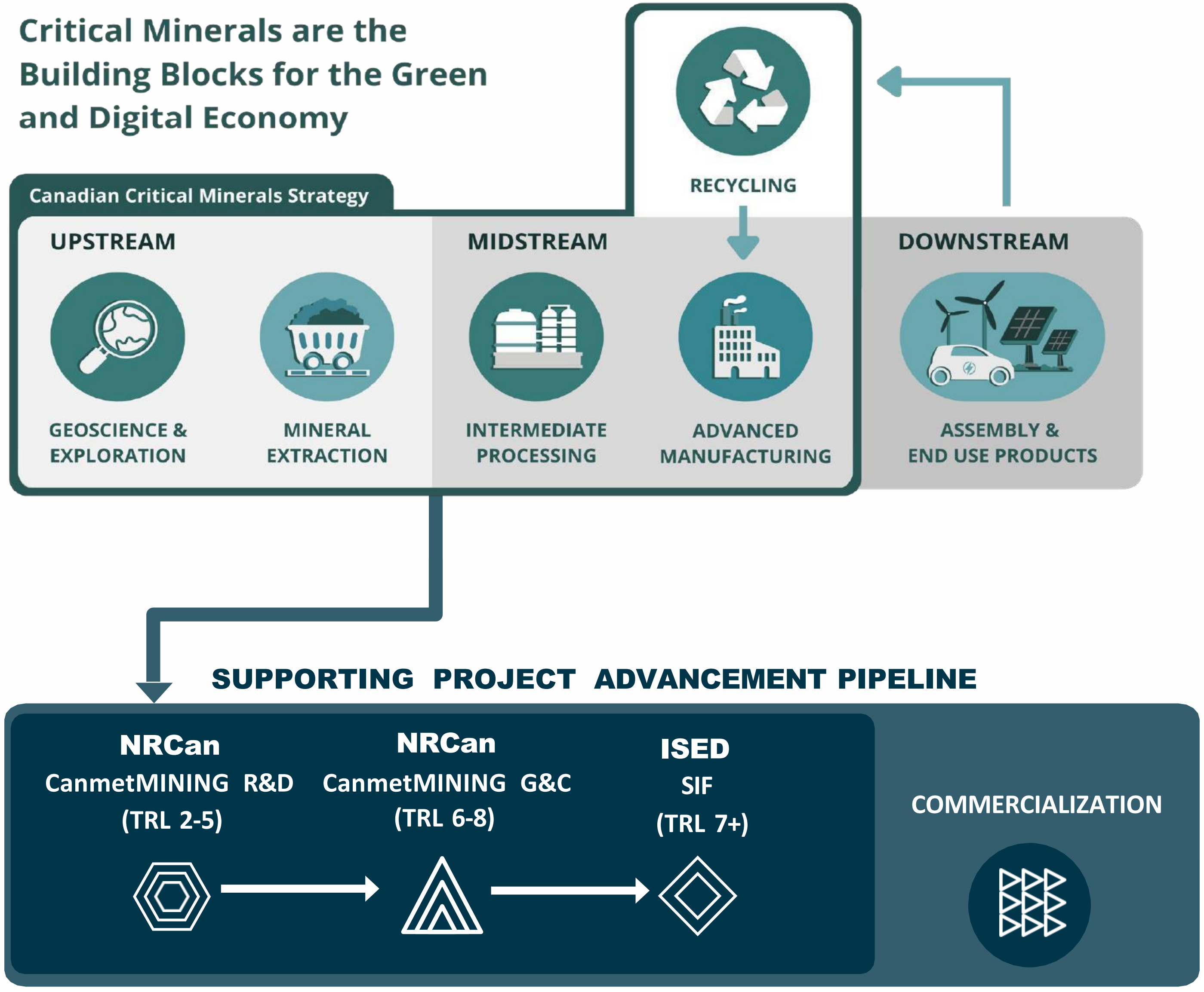
CanmetMINING is a trusted R&D organization and recognized as a global leader in Green Mining Innovation and the applications of digital technologies

Mission:

To drive Green Mining Innovation and application of digital technologies to generate economic and environmental benefits for the mining industry

Program Mandate:

Strengthening upstream/midstream supply of critical minerals, with a focus on battery and magnet elements for the electric vehicle supply chain



Overview - Canadian Lithium Brines

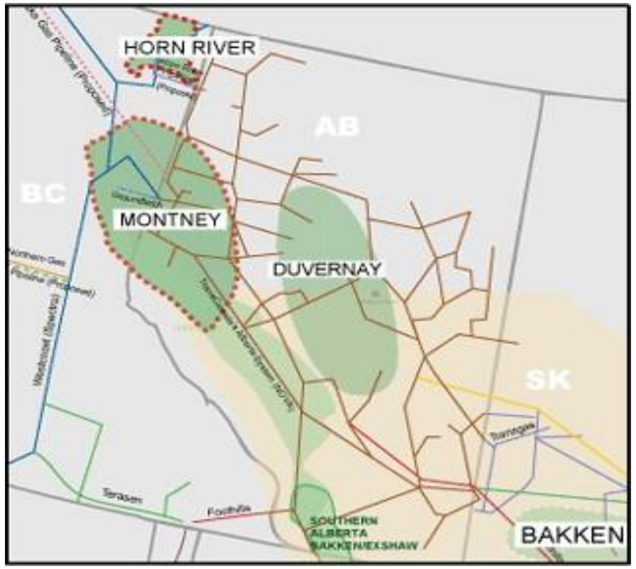
Significant growth in lithium material demand has driven interest in **alternative** lithium sources to further the electrification and security of Canada's economy.

Canada has an abundance of low-grade lithium-containing brines. Due to unique environmental conditions, geography, and lithium concentrations, conventional evaporative processes (salars) are **not feasible** with Canadian brines.

The development of novel **direct lithium extraction** (DLE), **separation**, and **purification** technologies will reduce water consumption, land use impacts, and waste generation for the recovery of lithium from Canadian brines.

Overview - Canadian Lithium Brines

- Oilfield brines: water produced with oil and gas from deep underground; mostly in Western Canada.
- Up to 10 times salinity of seawater, 345 g/L TDS as chlorides; Na^{+} dominant cation, followed by Ca^{2+}, K^{+}, Mg^{2+} and Sr^{2+}.
- Lithium: up to 140 mg/L but rarely >100 mg/L; 10s mg/L commonly reported.
- Major factors to overcome:
  - Lower lithium concentrations
  - Dissolved organic carbon
  - Multivalent cations (Ca^{2+}, Mg^{2+}, Sr^{2+})



Geographical location of Montney & Duvernay formations

Analyte	Montney	Duvernay
Cl	162,900	159,200
Na	63,000	67,000
Ca	11,000	12,000
K	1,830	2,420
Mg	1,270	849
S	108	111
Li	**57.5**	**57.2**
Fe	31.9	61.6
Sr	-	1,260
TOC	329	665
pH	5.79	5.60

Montney and Duvernay flowback produced water compositions in mg/L

Flowsheet Development

CanmetMINING

CanmetENERGY
Leadership in ecoInnovation

Pre-Treatment[1] → **Direct Lithium Extraction[2]** → **Polishing** → **Concentration[3]** → **Precipitation/ Crystallization** → **Lithium Precursors**

[1] - Technologies:
- Bioelectrochemical Cells (NRC-M)
- Carbon Adsorption & Filtration (CMIN)
- Nanofiltration (CMIN)

[2] - Technologies:
- Electrosorption (NRC-V)
- Crown Ethers (CanmetENERGY)
- Ionic Liquids (CanmetENERGY)
- Supported Liquid Membranes (NRC-O)
- Electrochemical Process (CMIN)

[3] - Technologies:
- Electrodialysis (CMIN)
- Reverse Osmosis (CMIN)
- Nanofiltration (CMIN)
- Vacuum Membrane Distillation (CMIN)

Direct Lithium Extraction (DLE) Technology R&D

- Research includes:
  - Ionic Liquid Extraction (CanmetENERGY - Devon)
  - Crown Ether-modified Adsorbents (CanmetENERGY - Devon)
  - Electrochemically Assisted Lithium Ion-Sieve (NRC - Vancouver)
  - Supported Liquid Membranes (NRC - Ottawa)

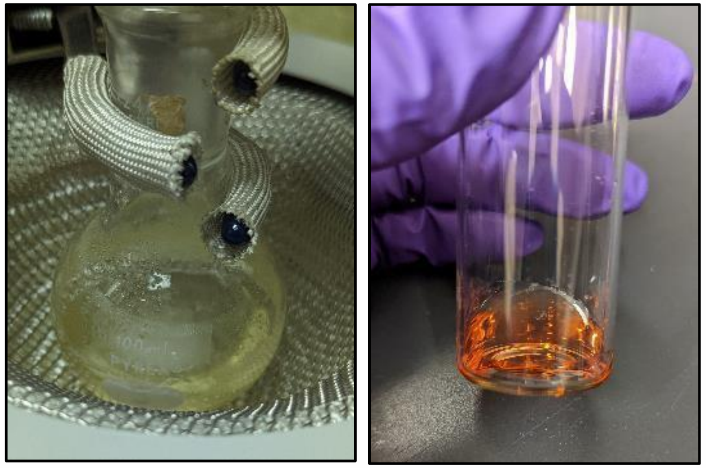
Lithium Ion-Sieve

Courtesy of NRC - Vancouver

Flat-sheet Supported Liquid Membranes

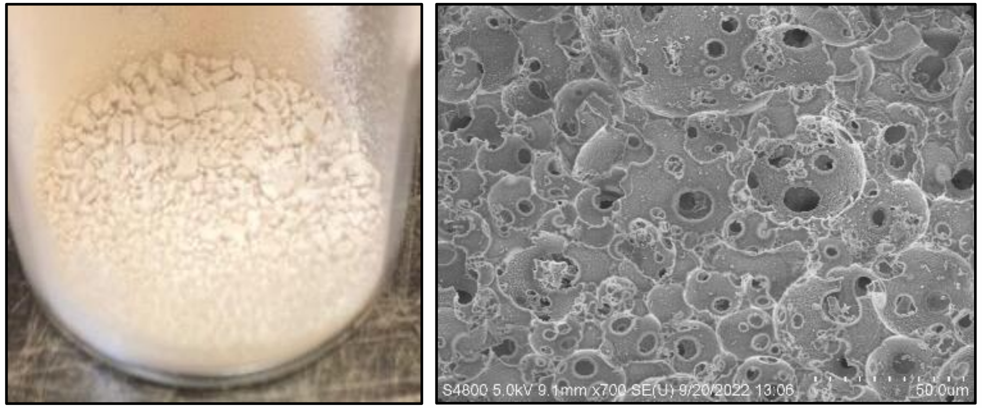
Courtesy of NRC - Ottawa

Ionic Liquid Extraction



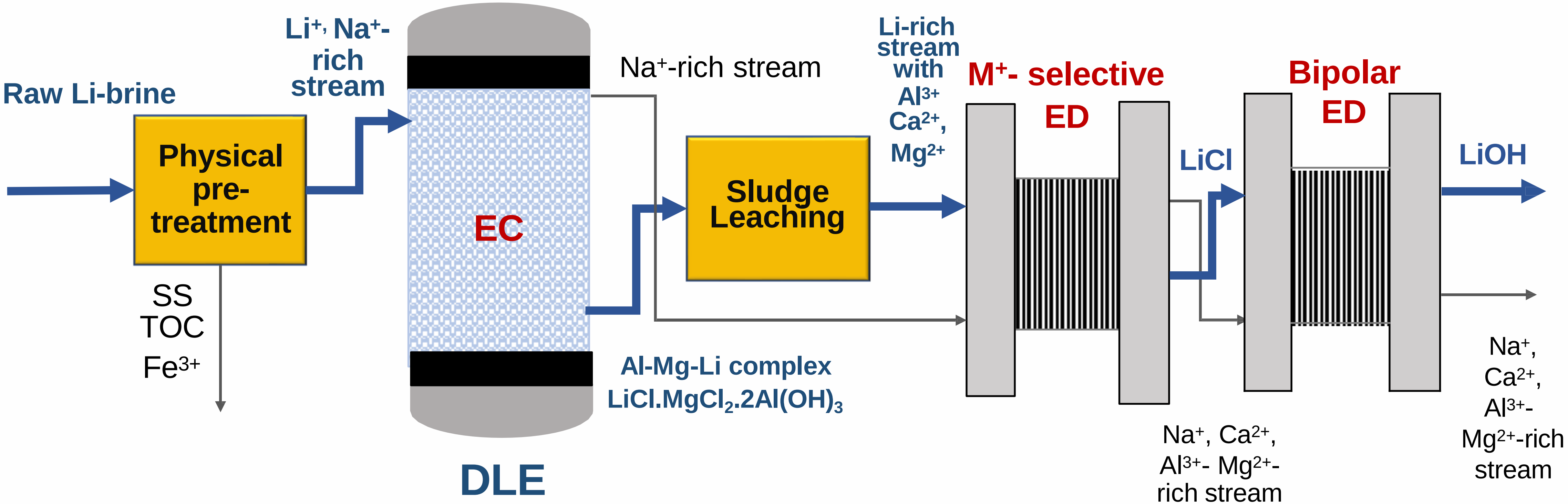
Courtesy of CanmetENERGY - Devon

Crown Ether-modified Adsorbents



Courtesy of CanmetENERGY - Devon

Technology Integration - Electrochemical Approach

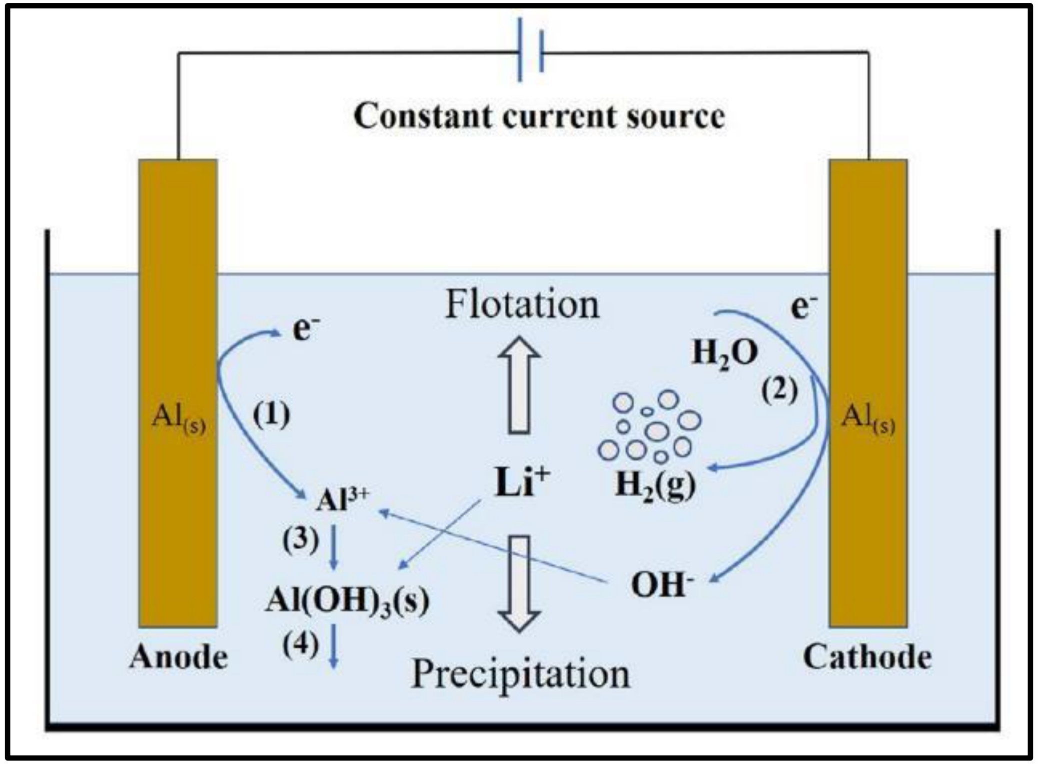


- **Physical pre-treatment -** is used to remove SS and TOC.
- **Monovalent-selective ED -** is used to remove multi-valent residues (mainly Al, Ca and Mg).
- **BPED -** is used to convert LiCl to LiOH (future work).
- M^{+}-selective ED and BPED can be combined in one stage ED.

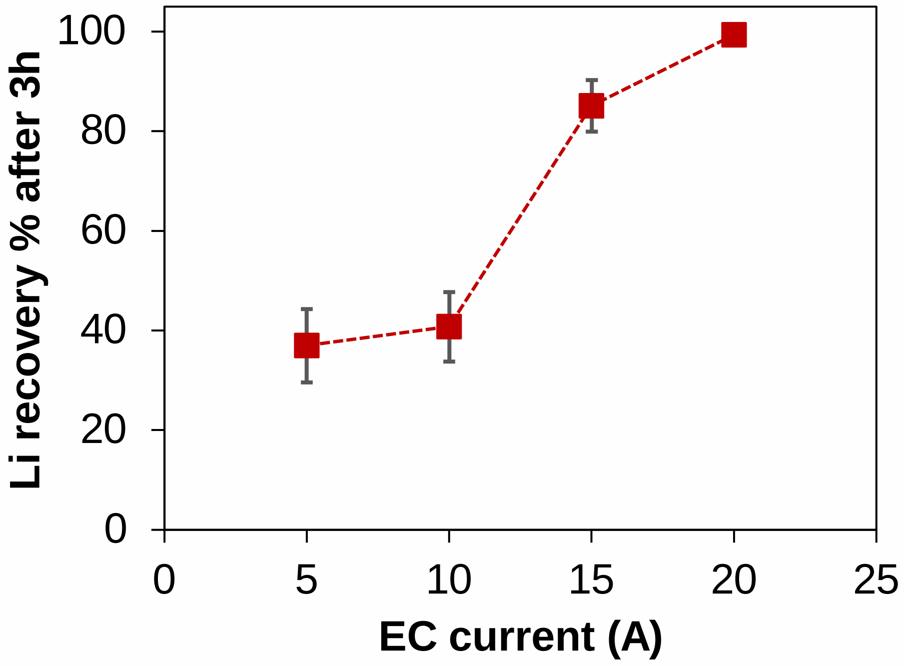
Electrocoagulation (EC)

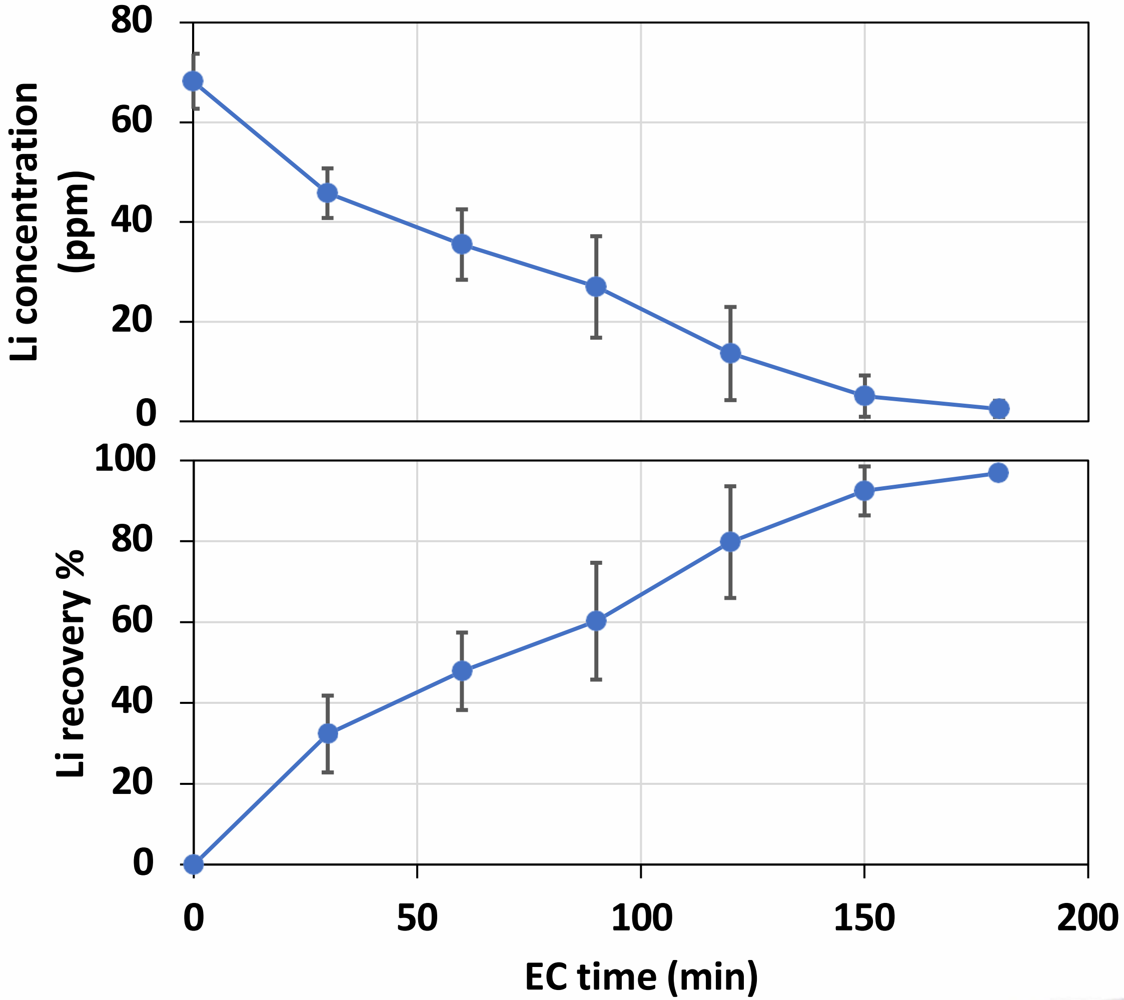
- Bench-scale EC experiments using Al or Mg anodes.
- Lithium brine feed:
  - 70 ppm Li
  - 70,000 ppm Na
  - 24,500 ppm Ca
  - 3,150 ppm K
  - 2,100 ppm Mg
  - 1,400 ppm Sr
- Mg anode did not lead to Li adsorption and recovery.
- Al anode results in formation of LDH-like structures, leading to Li recovery.

Bench-scale ECOTHOR®



Electrocoagulation (EC)

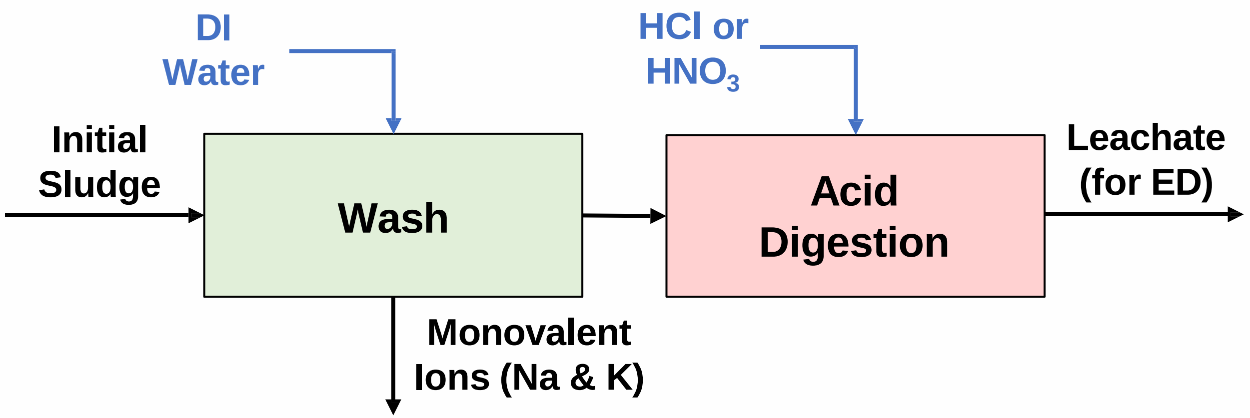




- Al anode resulted in >99% Li at a current of 20 A after 3 hours.
- Maintaining brine pH at 5.5-6.0 leads to higher Li recovery.
- EC effective at DLE ➔ Li needs to be recovered from sludge.

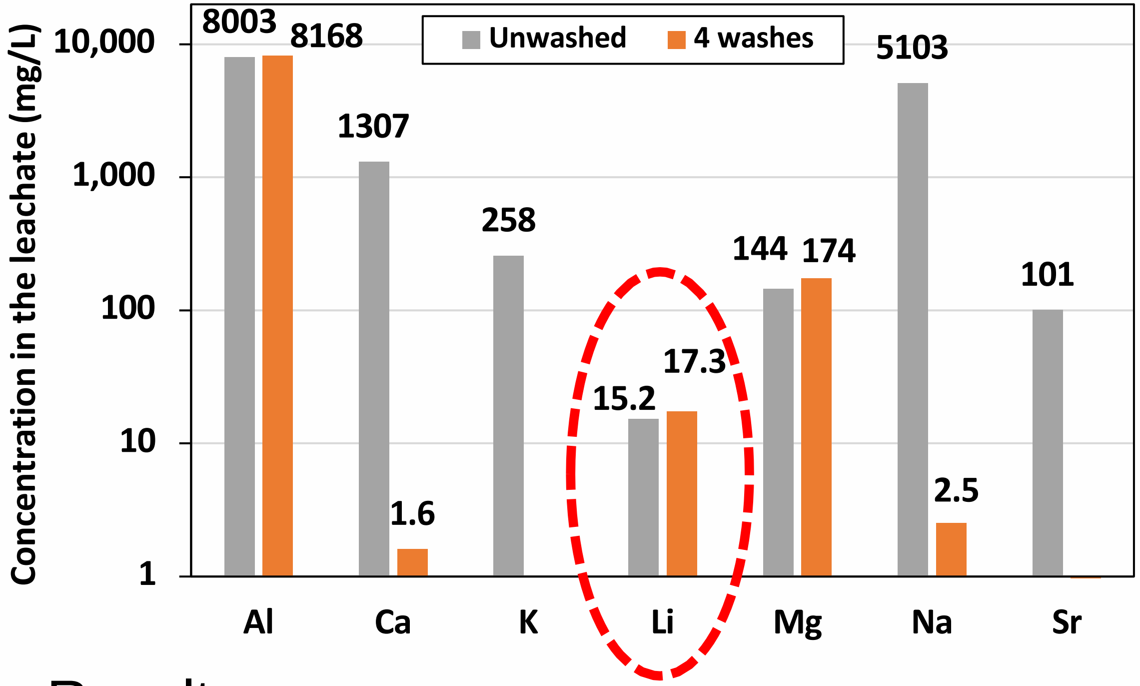
Post-EC Sludge Treatment

Procedure:



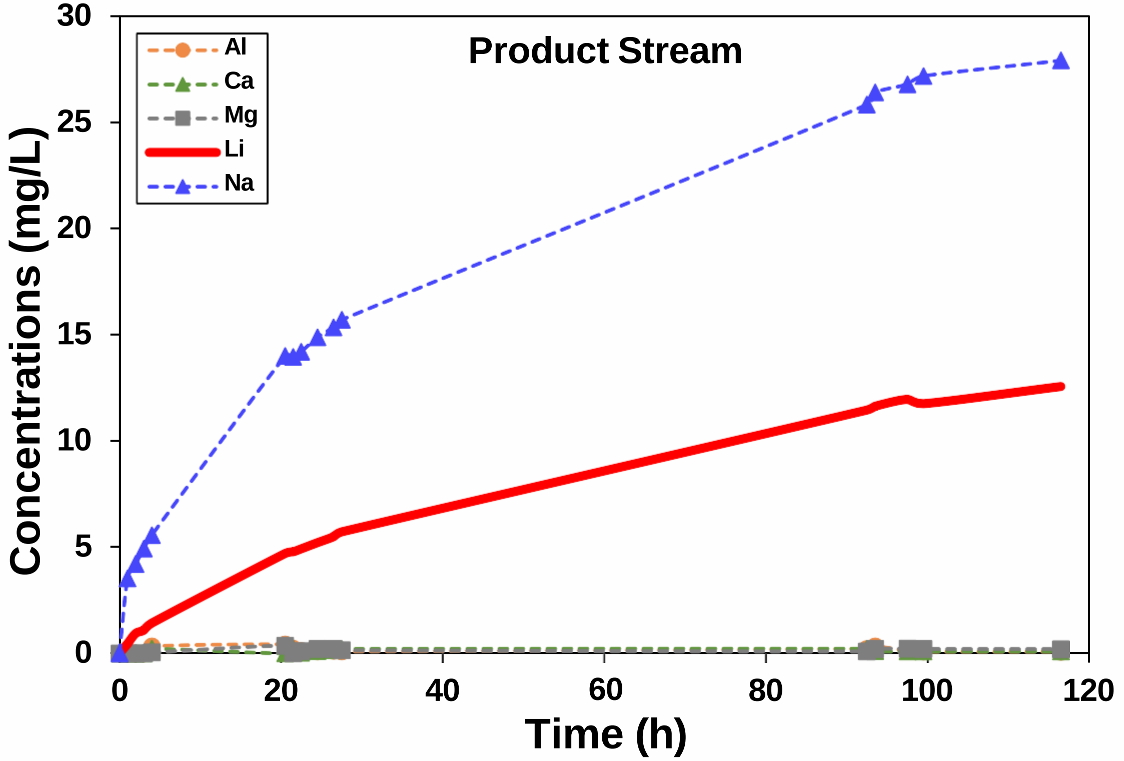
	Metal Content in Sludge (wt%)						
	Al	Ca	K	Li	Mg	Na	Sr
Before Washing	53.6	8.75	1.73	0.102	0.967	34.2	0.674
After Washing	97.7	0.019	0.000	0.207	2.08	0.030	0.001

Wash: Four cycles (DI water) ; **Digestion:** 2% HNO_3 at 80°C



- Results:
  - Over 99% of Ca, K, Na and Sr were removed after the wash cycles.
  - 2.0 - 2.5 wt% of initial Li was lost per wash cycle.

Electrodialysis (ED)



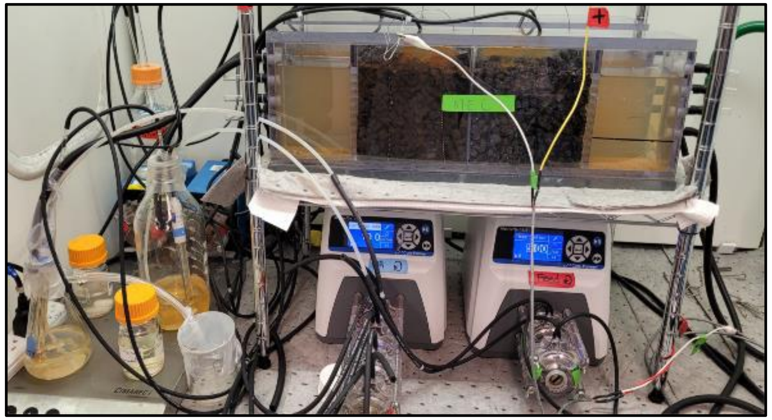
- The leachate produced in digestion of the washed sludge from electrocoagulation was used as feed for electrodialysis.
- Using **monovalent-selective ED**, multivalent ions (Al^{3+}, Mg^{2+},and Ca^{2+}) were completely removed.
- A high Na/Li ratio, which is the major obstacle in DLE, was greatly reduced using EC followed by ED.
- Still a work in progress, further tests are underway.

Concentrations (mg/L)		Al	Mg	Ca	Li	Na
Initial	Feed	**12,694**	**118.7**	**10.62**	**20.62**	**12.39**
	Product	0.00	0.00	0.00	0.00	0.00
Final	Feed	12,682	116.4	10.93	8.36	4.41
	Product	**0.091**	**1.00**	**0.00**	**12.57**	**27.91**

Pre & Post DLE Technology R&D

- Research includes:
  - Bioelectrochemical Pre-treatment (NRC - Montreal)
  - Electrocoagulation and Electrodialysis (CanmetMINING)
  - Adsorption and Ultrafiltration (CanmetMINING)
  - Vacuum Membrane Distillation (CanmetMINING)

Bioelectrochemical Pre-treatment



Courtesy of NRC - Montreal

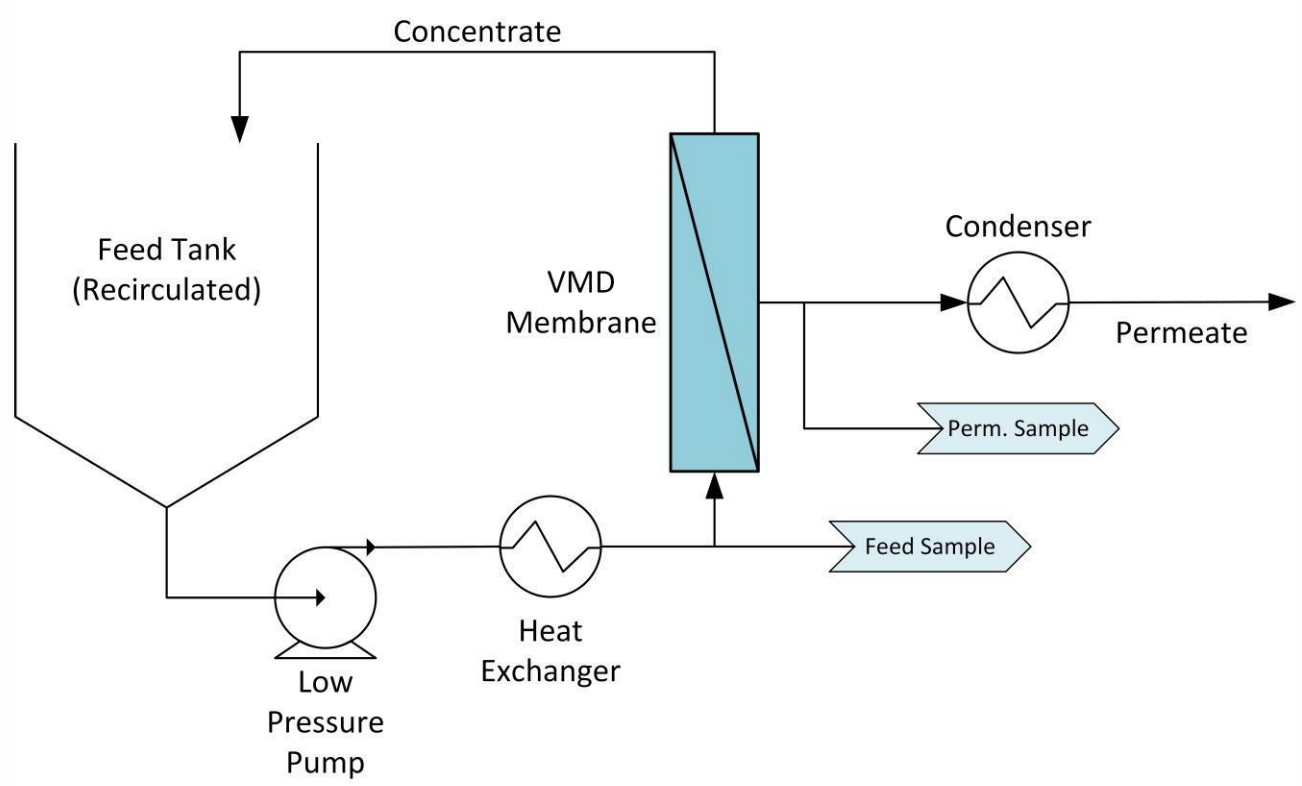
Vacuum Membrane Distillation

Electrocoagulation

Electrodialysis

Ultrafiltration

Vacuum Membrane Distillation (VMD)



- Thermally driven process, where water is vaporized and passes through a membrane under vacuum.
- Ideally, **ALL** ions and dissolved solids are rejected, producing a highly-concentrated brine and pure, distilled water.
- Driving force is partial pressure gradient between the two membrane sides.

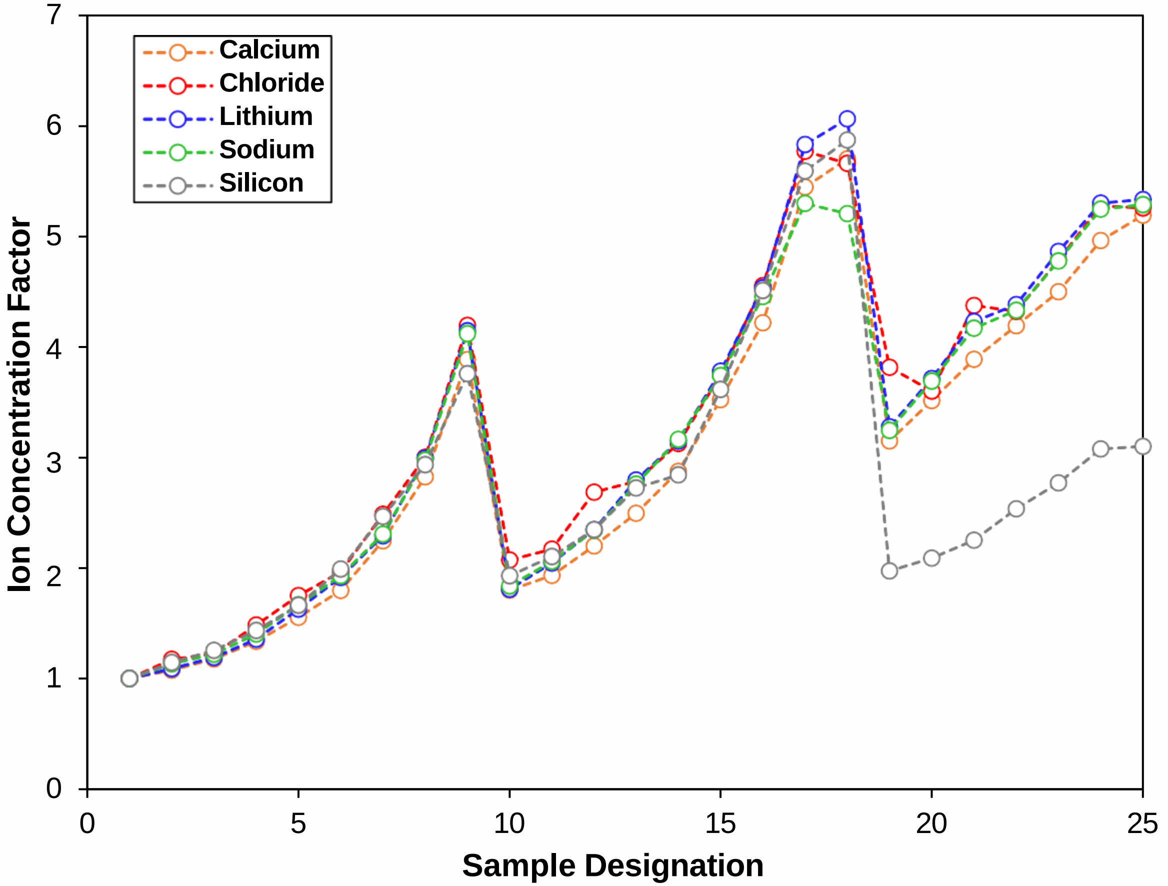
Pilot Trials - Industrial Brine

- CanmetMINING collaborated with its industrial partner KMX Technologies to process several UK-originated brine samples using vacuum membrane distillation technology at pilot-scale.

Analyte	Brine #1 (mg/L)	Brine #2 (mg/L)
Calcium	2,932	4,486
Lithium	**1,243**	**242**
Sodium	13,440	12,267
Potassium	362	587
Chlorine	42,530	24,748
Total Nitrogen	2,677	-
Sulfate	-	785
Dissolved Solids	**63,390**	**43,238**

Laboratory-scale VMD system at CanmetMINING

Pilot Trials - Industrial Brine #1



Analyte	Concentrate (mg/L)	Permeate (mg/L)
Calcium	15,220	0.27
Lithium	6,628	0.15
Sodium	71,040	0.43
Potassium	2,144	<0.35
Chlorine	223,500	0.73
Total Nitrogen	12,550	15.4
Dissolved Solids	332,230	17.9

- Majority of dissolved solids in permeate attributed to nitrogen (71-94%).
- Precipitation of colloidal silica detected after a reduction in feed temperature overnight and addition of fresh feed solution.

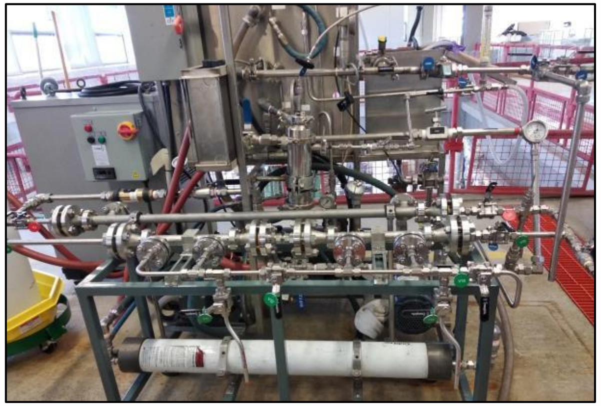
Conclusions

- A flowsheet for lithium recovery from low-grade Canadian oilfield brines using electrochemical technologies has been developed and tested at laboratory-scale.
- Electrocoagulation was used to successfully recover nearly all lithium using aluminum alloy electrodes. Lithium-containing sludge from EC was treated by washing cycles followed by acid leaching to produce leachate feed for electrodialysis.
- Electrodialysis with monovalent-selective membranes completely removed select multivalent contaminants (Al^{3+}, Mg^{2+} and Ca^{2+}).
- A vacuum membrane distillation (VMD) process was developed and operated at pilot-scale to concentrate lithium brine samples.
- Both samples were concentrated to the point of saturation of sodium chloride, with TDS concentrations of 332 g/L and 325 g/L respectively.

Future Work

- Lithium from Brines project to continue under the CMRDD2 program until 2027.
- In-house scale-up of electrochemical process from bench to semi-pilot systems.
- Optimization of post-EC sludge treatment to maximize Li/Na ratio in the leachate feed to electrodialysis.
- Integration of VMD technology with other DLE technologies, such as CanmetMINING's electrochemical flowsheet
- In-situ demonstration of VMD technology at pilot scale at a Canadian production site.
- Further technology optimization and integration, and pilot-scale demonstration.

Electrodialysis system at CanmetMINING



Reverse osmosis system at CanmetMINING

Acknowledgements

CanmetMINING members who have contributed to the Lithium from Brines project:

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- GSC - Calgary
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- NRC - Vancouver
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  - Gilles Robertson, Mauro Dal-Cin, Ben Yu
- NRC - Montreal
  - Boris Tartakovsky, Louis Jugnia

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Natural Resources Canada
Ressources naturelles Canada

Lithium mining and the environment

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Mackenzie Valley Operational Dialogue Workshop, 2024

Canada

Potential environmental impacts of hard-rock Li mining and substances of concern

- Similar to other types of hard-rock mining (e.g., high water and energy consumption, local physical disturbance to land; local soil contamination; regional air and water contamination, loss of local biodiversity)
- Mining Li produces large volumes of waste rock, tailings, processing chemical waste, and dust
- Waste rock contains mostly SiO_2, Al_2O_3, Na_2O, K_2O, and Fe_2O_3
- Can also contain trace amounts of potentially toxic elements
- Additional waste generated during processing (e.g., H_2SO_4, HF, $Ca(OH)_2$, $CaCO_3$)
- S contents are typically low, suggesting generation of minimal amounts of acid

Oxide	wt. %
SiO_2	50 to 82
Al_2O_3	8 to 27
Na_2O	0.4 to 6.7
K_2O	0.6 to 13
Fe_2O_3	0.1 to 8.4
Li_2O	0.02 to 1.3
SO_3	<0.03 to 3.9

Geochemistry of Li-bearing granite-pegmatite mine waste (Hudson-Edwards, 2024).

Environmental Regulations

- Metal and Diamond Mine Effluent Regulations (MDMERs) – regulated under the Fisheries Act
- Regulates the release of effluents into the aquatic environment:
  - Concentration of deleterious substances < authorized limit set out in **Schedule 4**
  - The effluent is not acutely lethal to Rainbow trout or *Daphnia magna*
  - pH is 6.0 – 9.5
- Deleterious substances and ph are measured once/quarter – once/week
- Toxicity tests conducted once/month
- Reported as monthly mean concentrations (mg/L) and loadings (kg and based on effluent volumes)

Schedule 4

	Deleterious Substance	Maximum Authorized Monthly Mean Concentration	Maximum Authorized Concentration in a Composite Sample	Maximum Authorized Concentration in a Grab Sample
1	Arsenic	0.10 mg/L	0.15 mg/L	0.20 mg/L
2	Copper	0.10 mg/L	0.15 mg/L	0.20 mg/L
3	Cyanide	0.50 mg/L	0.75 mg/L	1.00 mg/L
4	Lead	0.08 mg/L	0.12 mg/L	0.16 mg/L
5	Nickel	0.25 mg/L	0.38 mg/L	0.50 mg/L
6	Zinc	0.40 mg/L	0.60 mg/L	0.80 mg/L
7	Suspended Solids	15.00 mg/L	22.50 mg/L	30.00 mg/L
8	Radium 226	0.37 Bq/L	0.74 Bq/L	1.11 Bq/L
9	Un-ionized ammonia	0.50 mg/L expressed as nitrogen (N)	Not applicable	1.00 mg/L expressed as nitrogen (N)

MDMERs – Schedule 5

- Effluent characterization (Al, Cd, Fe, Hg, Mo, Se, NO_3, Cl, Cr, Co, SO_4, Tl, U, P, Mn)
- Sublethal toxicity testing:
  - Chronic fish test (growth & survival fathead minnow or early life stage of salmonid)
  - Chronic invertebrate test (survival and reproduction of *Ceriodaphnia dubia*)
  - Chronic plant test (growth of *Lemna minor*)
  - Chronic algal test (growth of *Raphidocelis subcapitata)*
- Water quality monitoring in the receiving environment
- Biological monitoring studies:
  - Fish population
  - Fish habitat - benthic invertebrate community
  - Fish tissue (Hg, Se)

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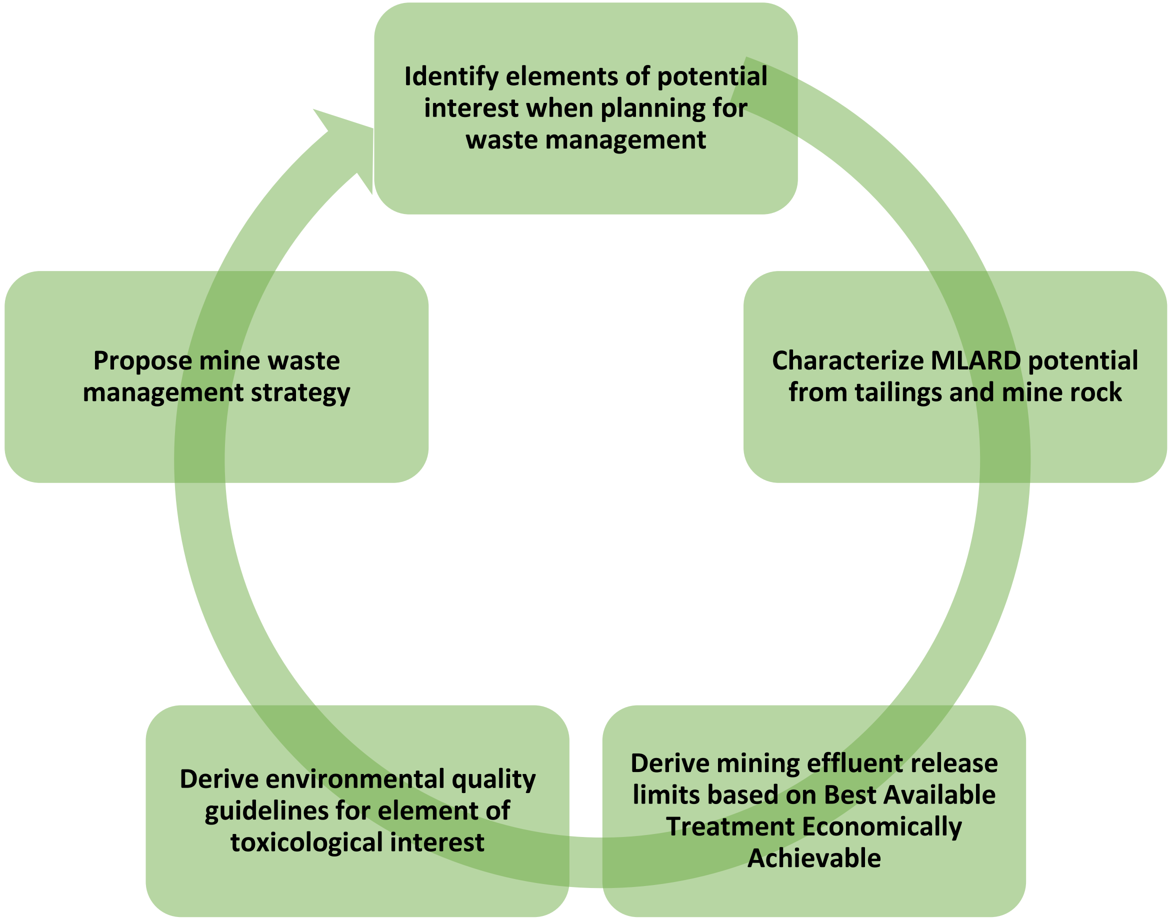
Rationale for this project: Improve mine waste management

- Three Li mining projects proposed, one in operation
  - Data poor ⇒ lack of monitoring, toxicity data
    - ECCC identified Li as priority substance for environmental guideline development
  - Data required for predicting potential impact to environment which are then used to identify mine material management
    - Is blending tailings with waste rock on surface adequate?
  - No data ⇒ extends duration of federal review assessment



Objectives

Impact Assessment focus:
Characterising Li mine waste from 2 mine locations, identifying elements of concern

- **Biogeochemistry:**
  - Transformation/dissolution
  - DNA extractions
  - Sequential extractions
- **Mineralogy:**
  - Characterisation XRD/SEM

Environmental regulations focus:
Toxicity, solubility and partitioning of Li in aquatic environment

- **Toxicity:**
  - Chronic exposures
  - Solubility and bioavailability
- **Geochemistry:**
  - Transformation/dissolution
  - Partitioning

Workflow

Sample Acquisition

Bulk Geochemistry
Sample digestion, XRF, ICP-OES and ICP-MS analyses

Bulk Mineralogy
Bulk mineral assemblage identified *via* XRD

Identified Accessory Phases
TIMA and SEM-EDS mapping

Microbial DNA
DNA extraction and sequencing

Water Solubility Test
Freshwater 24-hr screening tests at pH 6 and 8.5

Sequential extractions
7 binding phases

LiCl Solubility Test
Freshwater 24-hr screening tests at pH 6 and 8.5

Partitioning Test
28-day water to sediment partitioning test in freshwater pH 6

Li Fate Assessment Test
48-hr partitioning test in 3 environmental setups

Chronic Toxicity Test
Fingernail clams and cladocerans

Impact Assessment focus:
Characterising Li mine waste from 2 mine locations, identifying elements of concern

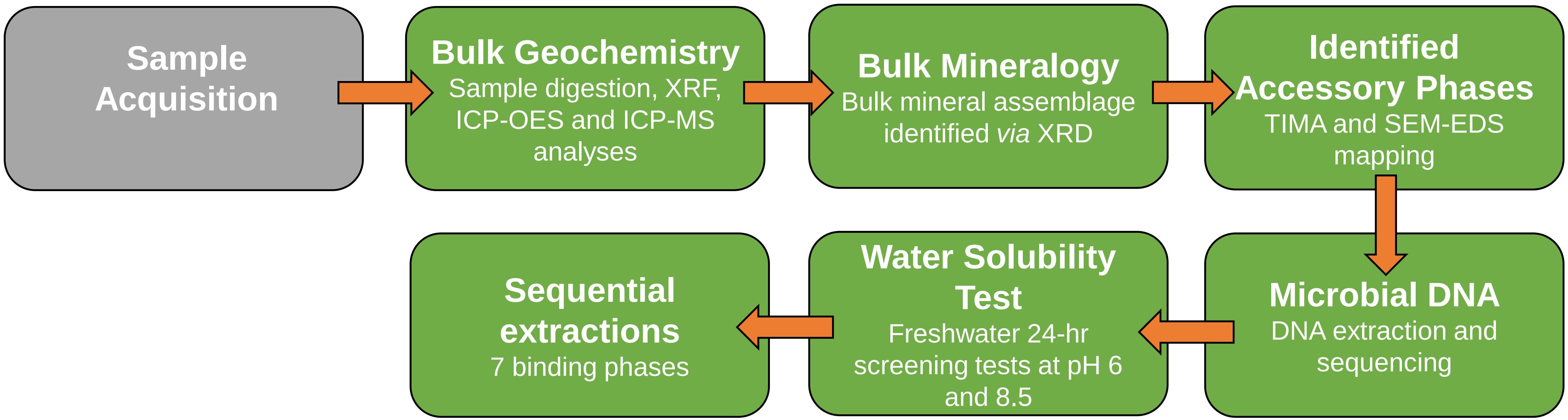
Biogeochemistry:
Transformation/dissolution
DNA extractions
Sequential extractions

Mineralogy:
Characterisation XRD/SEM

Li-bearing mine wastes

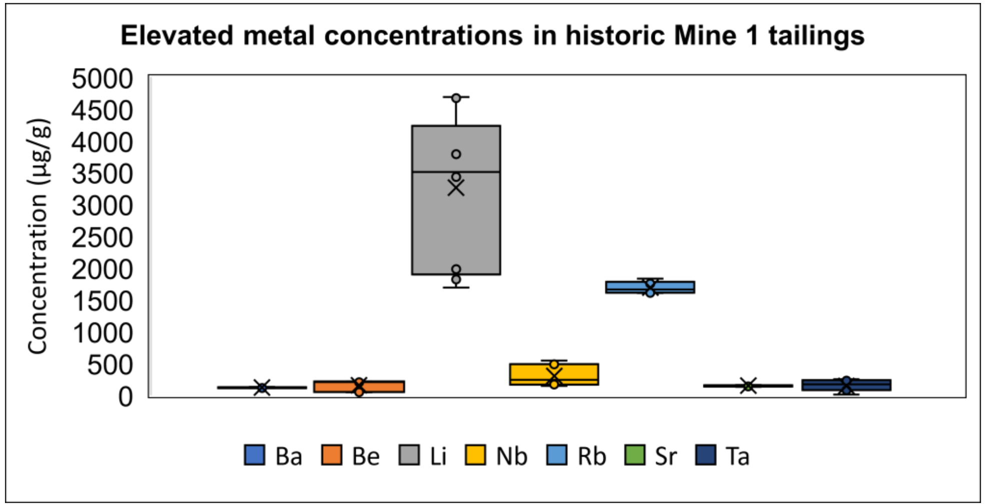
OBJECTIVE: To characterise a range of lithium-bearing mine wastes to understand presence of elements of concern and microbial communities present.

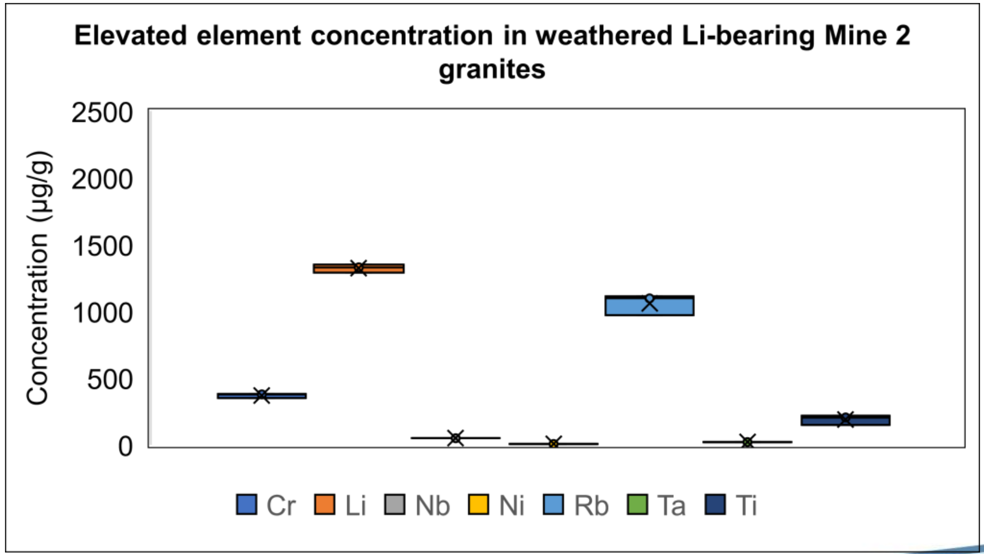
Two distinct sources of Li-bearing mine waste analyzed



Bulk geochemistry – Mine 1 vs Mine 2

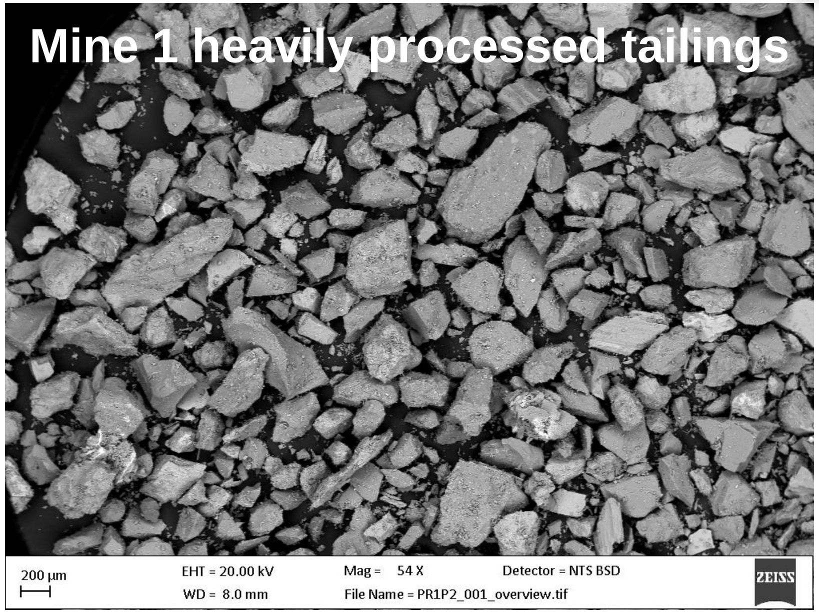
Element	Mine 1 tailings (mg/kg)	Mine 2 granites (mg/kg)
Li	309 to 2600	1190
Na	~ 50,000	1000 to 10,000
Ta	38 to 350	21 to 38
Cr	1.5 to 20	350 to 420



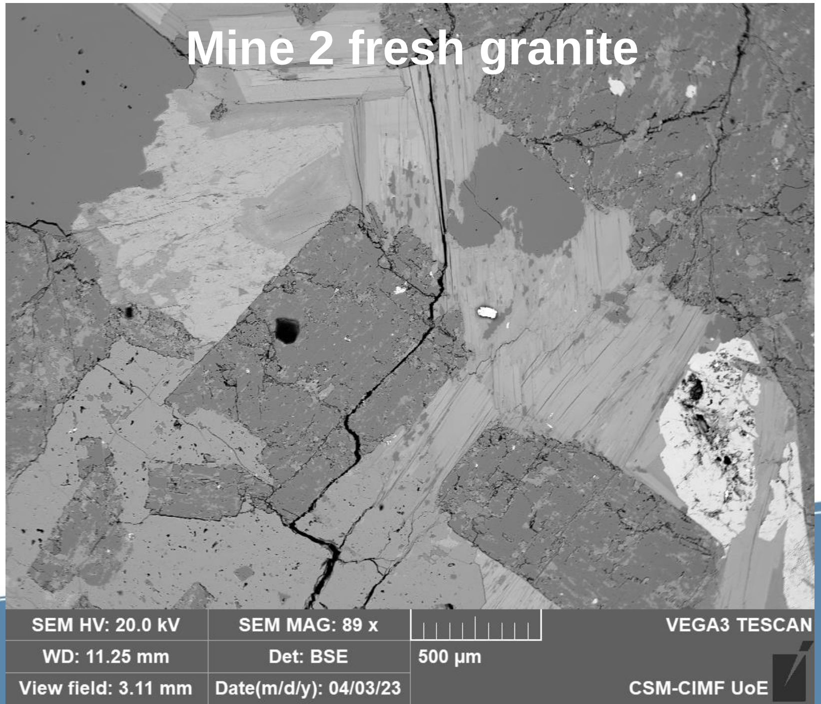


Bulk Mineralogy

Mine 1:
Quartz (SiO_2), plagioclase (albite) ($NaSiAl_2O_6$), spodumene $LiAlSi_2O_6$, mica (muscovite) $(K,Na)(Al,Fe,Mg)(Si_3AlO_{10})(OH,F))$, and amphibole rich $(K,Na)_{0\text{-}1}$ $(Na,Ca,Fe,Mg,Mn,Li,Zn)_2(Mg,Fe,Ti,Mn,Al, Zn, Cr)_5(Si,Al)_8O_{22}(OH,F,Cl)_2)$.



Mine 2:
Quartz (SiO_2), plagioclase (albite) ($NaSiAl_2O_6$), K-feldspar ($KAlSi_2O_6$), mica (muscovite) $((K,Na)(Al,Mg,Fe)_2(Si_3Al)O_{10}(OH,F)_2)$, Zinnwaldite $(KLi_2Al(Si_4O_{10})(F,OH)_2$
and kaolinite ($Al_2Si_2O_5(OH)_4$) rich.



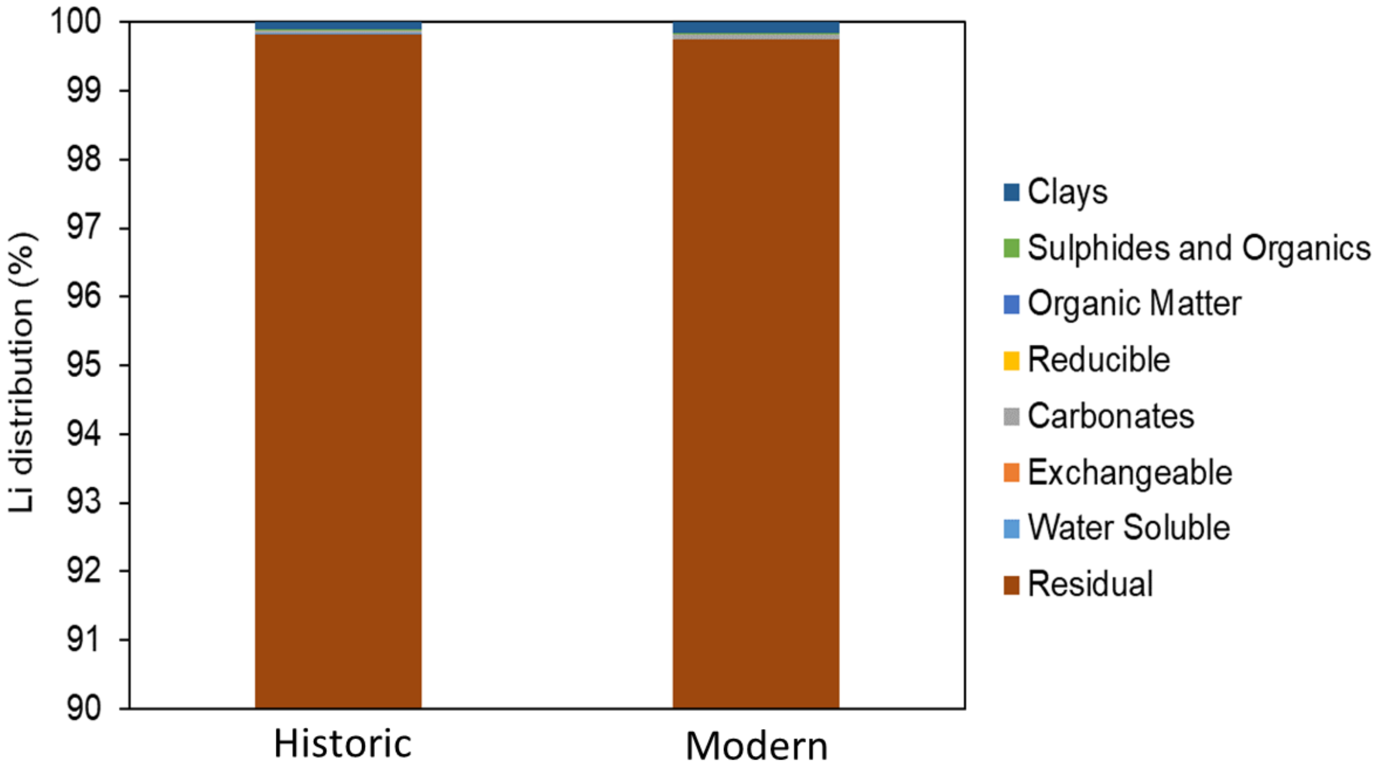
Sequential extractions

Determine distribution of metals in tailings into operational phases

Fraction	Solid phase or '*operational speciation*'	Environmental Relevance
Water-soluble	Weakly adsorbed ions	Highly labile and potentially bioavailable
Exchangeable	Bound to carbonates	Released readily into the environment (ion-exchange process)
Reducible	Bound to hydrous oxides of Fe and Mn	Oxic environment: metals less mobile Anoxic environment: metals more mobile
Oxidizable	Bound to organic material	Metals remain in solid phase. But may be mobilized by decomposition process
Residual	Bound to silicate and mineral phases	Non-leachable & non-bioavailable fraction

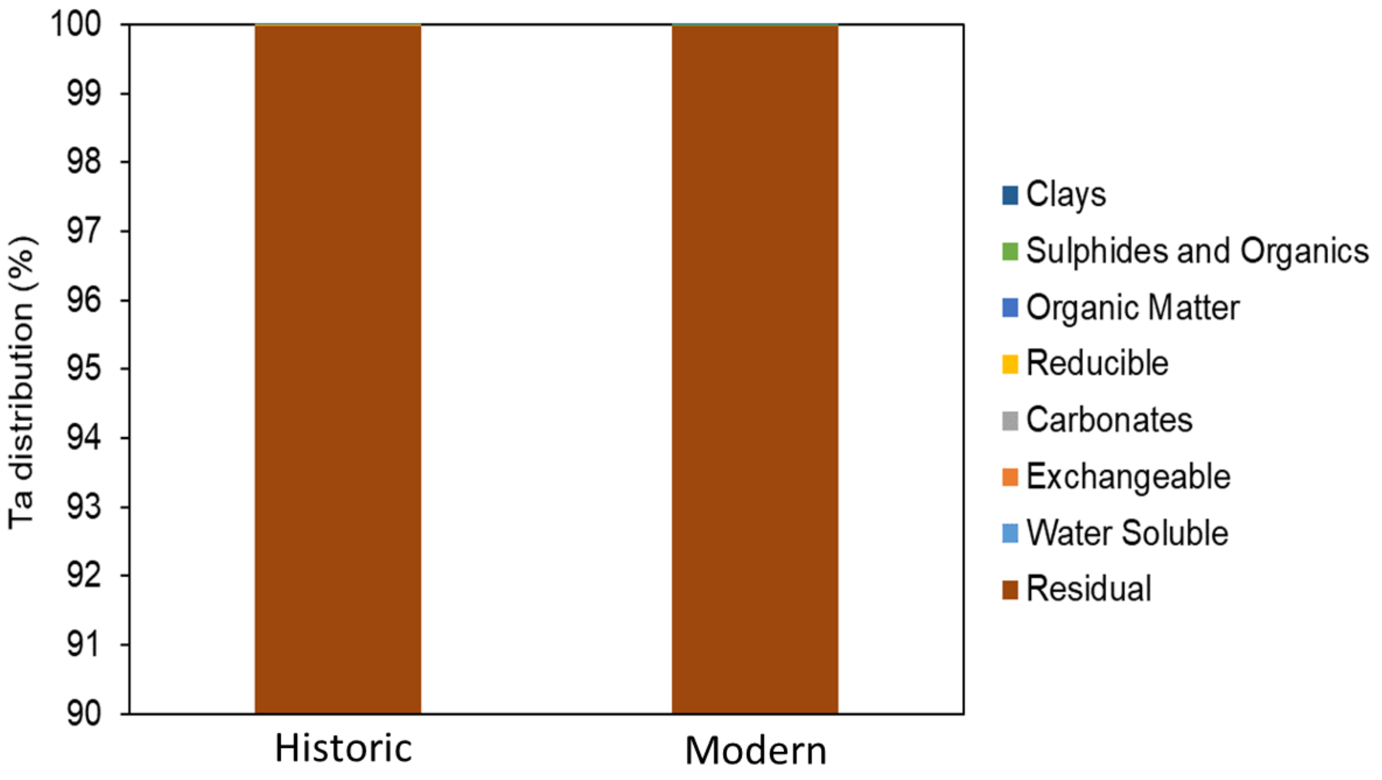
Sequential extractions Li

- ~99.9 % of the Li is in the residual and clay phases = immobile
- ~0.1 % is associated with carbonate, sulphide, and organic phases = mobile



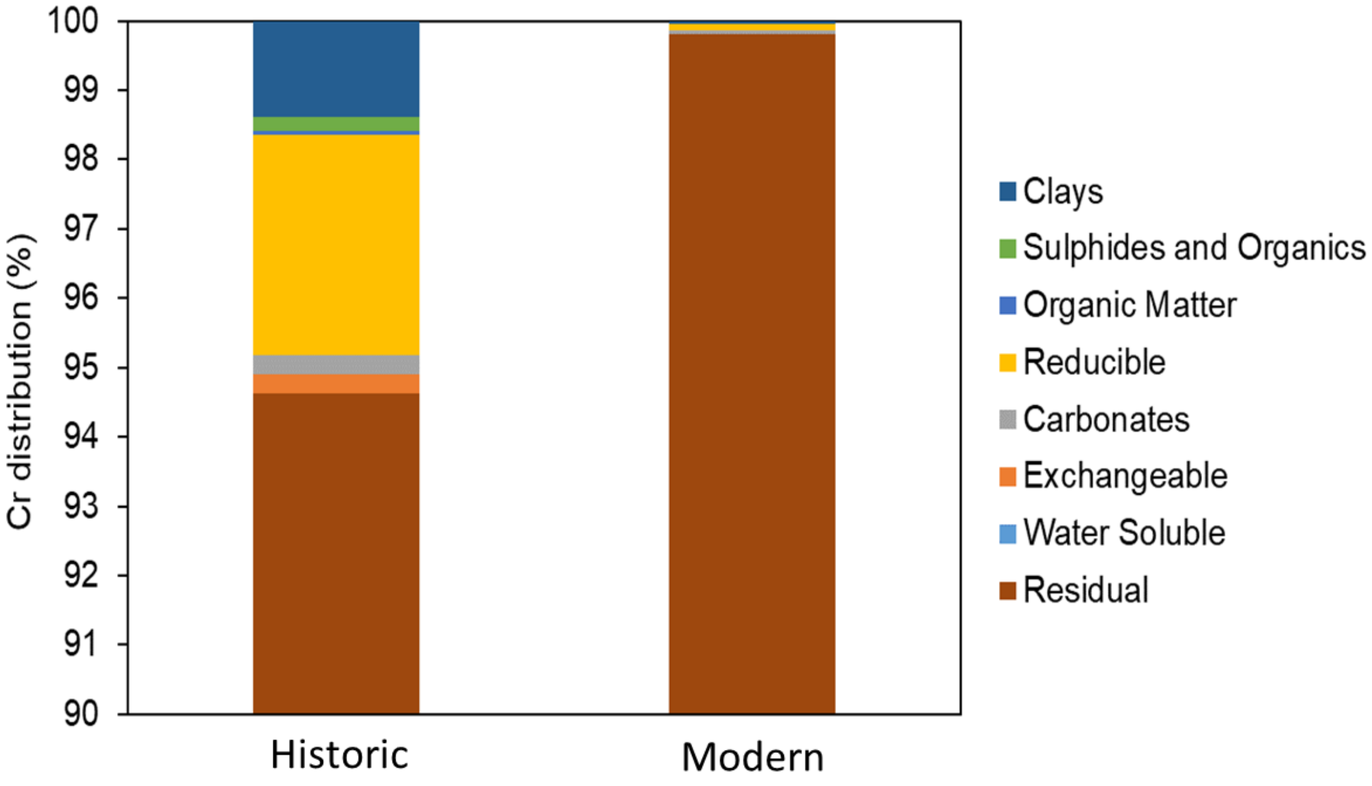
Sequential extraction Ta

- Most Ta associated with residual
- Some associated with sulphides, organic matter & reducible phases
- Low solubility = potential mobility is low



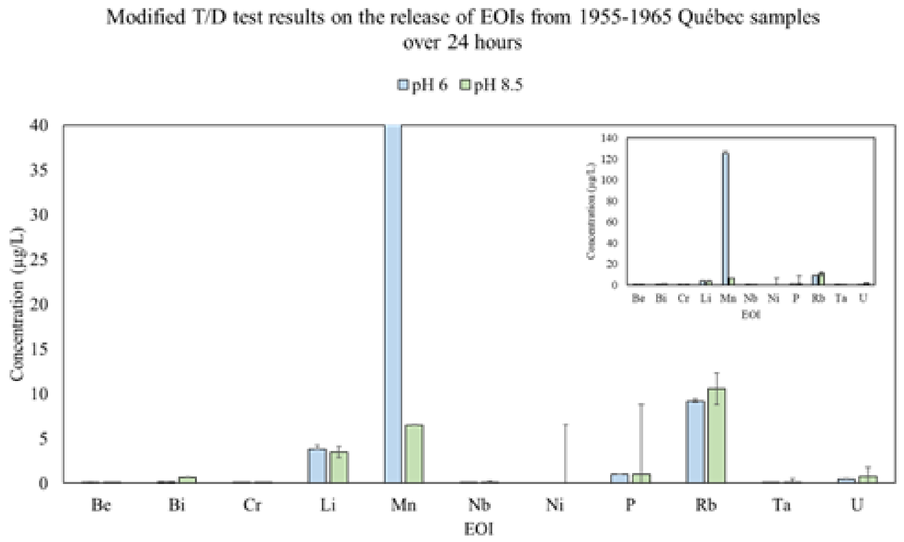
Sequential extraction Cr

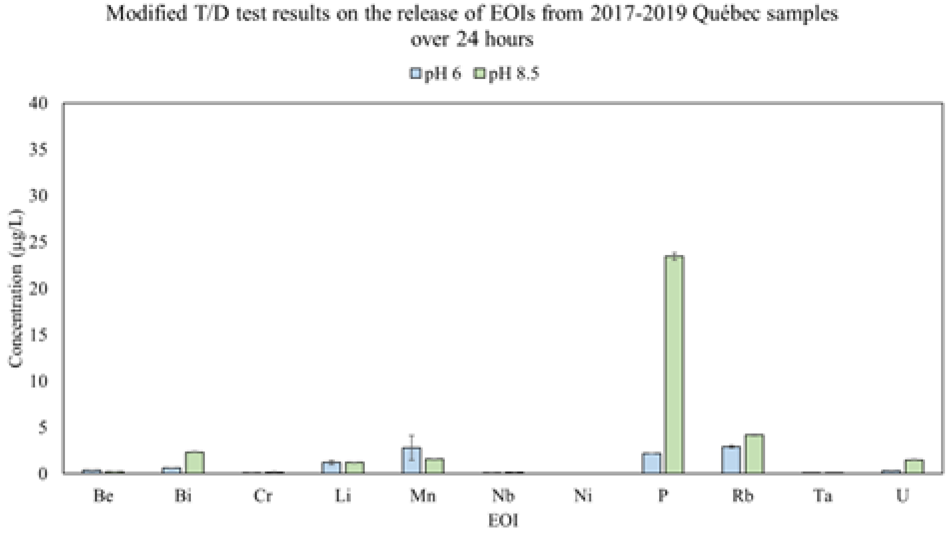
- Most Cr associated with residual
- Lower proportions in reducible, exchangeable, carbonate, sulphide and organic phases
- Low solubility = potential mobility is low



Transformation/dissolution 24 h screening tests

- Evaluate elements released into solution from Li tailings at pH 6.5 and 8 over 24 h
- 1 L flasks with 10 g of tailings in OECD 203 aquatic medium
- Very low solubility of elements from tailings (ppb)
- Aligns with sequential extraction results - Li, Ta and Cr predominantly associated with non-mobile phases
- Points to Phosphorus as an element to manage as concentrations in the dissolution tests were like levels found in oligotrophic lakes (Stoddard *et al.*, 2016)





Objectives

Environmental regulations focus:

Toxicity, solubility and partitioning of Li in aquatic environment

Toxicity:

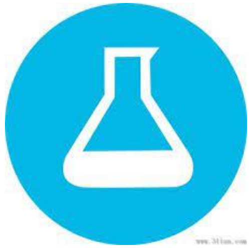
Chronic exposures

Solubility and bioavailability

Geochemistry:

Transformation/dissolution

Partitioning



Aquatic Toxicity and solubility

Toxcitiy tests

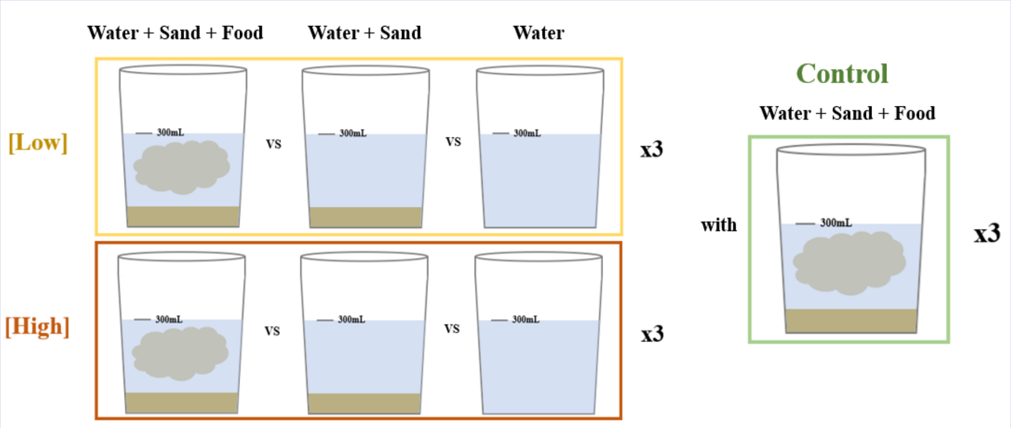
Cladoceran

- 30-d *Daphnia pulex*
- Survival and reproduction
- 0.5, 1, 1.5, 2, 2.5, 3 mg/L

Clam

- 28-d Fingernail clam - *Pisidium sp.*
- Survival, growth and burrowing
- 0.05, 0.10, 0.50, 1.00, 5.00, 10.00 mg/L

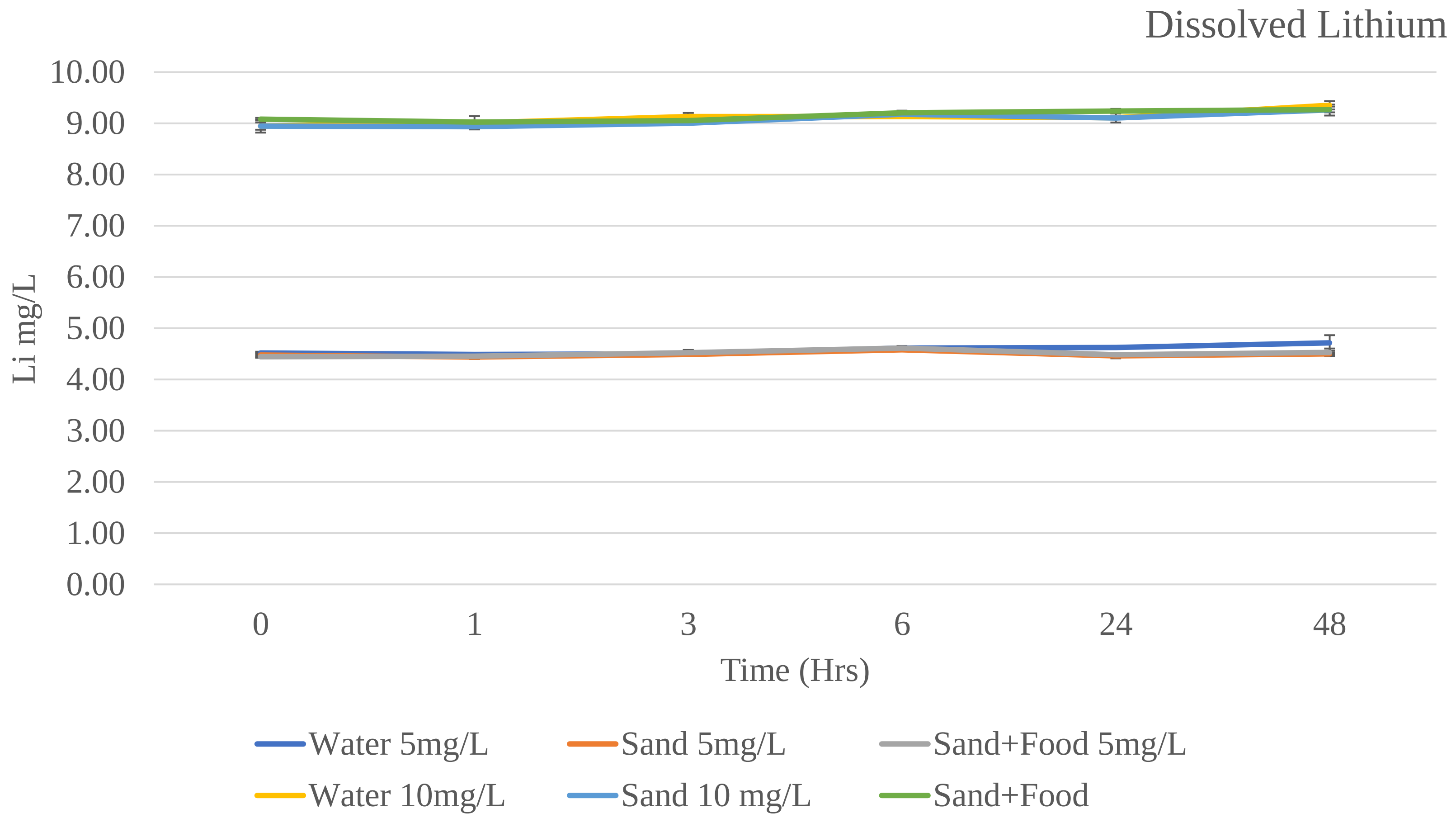
Solubility tests – 48h



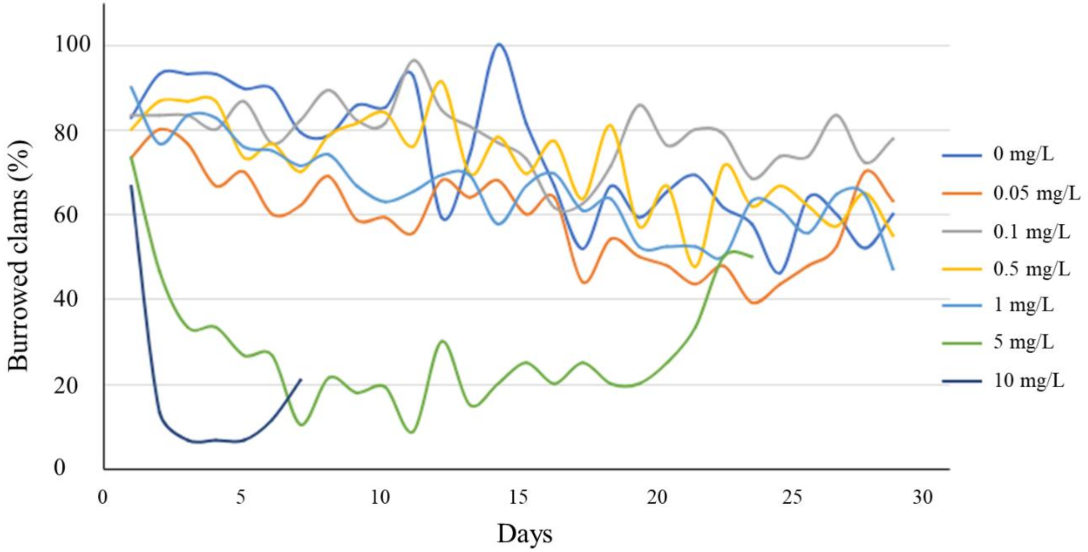
- High (10mg/L) and low (5mg/L)
- Sampled at 0h, 1h, 3h, 6h, 24h, 48h
- Measure Total and Dissolved concentrations

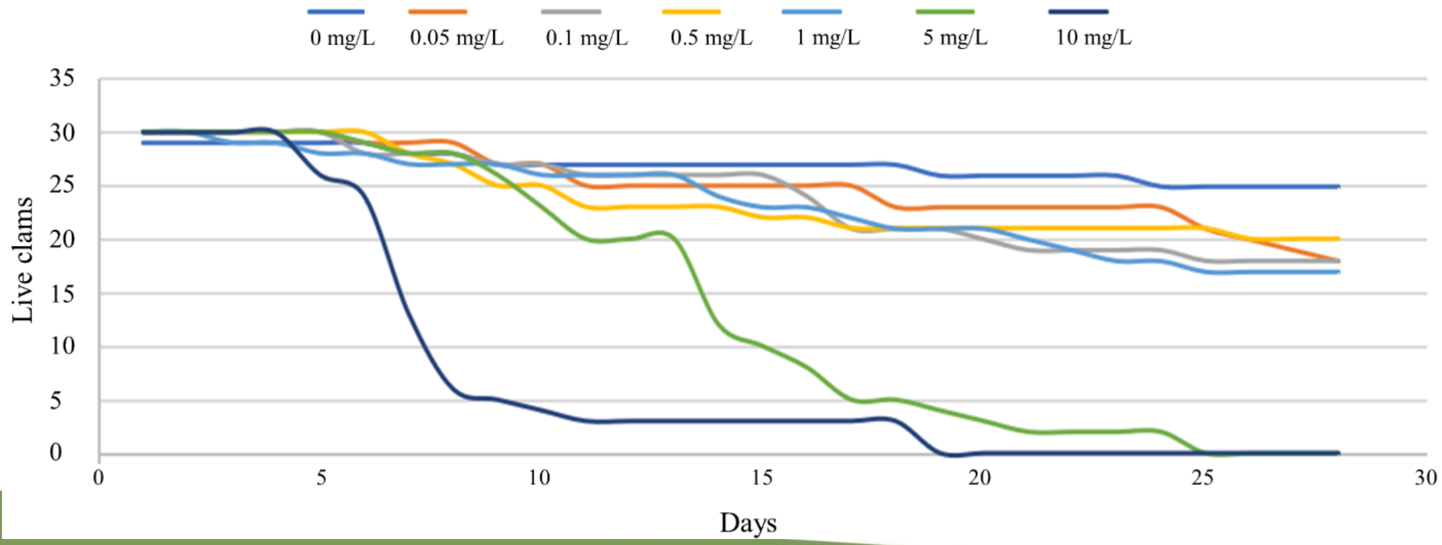
Results – Solubility test

Target concentrations – 5 & 10 mg/L



Chronic toxicity to clams

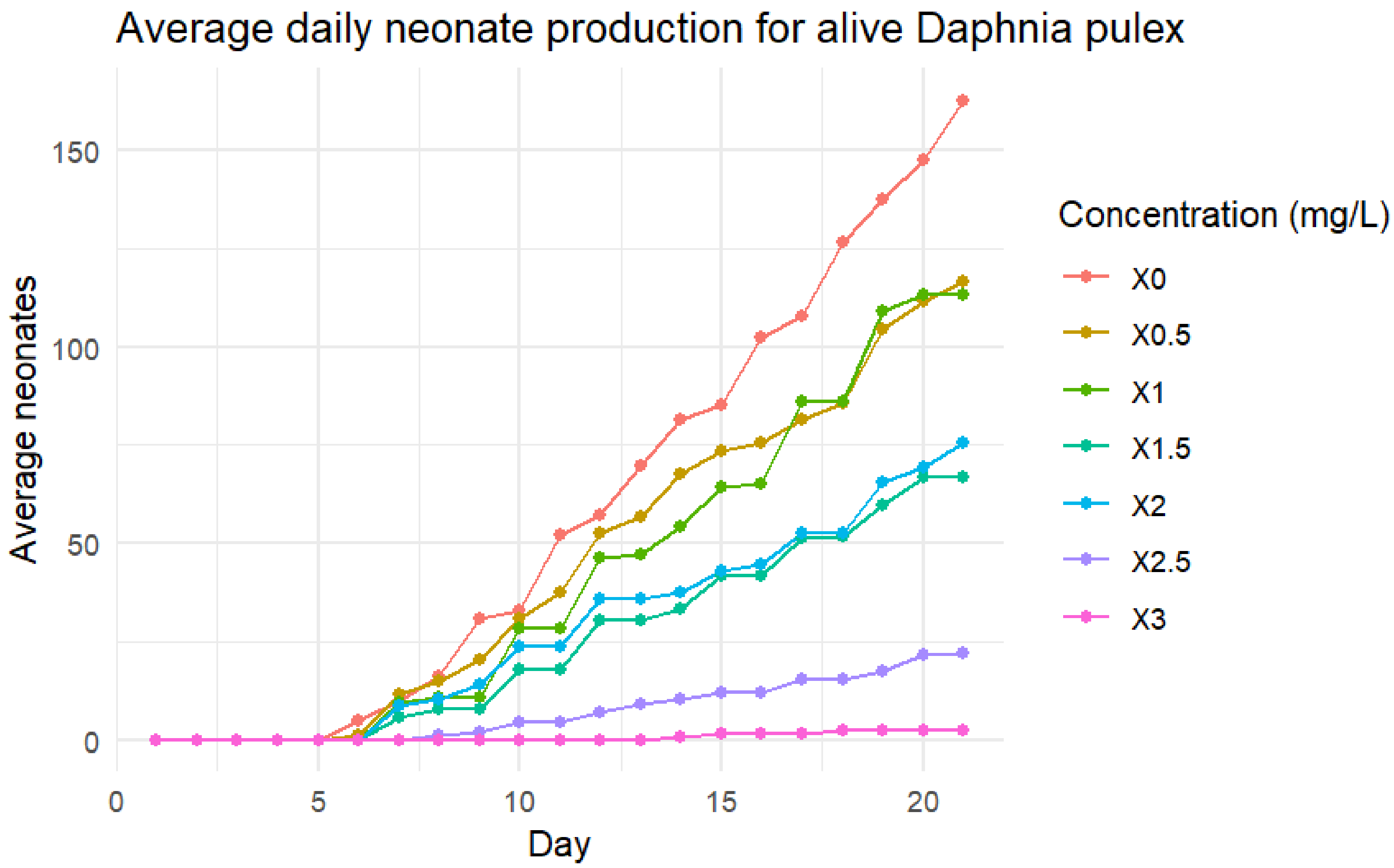




End point - Survival	
E/LC50 (mg/L)	1.47 ± 2.21
E/LC25 (mg/L)	1.14 ± 0.64
E/LC10 (mg/L)	0.88 ± 0.55

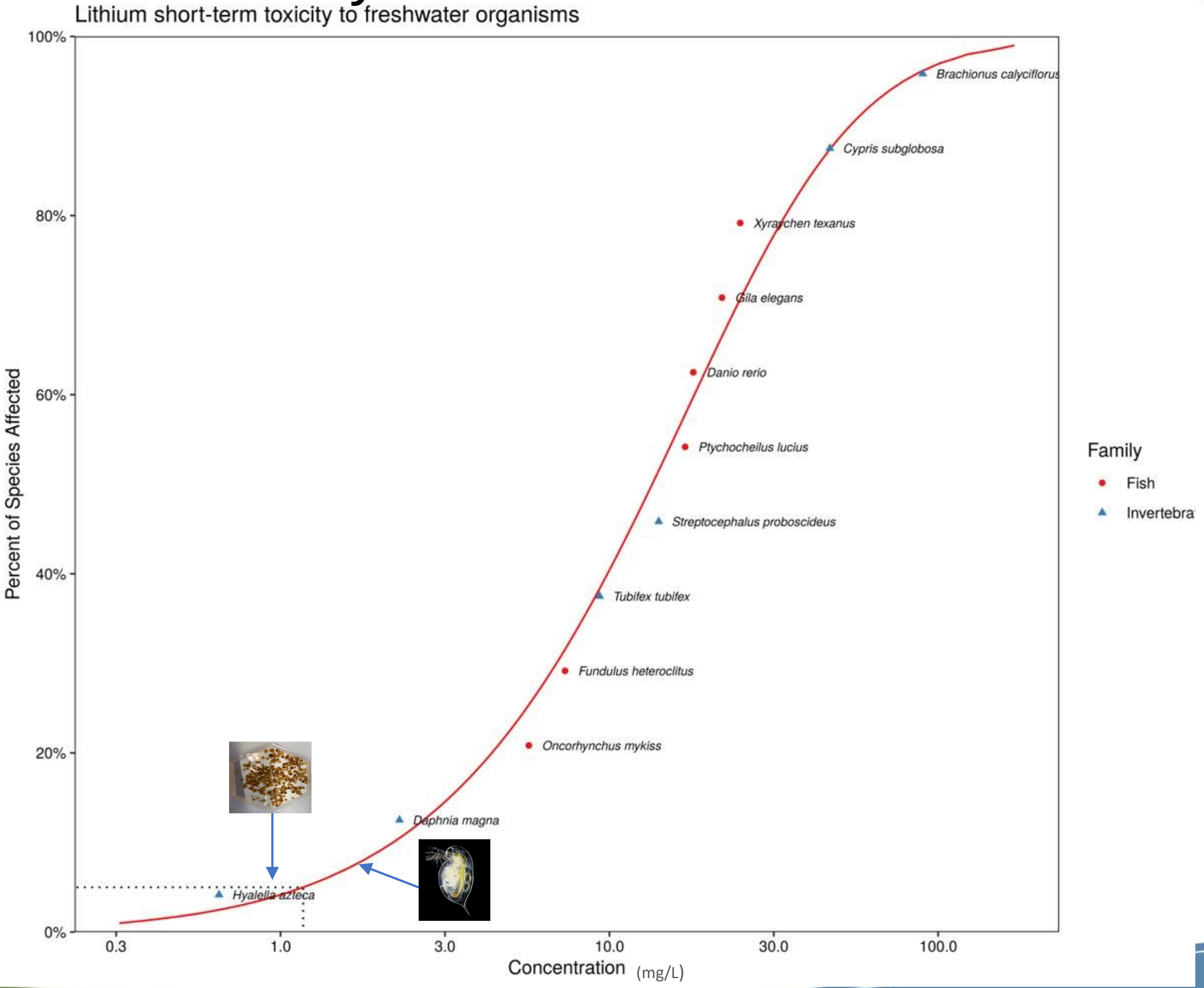
Chronic toxicity to *Daphnia pulex*

End point - Reproduction	
EC50	3.01 mg/L
EC25	2.43 mg/L
EC10	1.96 mg/L



Guideline development - Species sensitivity distribution

- No chronic toxicity guideline for the protection of the aquatic environment.
- Guideline based on species sensitivity distribution – 95% of species protected
- Preferred long-term chronic toxicity data
- Currently more short-term Li toxicity data
- Based on SSD – Li guideline ~ 1.25mg/L (based on short-term toxicity tests)



Conclusions

- A number of elements were identified for further investigation:
  - Guideline development - Li and Ta
  - Lack of knowledge on potential environmental impact from Li mining
  - Effluent limits for Li, P, Cr and Ta
- Most elements are primarily hosted in silicate phases and not mobile, making releases to the aquatic environment low.
  - Longer leaching tests needed to improve environmental relevance
  - Drilling campaigns on tailings to map the trends across depth
- Li is not very toxic to aquatic invertebrates (>1mg/L) compared to other elements (e.g. Cu, As etc).
  - More longer term chronic tests needed to ensure guideline is protective

Work is funded by the Critical Minerals Research, Development and Demonstration (CMRDD) Program at NRCan

Mackenzie Valley Operational Dialogues

History of MVOD

- MVOD was created in 2020 as an opportunity to learn about the perspectives and expertise of resource co-management partners, identify common challenges, and collectively work to develop operational work plans for regulatory topics
- This initiative brings together representatives from Indigenous governments and organizations, the minerals industry, co-management boards, GNWT, and the federal government to explore regulatory topics
- While the MVOD was created in response to concerns raised by industry, the initiative focusses on shared objectives and goals of all participants using a dialogue-first approach to develop solutions together that better serve all

Shared Goals and Objectives

Goal: Maintain a regulatory regime in the Mackenzie Valley that is understood, trusted, effective, and efficient for all involved (including Indigenous Governments and Organizations, territorial and federal governments, resource co-management boards, and proponents).

Objectives:

- To advance regulatory operations using a dialogue-first approach by seeking to understand issues from various perspectives and collectively building solutions that do not require legislative amendments/change.
- To create a forum where resource co-management partners can meet (outside of specific projects) to provide updates on regulatory initiatives, ask questions, share knowledge, discuss challenges, and collaborate on work plans

Light Work Plans

The current LWPs focus on:

LWP 1: Addressing Administrative Challenges

LWP 2: Analytics Trackers

Light Work Plan 1

ADDRESSING ADMINISTRATIVE CHALLENGES; CONSIDERATION OF WATER REGULATION AMENDMENTS

Update on MVOD Light Workplan 1

Kathy Racher

May 2024

Regulatory process - areas for improvement

- Light Workplan 1 focuses on improving the efficiency of the regulatory application and review process for small scale mineral exploration projects.
- There were four main areas for improvement identified:

DEFINITION OF ICE-BRIDGE WATER USE

INDIGENOUS ENGAGEMENT

MANAGEMENT PLANS

‘SMALL SCALE PROJECT’ DEFINITION

This presentation

- This presentation summarizes:
  1) Issues and perceptions about the regulatory process that were raised in discussions with parties involved in MVOD
  2) Progress made on addressing those issues and perceptions
- We recognize that some of the issues/perceptions may have changed over the past year – if so, please identify those changes so that the workplan can be revised.

The definition of “water use” for ice-bridges

- In 2020, the Land and Water Boards (LWBs) became aware that water uses where the water is returned to the same water source were being regulated differently in the Mackenzie Valley and Nunavut (even though the definition of water use in the legislation is the same).
  - Based on the information they had then, the LWBs clarified their interpretation of the definition of water use and how this interpretation applies to this type of water use.
- One specific question that resulted from this was whether the volume of water used for building ice-bridges should be factored into the determination of whether an applicant needs a type A or a type B water licence.
  - This matters because type A licences require a much longer time to process and issue than type B water licences.

Progress

- After discussions about this issue at the February 2023 MVOD meeting, the LWBs started to collect the evidence needed to reconsider the interpretation of the regulations with respect to water use for ice-bridges.
  - Step 1: Public review of LWBs' interpretations and reasoning regarding ice-bridge water use (July – Nov 2023)
  - Step 2: LWB counsel's analysis of review comments and development of potential revised interpretations (Nov 2023 – April 2024)
  - Step 3: Public review of potential changes to the LWBs' interpretations (April – May 2024)
  - Step 4: Evidence and potential revised interpretations will be presented to Full Board for decision (early July 2024)
- The LWBs received many comments from representatives of federal, territorial and Indigenous governments as well as industry (view on LWB's Online Review System).

All parties supported the exclusion ice-bridge water use from the determination of whether a miscellaneous project (e.g., mineral exploration) needs a type A or a type B water licence.

Almost all parties recognized and supported the need to amend the Regulations to clarify these matters for the long term.

Indigenous engagement

- Industry representatives have expressed that:
  - There is a general lack of clarity on engagement requirements (the who, when, and how) for regulatory processes.
  - There isn't an up-to-date engagement group contact list.
- Licence/permit applicants feel that this affects their ability to engage properly prior to making their applications, causing delays in the regulatory process.

Progress

- In 2023, the LWBs started the process of updating their Engagement Guidelines.
- Community engagement sessions (Tea & Talks) have taken place so far in Łíídlı̨ı̨ Kų́ę́ and Gameti. More will be planned in the various regions of the Mackenzie Valley.
- The LWBs are engaging on the possibility of an interactive online engagement mapping tool. The idea is that it would be available to anyone on the LWBs' websites.

“Small-scale project” definition

- Some industry representatives feel that although the current regulatory process works well for large projects (e.g., mines), it does not work well for small- scale projects (e.g., mineral exploration). Perceptions include:
  - That the thresholds/triggers for authorizations or management plans are getting lower over time.
  - That parties, including LWB staff, don’t understand what small-scale projects are all about, so these projects get the same requirements as larger projects.
  - Although regulations have not changed in decades, there seems to be more and more information requirements.
- All these things mean that applicants believe that they must do much more work than they think is warranted by the environmental impacts of these small projects.

Progress

- The current legislation does not contain a definition of “small-scale”; also, the Waters Regulations are silent on mineral exploration projects.
- Following the last MVOD meeting, the LWBs have dedicated more resources to meet with operators that identify themselves as having small-scale projects as well as consultants that work with these companies.
  - The LWBs are seeking more specific information on the management plans, information requirements, or permit/licence conditions that are believed to create unnecessary challenges for small-scale operators.
  - With this information, we can work collectively to find efficiencies.
- The tour of a small-scale project as done on Tuesday this week as well as some of the presentations given at this MVOD meeting are also meant to help parties form a realistic perspective on small exploration project scales, risks, and potential impacts.

Management Plans

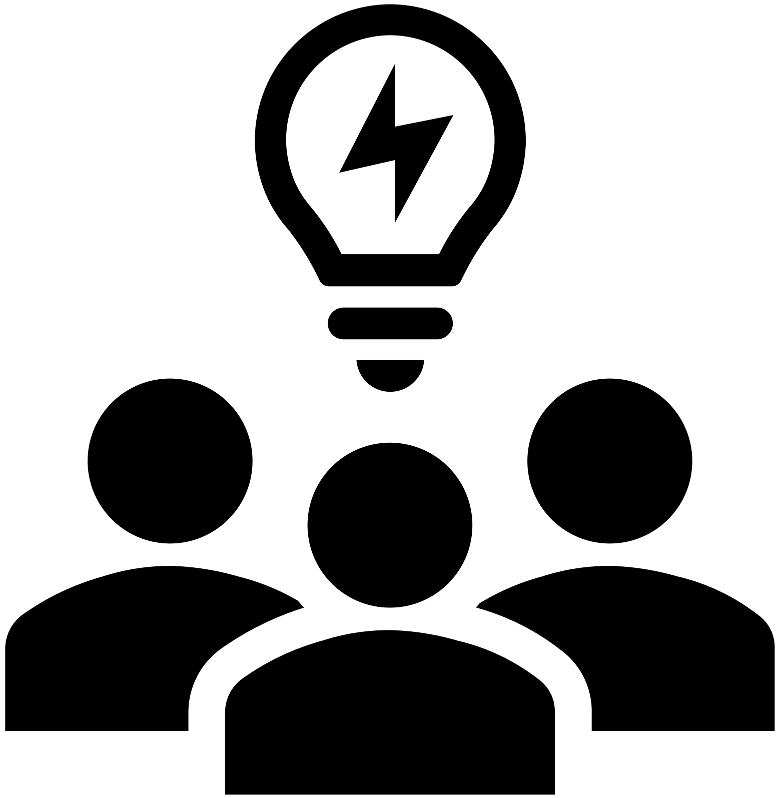
- Some industry representatives perceive management plan requirements as onerous and as significant hurdles to the application process.
- Questions were also raised about whether it was possible to replace at least some management plans with requirements within the terms and conditions of licences/permits.

Progress

- Every project, even if relatively small-scale, is unique in terms of equipment, activities, water use, the need for roads, seasonal/all-weather work, etc.
  - The lack of a “standard” small-scale project makes it challenging to develop “standard” management plan templates.
  - The possibility that templates could be developed for small drilling/exploration projects that don’t require a water licence is still being investigated.
- Information/ideas gathered at this meeting may help to make further progress on this topic.

New idea – consider changes to water regulations

- Over the past many years, the LWBs and other parties have identified issues with the water regulations that continue to cause uncertainty in the regulatory process.
- In the November 2023 MVOD virtual meeting, the LWBs shared their thoughts about areas of the regulations that are causing operational challenges and where additional clarity could be helpful for all parties.



The issues identified fall into one or more of three broad categories

- Project types not contemplated in the regulations
- Real or perceived disconnect between the amount of regulatory process required and the potential impacts of some regulated activities
- Unclear language used for some provisions

Progress

- On May 28, 2024, the LWBs sent a letter to the responsible Ministers at the GNWT and CIRNAC with recommendations for focused amendments to both the Waters Regulations and Mackenzie Valley Federal Areas Waters Regulations

- The main points in the letter were:
  - The Regulations are outdated and a source of uncertainty in the regulatory process
  - Focused amendments to the Regulations should be prioritized over updates to the Waters Act
  - Many proponents and some co-management partners support focused amendments to the Regulations
  - The letter is intended to reinitiate a discussion between co-management partners

Thank you – and time for questions

MVOD: LWP 4 – Comms Strategy (Now Retired)

- As part of the LWP 4 – Communications Strategy, the MVOD Organizing Committee is tracking NWT Environmental Audit recommendations that can be completed through MVOD

- LWP 4 has been completed, but tracking the Audit remains a standing item

- You can find both the Communications Strategy and Audit tracking (called Initiative Tracker) documents, along with all other past MVOD workshop summaries & presentations on the MVLWB website, under "External Initiatives"
  - Communications Strategy
  - Initiative Tracker

You can find the 2020 Audit technical report, recommendations, and fact sheets here: 2020 NWT Environmental Audit | Environment and Climate Change (gov.nt.ca)

What is the NWT Environmental Audit?

- An independent review of the NWT environmental regulatory system in the Mackenzie Valley and of the environmental data available to make resource management decisions in the NWT (Takes place every 5 years)

- The independent auditors provide recommendations to responsible parties (GoC, GNWT, LWBs) to help guide improvement of the regulatory system

- The last Audit was completed in 2020, and the next Audit will be released in 2025 (underway now). Examples of items from 2020 linked to MVOD:
  - 1-2: The GNWT and CIRNAC establish a process for parties to meet on a regular basis and discuss implementation opportunities and challenges … this process will need to include IGOs and industry as appropriate. (LWP#4).
  - 1-7: That the LWBs regularly meet with key client groups outside of specific regulatory processes to discuss opportunities and challenges with the goal of continuing to improve the regulatory system. (LWP#1).

External Initiatives Updates and Q&A

1. Critical Minerals Strategy (NRCan)

3. Northern Regulatory Initiative (CIRNAC)

2. Regional Energy and Resource Tables (NRCan)

4. Mineral Resources Act and Regulations Project (GNWT)

Natural Resources Canada | Ressources naturelles Canada

Canadian Critical Minerals Strategy Update

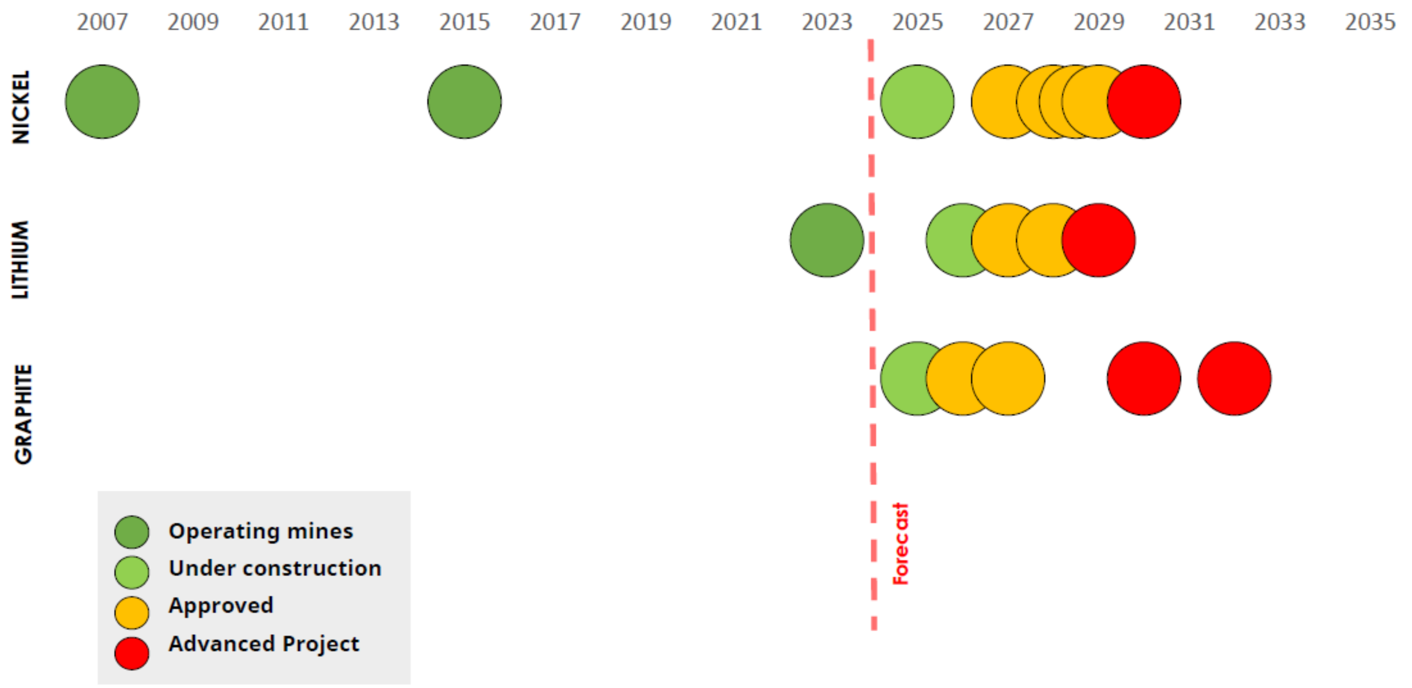
PDAC 2024 TCS INFO SESSION

Canada

New Mines Needed for Canada to Support Domestic EV Battery Production

- 15 more mines need to open over the next decade to supply enough minerals for 4 EV battery factories.
- The pace of new battery metal mine openings needs to increase fivefold through 2035 to fully support domestic battery production.

Canada has opened **three new mines** since 2007.



Update of Canada's Critical Minerals List and Methodology

Consultation and analysis on review of CM list complete.

- Purpose of consultation was to receive feedback on updated criteria that will define mineral criticality for Canada

For a mineral to be deemed critical for Canada, the proposed criteria specify the mineral meets one or more of the following:

- essential to Canada's economic or national security
- required for our national transition to a sustainable low-carbon and digital economy
- a sustainable and strategic source of critical minerals for our international allies

and both of the following:

- its supply is threatened
- it has a reasonable chance of being produced in Canada in the near- to medium-term

Critical Minerals Strategy's Areas of Focus

The **Canadian Critical Minerals Strategy** will increase the supply of responsibly sourced critical minerals and support the development of domestic and global value chains for the green and digital economy

Drive Research, Innovation and Exploration

Investment in exploration through enhanced geoscience data creation, research and analysis

Accelerate Project Development

Accelerate development of Canada's critical minerals mining, processing, component inputs, and recycling projects

Advance Indigenous Reconciliation

Advance Indigenous economic reconciliation, improve access to capital and meaningful participation in critical minerals projects

Grow a Diverse Workforce and Prosperous Communities

Promote the contribution of diverse workers to Canada's green energy transition as part of the critical minerals workforce

Build Sustainable Infrastructure

Build sustainable infrastructure to enable critical minerals development with benefits for local communities

Strengthen Global Leadership and Security

Develop more resilient global supply chains that are protected from market disruption, enhancing Canada's economic security

Investing in Critical Minerals Development

Budgets 2021, 2022 and 2023 provide major investments to **implement the Critical Minerals Strategy**.

RESEARCH AND DEVELOPMENT
$144.4 million under B2022, and $47.4 million, under B2021 to support R&D of technologies to support critical mineral value chains

INFRASTRUCTURE
Up to $1.5 billion for infrastructure investments for critical mineral development & Canada Infrastructure Bank to support large-scale infrastructure enabling critical mineral projects

INDIGENOUS ENGAGEMENT AND CAPACITY
$25 million for early engagement and capacity building

TAX CREDITS
30% *Critical Mineral Exploration Tax Credit* and new 30% *Clean Technology Manufacturing Investment Tax Credit*

REGULATORY SUPPORT
$40 million to support northern regulatory processes (CIRNAC)

INNOVATIVE PROJECTS
$1.5 billion to support manufacturing, processing, and recycling applications

GLOBAL PARTNERSHIPS
$70 million to advance Canada’s global leadership on critical minerals

PUBLIC GEOSCIENCE
$79.2 million to help find the next generation of critical mineral deposits

Results to Date

Pillar 1: **Drive Research, Innovation and Exploration**	Pillar 2: **Accelerate Project Development**	Pillar 3: **Building Sustainable Infrastructure**	Pillar 4: **Advancing Reconciliation with Indigenous Peoples**	Pillar 6: **Strengthening Global Leadership and Security**
Critical Minerals Geoscience and Data Initiative	Northern Regulatory Initiative	Critical Minerals Infrastructure Fund	Indigenous Natural Resource Partnerships (INRP) Program	Global Partnerships
Critical Minerals Technology and Innovation Initiative	SIF Critical Minerals Investment Target			
	Critical Minerals Concierge Service			

Calls for Proposals and Consultations

- **TBS-led Supply Chain Regulatory Review consultations, including on critical minerals**
- **Critical Mineral List Consultation**
- **Call for Proposals of the Critical Mineral Traceability Grant**
- **Call for Proposals of the Critical Minerals Infrastructure Fund (CMIF)**

Tax Incentives for Critical Minerals

Critical Minerals Exploration Tax Credit (CMETC)

- A 30% Mineral Exploration Tax Credit for targeted critical minerals (i.e., nickel, lithium, cobalt, graphite, copper, rare earths elements, vanadium, tellurium, gallium, scandium, titanium, magnesium, zinc, platinum group metals, and uranium) under Budget 2022.
- Budget 2023 announced the CMETC would be expanded to also include lithium-from-brines.

Clean Technology Manufacturing Investment Tax Credit (CTM-ITC)

- A 30% refundable tax credit, under Budget 2023, applicable towards the cost of investments in, among others, new machinery and equipment used to mine, process, or recycle six critical minerals: lithium, cobalt, nickel, graphite, copper, and rare earth elements

Contact Us:

Critical Minerals Centre of Excellence

cmce-cemc@nrcan-rncan.gc.ca

Visit NRCan’s webpage for more information on critical minerals:

https://www.canada.ca/en/campaign/critical-minerals-in-canada.html

Visualizing Canada's Support Measures for Critical Minerals

Measures with Minimum Project-Based Support

$1 million | $1-10 million | $10-$20 million | $20-100 million | $100 + million

Major Projects Table
Science-Policy Table
Indigenous Partnerships
International Partnerships

Innovation and Business Development

- Natural Sciences and Engineering Council (NSERC)
- Regional Development Agencies
- NRCan's Critical Minerals Research, Development and Demonstration Program (CMRDD)
- Sustainable Development Technology Canada (SDTC)
- Business Development Bank of Canada (BDC)
- Canada Innovation Corporation (CIC)
- Canada Growth Fund (CDEV)
- ISED's Strategic Innovation Fund (SIF)
- Export Development Canada (EDC)

Infrastructure

- NRCan's Critical Mineral Infrastructure Fund (CMIF)
- Canada Infrastructure Bank (CIB)

Other Services and Support Measures

Facilities, Equipment and Research

- NRCan's CANMET Labs (Mining & Materials)
- National Research Council (NRC) Labs
- NRCan's Geological Survey of Canada (GSC) Initiatives

Tax Measures

- Canada Revenue Agency's (CRA) Critical Mineral Exploration Tax Credit
- CRA Scientific Research and Experimental Development Tax Incentive
- CRA's Investment Tax Credit for Clean Technology Manufacturing
- CRA's Federal Corporate Income Tax (FCIT) reduction for Zero-Emission Technology

Indigenous Partnerships

- NRCan's Indigenous Natural Resource Partnerships Program (INRP)
- CIRNAC's Northern Regulatory Initiative

International Programs

- NRCan's Global Partnerships Initiative
- GAC's Trade Commissioner Service, CanExport Program
- CIC's International R&D Partnerships

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Regional Energy and Resource Tables

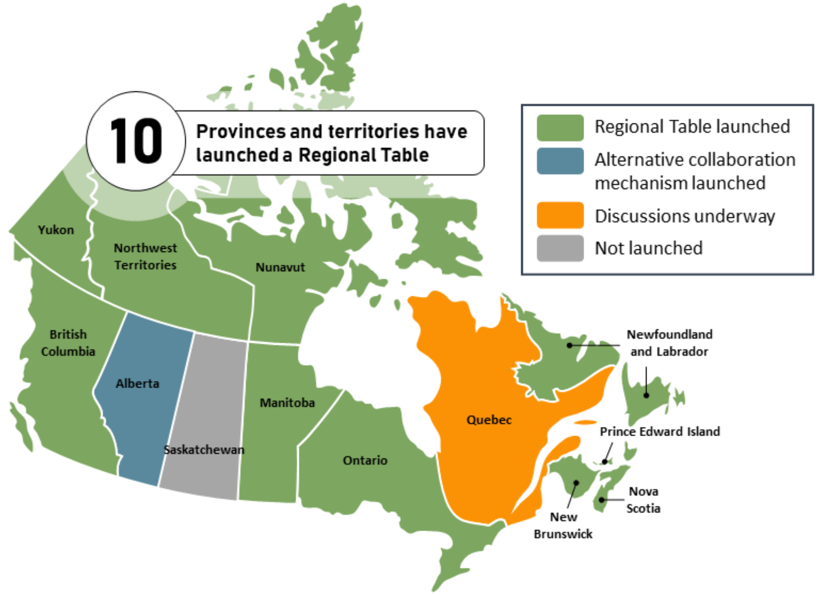
Mackenzie Valley Operational Dialogue

May 30, 2024

Canada

REGIONAL ENERGY AND RESOURCE TABLES

- As Canada **transitions to a low-carbon future**, our country possesses tremendous **potential to be a highly competitive, prosperous leader in the net-zero economy**.
- Regional Tables are being established in each province and territory to **enable all regions of Canada to seize the economic opportunities enabled by the energy transition**.
- NRCan is working jointly with each province and territory, in collaboration with Indigenous partners, and with the input of key stakeholders to **advance economic priorities in the energy and resource sectors**.
  - This includes working to align resources and timelines, which can better inform future investment decisions



OBJECTIVES

- Identify and accelerate the highest potential growth opportunities in each region
- Transform the way we produce, transport, store and use energy to enable net-zero emissions
- Equip the workforce to participate in and benefit from the global shift to net-zero

NWT Regional Table Priorities

Through early conversations with the GNWT and Indigenous partners, there is general agreement on the following proposed priority areas.

- **Critical Minerals**
- **Electrification**
- **Indigenous Leadership and Capacity**

As conversations continue these priorities will be further scoped and refined, narrowing in on actions that can be taken in the near-term to accelerate progress.

NORTHWEST TERRITORIES REGIONAL TABLE

1. Early Federal-Territorial Dialogue
2. Early Engagement with Indigenous Partners on Broader Initiative
3. Identify Priorities and Develop Collaboration Framework
4. Launch Collaboration Framework
5. One-Year Progress Report

Going forward…

- Discuss key energy and natural resource priorities for the Northwest Territories
- Ensure that Indigenous interests, perspectives, and priorities are captured and reflected throughout the Regional Tables process and the Northwest Territories Collaboration Framework
- Undertake stakeholder engagement on targeted priority areas

Mineral Resources Act & Regulations (MRAR)

GNWT – Julie Ward

Director, Mineral Resources Act Implementation

May 31, 2024

Outline

1. Importance of Mining in the NWT
2. What does sustainable exploration and mining look like?
3. The Mineral Resources Act import changes
4. ITI's dual role in Governance
5. History and Future of legislation
6. Collaborative Development of the MRA Regulations
7. Timeline to coming into force

Why is Mining Important?

North

N.W.T. could lose hundreds of jobs and residents when the mines close, economist warns

Report highlights economic impacts of mine closure

Jenna Dulewich · CBC News · Posted: Apr 09, 2024 11:11 AM MDT | Last Updated: April 9

Diavik Diamond Mine, NWT - Rio Tinto

Did you know that diamond mining accounted for more than one-fifth of the Northwest Territories' economy in 2020?! With facts like that, it is clear that the mining sector is not only a massive part of the Canadian territory's economy, but also the identity of many Northwesterners.

In Rush for Key Metals, Canada Ushers Miners to Its Fragile North

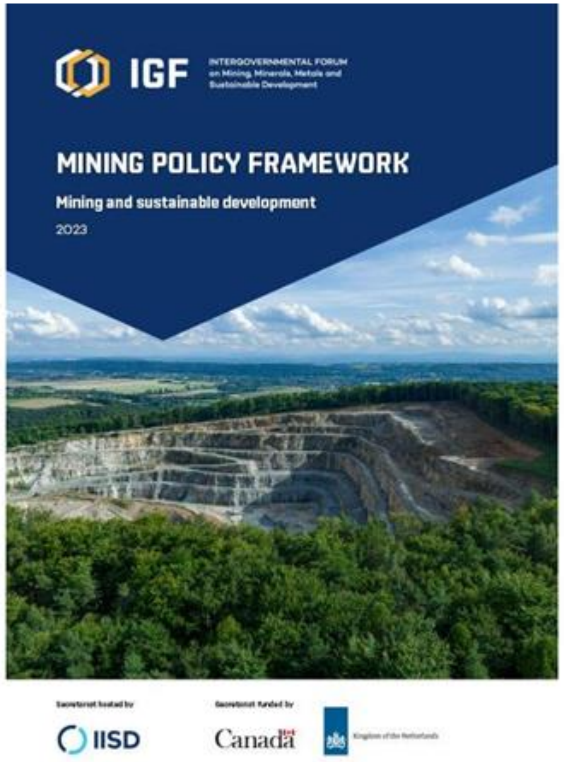
Canada is offering incentives to mining companies to dig in its northern regions for the critical minerals needed for EVs and solar panels. But based on past abuses, critics fear carbon-rich peatlands will be lost, wild rivers polluted, and enormous cleanup projects left behind.

/canada-critical-minerals-mining

How do we manage exploration and mining sustainably?

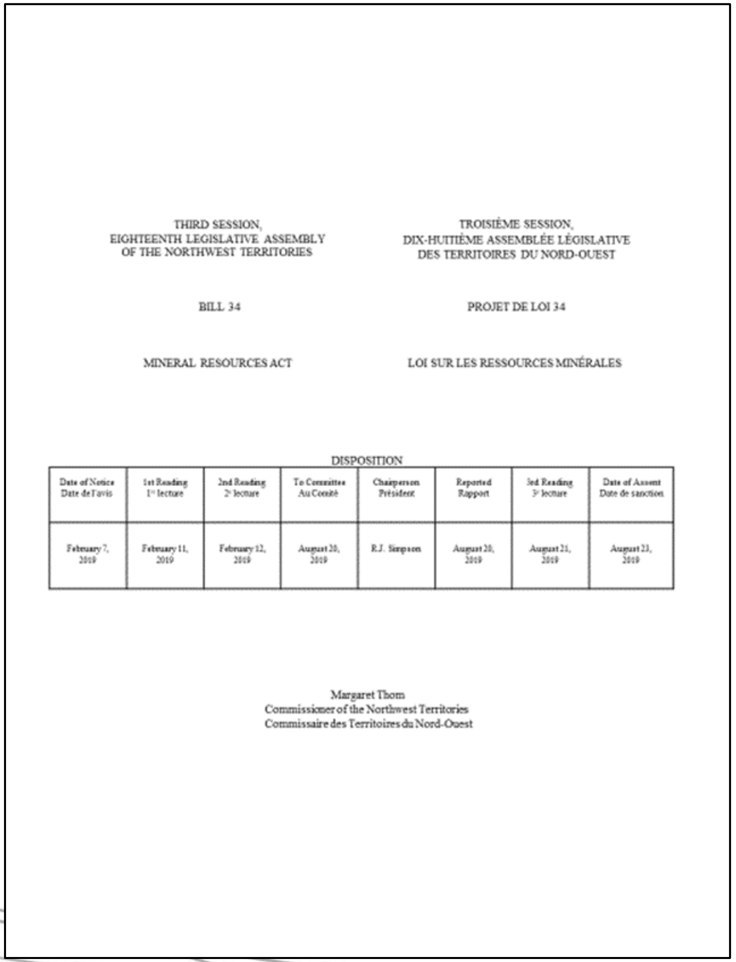
Intergovernmental Forum on Mineral Policy Framework

1. Laws, Policies and Institution
2. Financial Benefits
3. Socio-economic Benefits
4. Environmental Management
5. Post-Mining Transition
6. Artisanal and small-scale mining



Why is the Mineral Resources Act (MRA) Important for NWT?

- Merit based tenure regime (e.g. mineral claim for exploration and mineral lease for mining);
- Increased generation and public access to geoscience;
- Increased opportunity to share information between Industry and Indigenous Governments (e.g. Notice of application to record a claim, notice of intended work, notice of transfer etc.;
- Review and update of royalty regime and allowable deductions;
- Mandatory benefits for Indigenous Governments and NWT residence for mines greater than $75M Capital Expenditure/ 250 person years;
- Government declaration of ‘material change’ for a producing mine when agreements need to be revisited; and,
- Separate rules for small-scale mining.



THIRD SESSION,
EIGHTEENTH LEGISLATIVE ASSEMBLY
OF THE NORTHWEST TERRITORIES

TROISIÈME SESSION,
DIX-HUITIÈME ASSEMBLÉE LÉGISLATIVE
DES TERRITOIRES DU NORD-OUEST

BILL 34

PROJET DE LOI 34

MINERAL RESOURCES ACT

LOI SUR LES RESSOURCES MINÉRALES

DISPOSITION

Date of Notice Date de l'avis	1st Reading 1re lecture	2nd Reading 2e lecture	To Committee Au Comité	Chairperson Président	Reported Rapport	3rd Reading 3e lecture	Date of Assent Date de sanction
February 7, 2019	February 11, 2019	February 12, 2019	August 20, 2019	R.J. Simpson	August 20, 2019	August 21, 2019	August 23, 2019

Margaret Thom
Commissioner of the Northwest Territories
Commissaire des Territoires du Nord-Ouest

ITI's Dual Role in Exploration and Mining Governance

Promoting the optimum development of the sector to the benefit of government and society through sound economic development policies and programs

Ensuring development occurs in a safe and sustainable manner through **effective regulatory governance**

History and Future Legislation

2014

During Devolution in 2014, NWT Lands Act and Mining Regulations were created to mirror federal legislation.

Apr. 2014

Along with Devolution, Northwest Territories Intergovernmental Agreement on Land and Resource Management Act

Aug. 2019

Mineral Resources Act

Bill 34 passed

Dec. 2020

Intergovernmental Council on Land and Resource Management: Legislative Development Protocol

Mar. 2021

Technical Working Group under the Protocol (~March 2021)

Dec. 2021

Invited all NT Indigenous Governments to participate in Technical Working Group

2025

Draft Regulations available

2026

Implementation complete and Act comes info force

Collaborative Development of MRAR:

Technical Working Group is made of representatives from Intergovernmental Council:

- Government of the Northwest Territories
- Inuvialuit Regional Corporation
- Gwich'in Tribal Council
- Sahtu Secretariat Incorporated
- Northwest Territory Métis Nation
- Tłı̨chǫ Government
- Acho Dene Koe First Nation and the Fort Liard Métis Local #67
- Salt River First Nation
- Denínu Kų́ę́ First Nation
- Kátł'odeeche First Nation

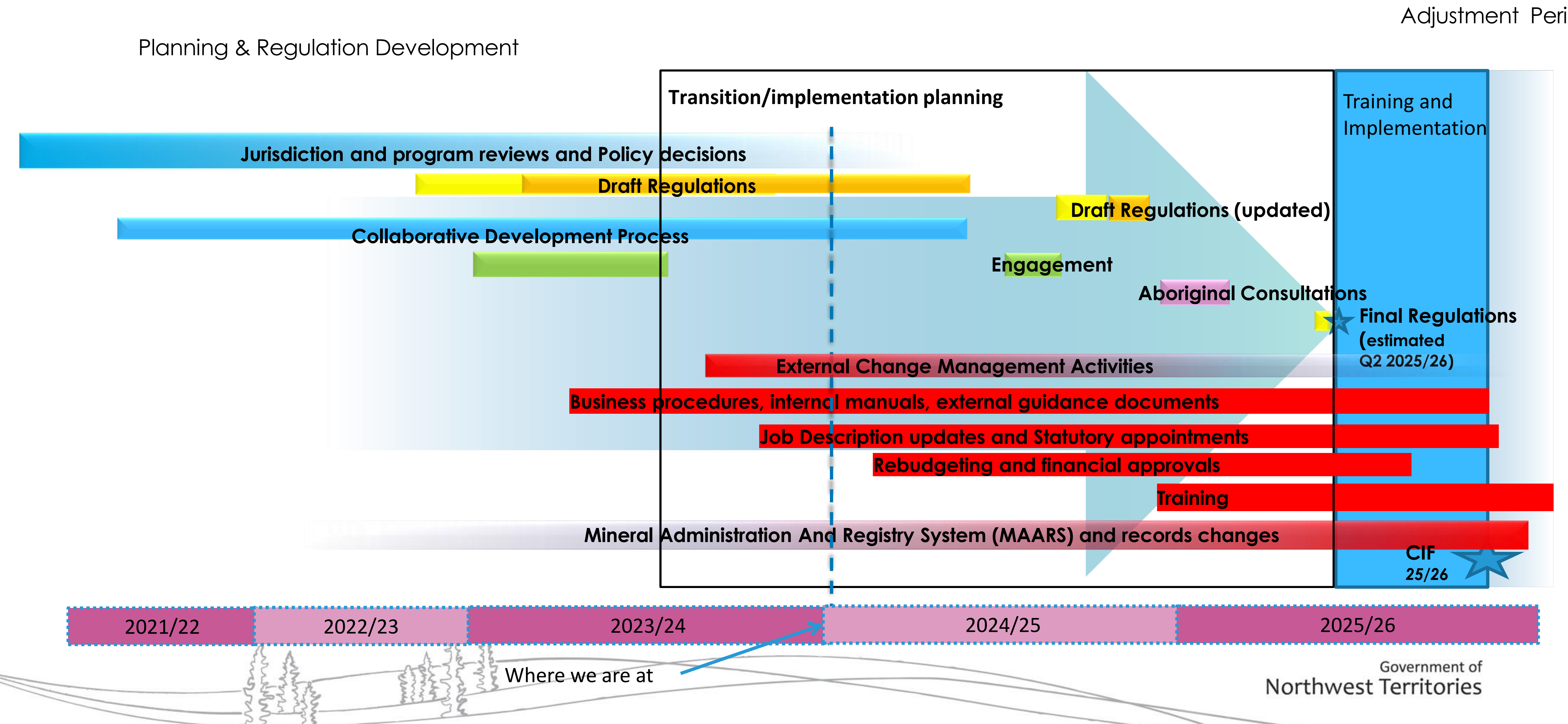
Other Indigenous Governments who choose to participate:

- Yellowknives Dene First Nation (Dec. 2021)
- North Slave Métis Alliance (Dec 2021)
- Łútsël K'é Dene First Nation (April 2024)

Technical Working Group:
327.5 hours spent meeting to develop regulatory policies

Figure 2 – Collaborative development hours spent on *MRA* regulation policy intentions development.

Timeline for Implementing Regulations



In Closing…

- The change on Industry when the act comes-into-force will be substantial
- Indigenous Governments involvement in management of resources in their area will be ground-breaking
- Considerable new authorities causing reorganization of GNWT resources at the Mineral and Petroleum Branch
- Overdue and necessary changes that need to be done respectfully, in the right way

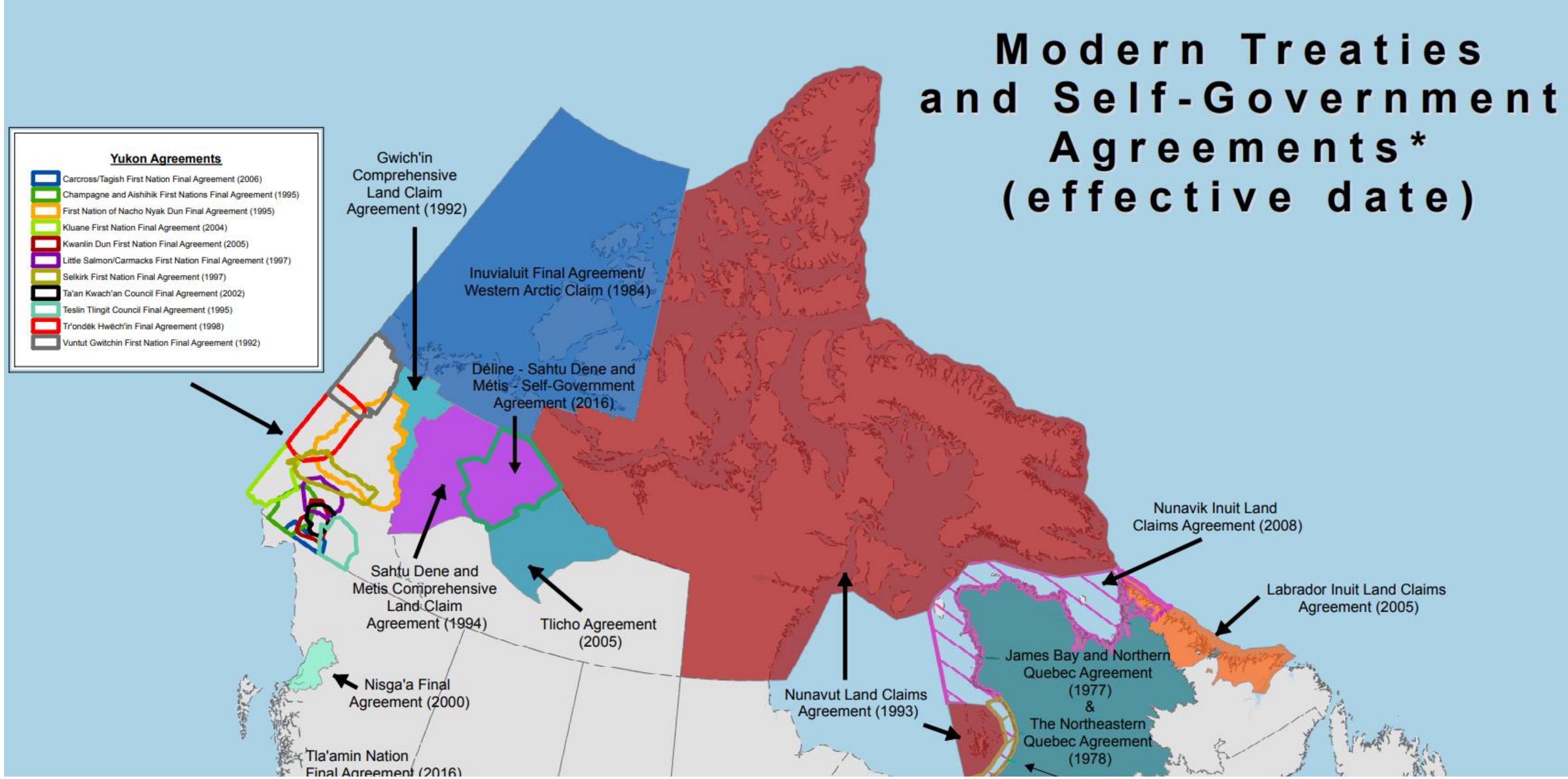
Crown-Indigenous Relations and Northern Affairs Canada
Relations Couronne-Autochtones et Affaires du Nord Canada

The Northern Regulatory Initiative

Mackenzie Valley Operational Dialogue (MVOD) Meeting

May 30, 2024

Modern treaties form the basis of northern regulatory systems



The Northern Regulatory Initiative

includes $40 million over 7 years to support northern regulatory processes

The Northern Regulatory Initiative

Objective: clear, trusted, and functional regulatory systems that reflect and respect the contexts in each territory.

- Indigenous participation in resource management processes (IA and LUP)
- Crown consultation clarity and coordination
- Regional/ Cumulative Effects Studies
- Multi-party Regulatory Dialogues

Work with governments, partners, rights holders, and stakeholders in each of the three territories to advance these four areas, further identify and refine priorities, and design and implement actions is ongoing.

Northern Regulatory Initiative: Current Status

Participation in Impact Assessment and Land Use Planning Processes

- Supporting Indigenous participation in pre-submission and post-decision stages of environmental assessments and land use planning initiatives.

Crown consultation clarity and coordination

- Federal Government continues national/ pan-northern work to examine issues and strategies to clarify and coordinate Crown consultation processes.
  - Pan-territorial board forum February 2024; regional based approaches, leverage existing forums to explore ideas.
  - November 2023 MVOD; community consultation/ engagement policy/guidelines.

Northern Regulatory Initiative: Current Status

Regional Studies

- Early stages of regional study are underway in the Slave Geological Province (NWT), as requested by the Tłı̨chǫ Government.
  - Terms of reference nearing completion, expect launch in the fall 2024
  - The study is expected to be conducted over 2-3 years.

Regulatory Dialogues

- Continued preliminary discussions with partners in each of the three territories to support ongoing and future collaborative dialogues.
- In the NWT, the Mackenzie Valley Operational Dialogue (MVOD) is being leveraged to discuss operational components of small-scale exploration.

Contact

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General Inbox:

Initiativedereglementationdunord-Northernregulatoryinitiative@sac-isc.gc.ca

Masì / Thank You