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Arc Evolution and Variability in Magmatic Porphyry Fertility of the Southern Quesnel Arc, south-central British Columbia (NTS082E, L, 092H, I, P, 093A, B)

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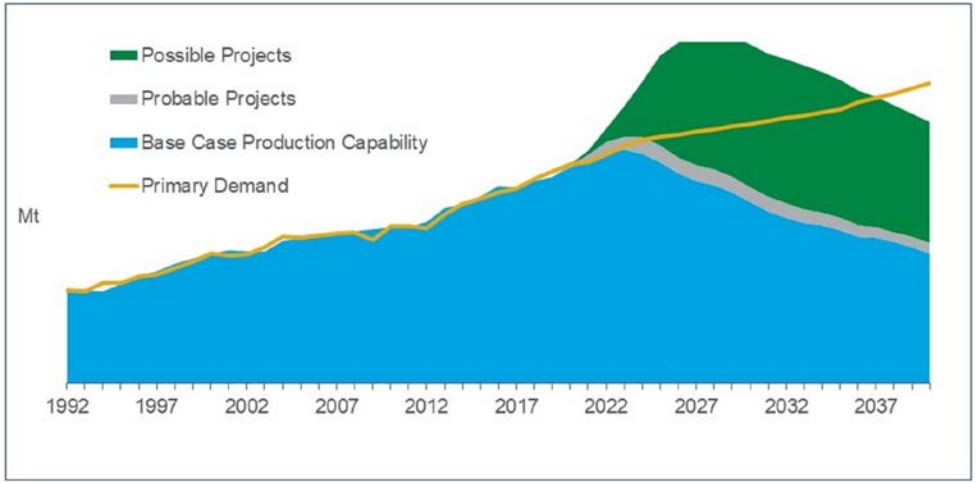
SEG Canada Foundation

Geoscience BC

Demand for Copper



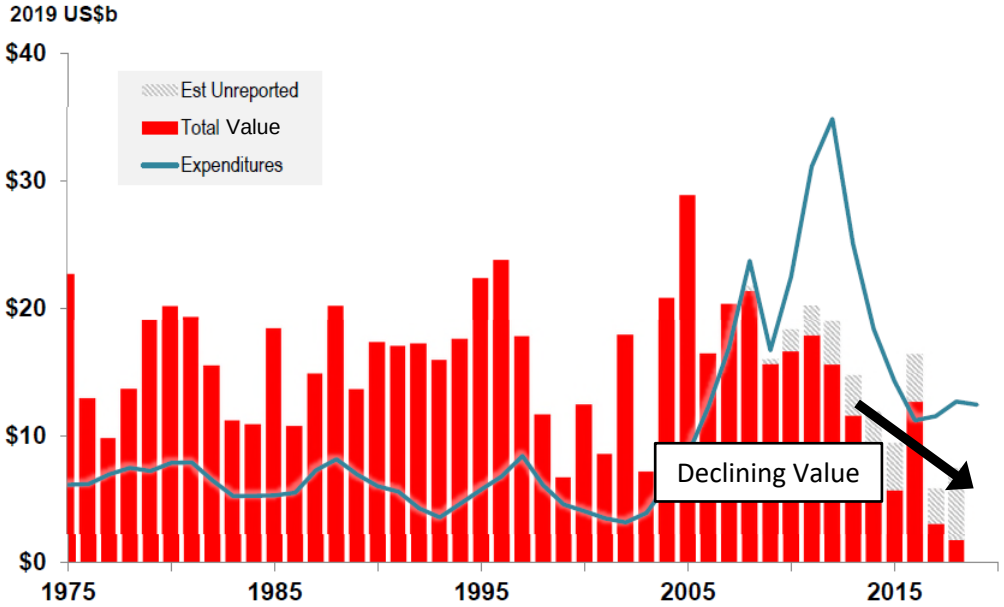
Wood Mackenzie (2019)

Copper usage has **increased by 3.4%** annually since the 1900's.

Reliance on **renewable energy** and **EV's** will continue to drive global demand.

New discoveries are needed to meet **Cu demand**.

Cost and Value in Exploration: 1975-2018

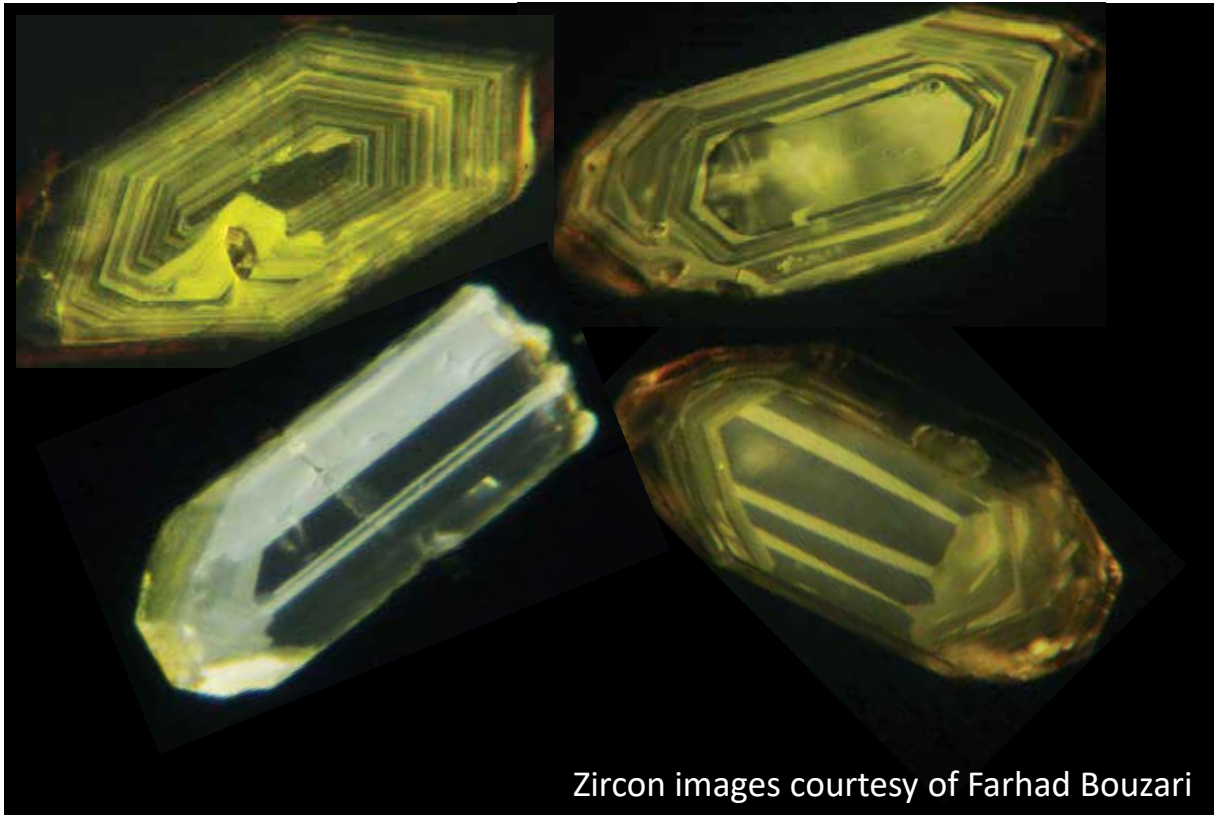


Schodde (2019)

Conventional Exploration Methods are **ineffective**

New Tools are needed to **identify deposits** and asses their **economic potential**

Porphyry Magma Fertility – Trace Elements in Zircon (TEZ)



Regional Geology

Quesnellia – Middle Triassic to Early Jurassic:

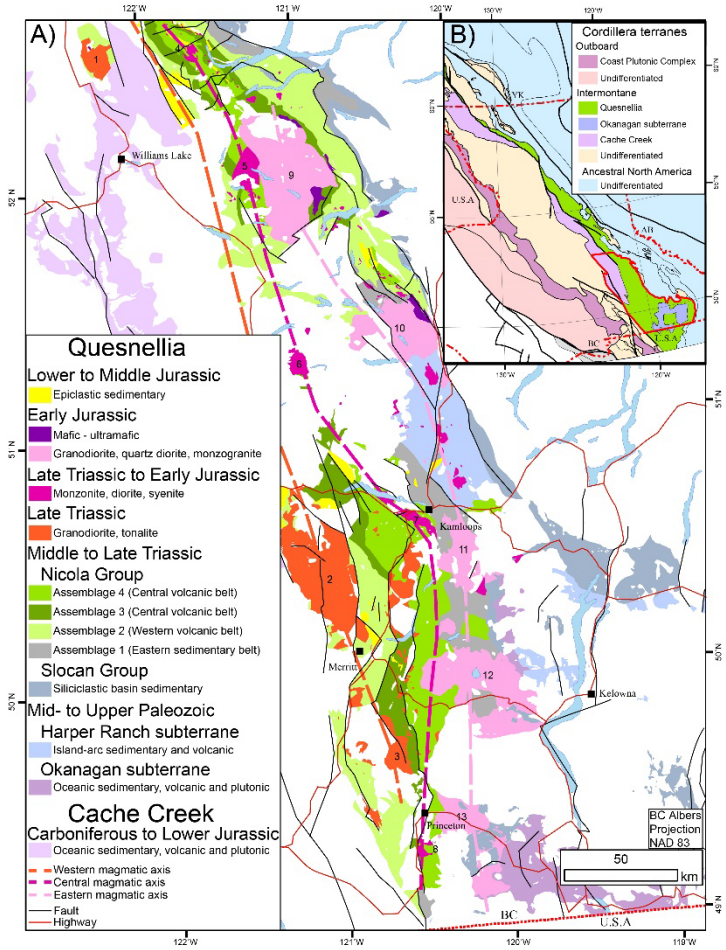
- **Nicola** and **Rossland** Group island-arc assemblages
- **Slocan** Group siliciclastic basin
- Basement of Middle to Upper Paleozoic oceanic **Okanagan** and island-arc **Harper Ranch** subterranes.

Eastern **Quesnellia**:

- Unconformable on oceanic **Slide Mountain** terrane and pericratonic **Kootenay** terrane.

Western **Quesnellia**:

- mid-Mesozoic oceanic **Cache Creek** terrane faulted against the western margin of **Quesnellia**.



Nicola Group

Assemblage 1 - Middle Triassic (Anisian and Ladinian)

- Basin sedimentary rocks with
- local volcaniclastic and basaltic rocks.

Assemblage 2 - Late Triassic (Carnian and early Norian)

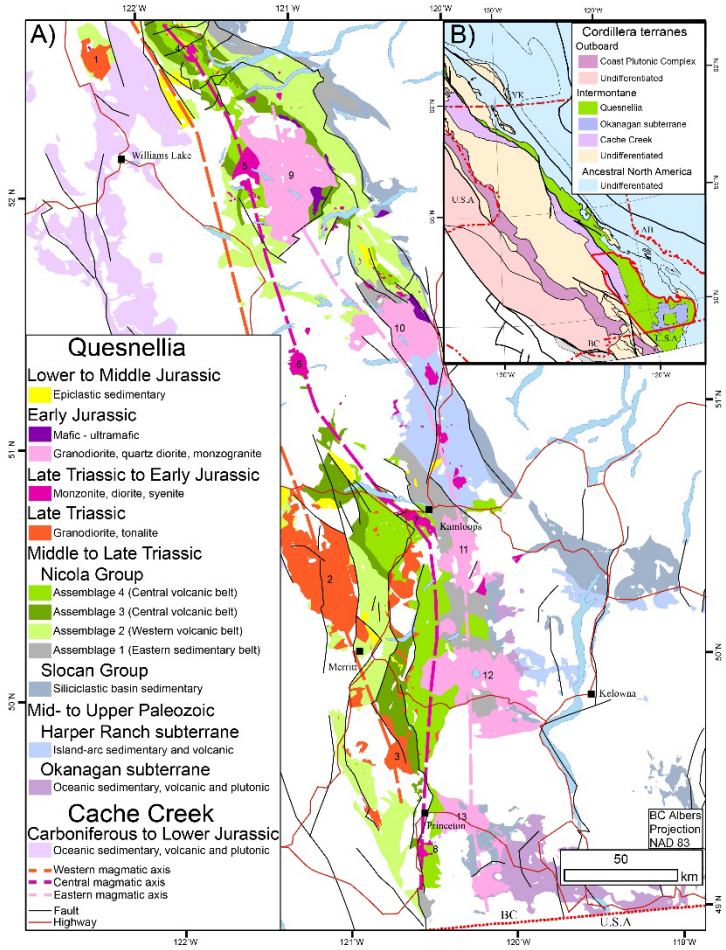
- Volcanic sandstone and conglomerate intercalated with
- calc-alkaline to tholeiitic subaerial basaltic flows and breccias.

Assemblage 3 - Late Triassic (Norian)

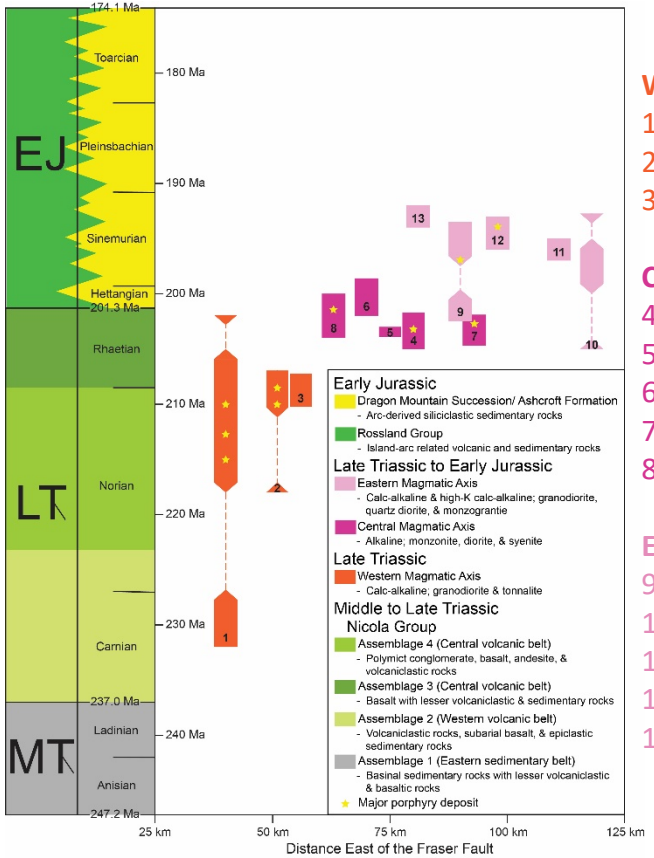
- High-K, calc-alkaline to alkaline basaltic flows intercalated with
- lesser volcaniclastic and sedimentary rocks.

Assemblage 4 - Late Triassic (Rhaetian)

- Dominated by polymict conglomerate with
- lesser calc-alkaline to alkaline basalt and andesite.



Southern Quesnellia Plutonism



Western Magmatic Axis (229 – 206 Ma)

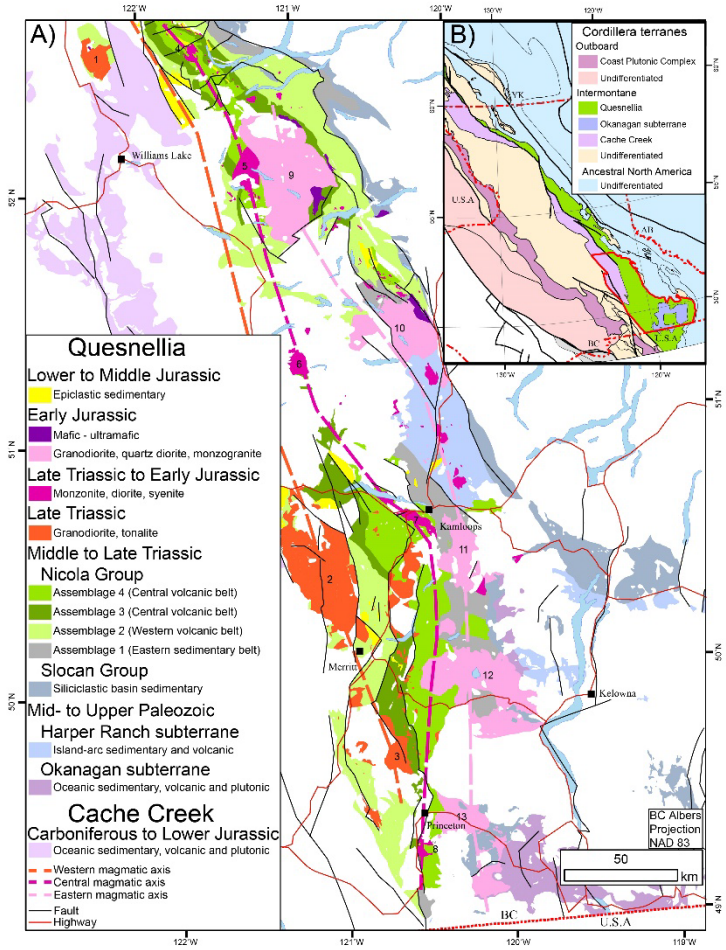
1) Granite Mountain batholith
2) Guichon Creek batholith
3) Alice Lake pluton

Central Magmatic Axis (207 – 198.6 Ma)

4) Mount Polley
5) Spout Lake pluton
6) Rayfield River
7) Iron Mask batholith
8) Copper Mountain

Eastern Magmatic Axis (205 – 192.7 Ma)

9) Takomkane batholith
10) Thuya batholith
11) Wild Horse batholith
12) Pennask batholith
13) Bromley batholith



Magmatic Axes Characteristics

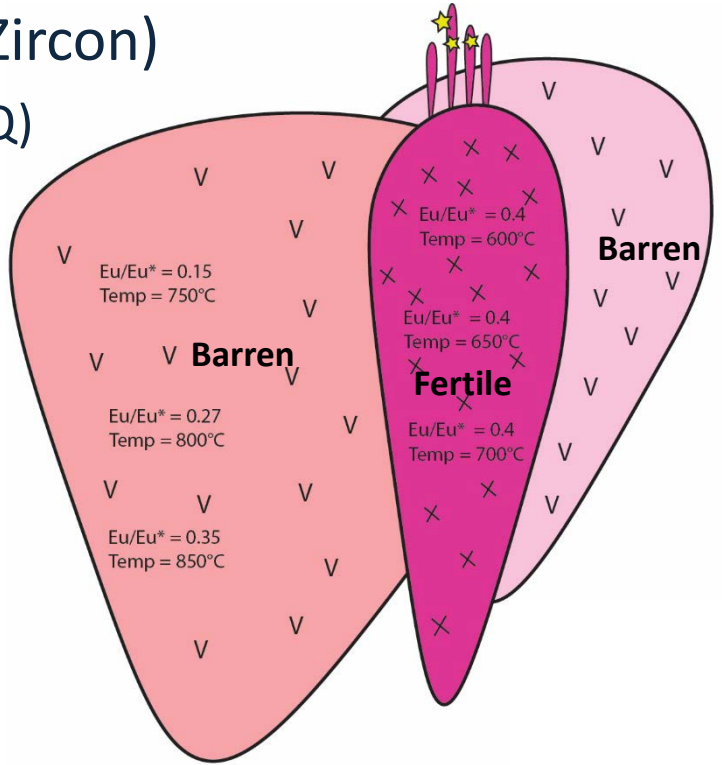
	Western magmatic axis	Central magmatic axis	Eastern magmatic axis
Age (Ma)	229–206	207–198.6	202–192.7
Magmatic affinity	Calc-alkaline	Alkaline	Calc-alkaline, high-K calc-alkaline
Predominant rock type	Granodiorite and tonalite	Diorite and monzonite	Granodiorite and quartz diorite
Batholith area (km^2)	up to 1300	32–120	up to 1300
Batholith thickness (km)	>6	4	
Average emplacement depth (km)	5	1	4
Major porphyry districts	Highland Valley and Gibraltar	Copper Mountain, Afton-Ajax, and Mount Polley	Brenda and Woodjam
Metal assemblages	Cu-Mo±Au	Cu-Au	Cu-Mo & Cu-Au
Historical copper production (Mt)	6.39	1.83	0.28
Current copper resource (Mt)	2.81	4.1	0.79*
Total contained copper (Mt)	9.2	5.93	1.07

* inferred resource

Porphyry Magma Fertility

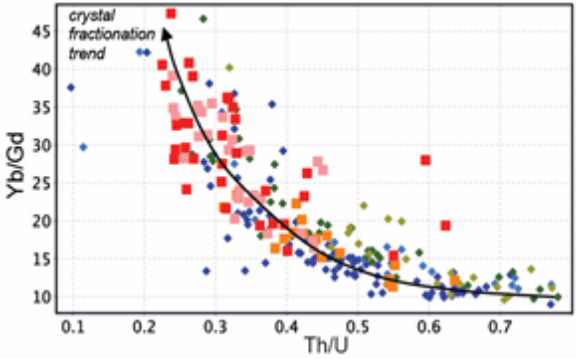
Key Magmatic Parameters (Proxies in Zircon)

1) **Oxidation State** (Eu/Eu*, Ce/Ce*, & ΔFMQ)
2) **Temperature** (Ti-in-zircon-thermometer)
3) **Water Content** (Eu/Eu*)
4) Metal Content
5) Chlorine Content
6) Sulphur Content

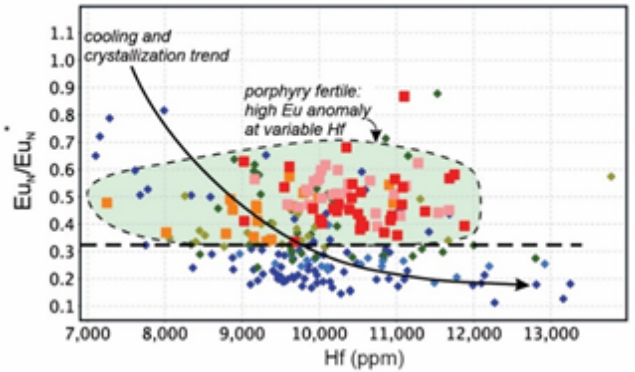


Trace Elements in Zircon – Western Axis – Guichon Creek batholith

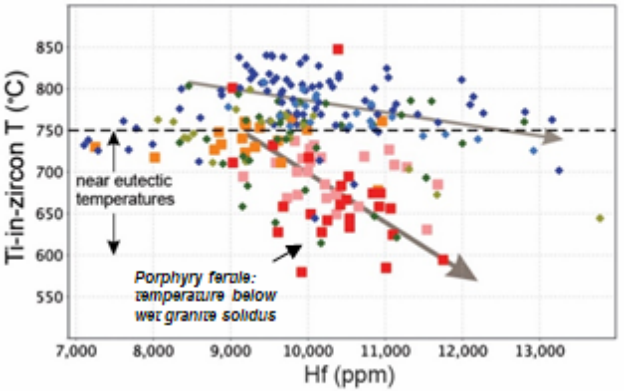
Crystal Fractionation

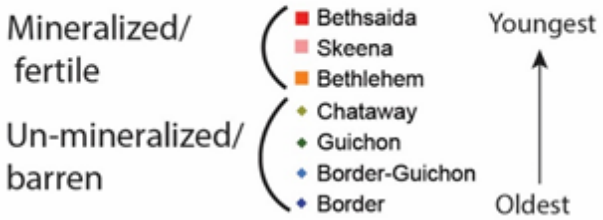


Oxidation & Water vs. Cooling & Crystallization



Temperature vs. Cooling & Crystallization

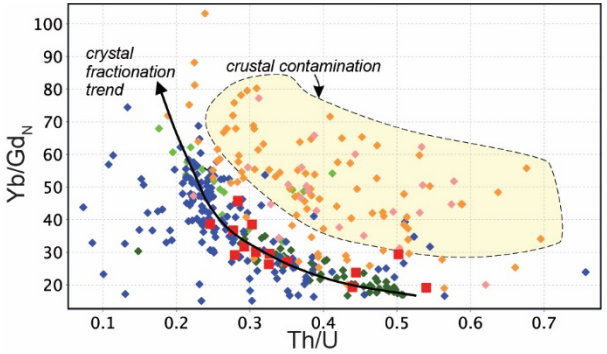




Bouzari et al. (2020)

Trace Elements in Zircon – Eastern Axis – Takomkane batholith

Crystal Fractionation



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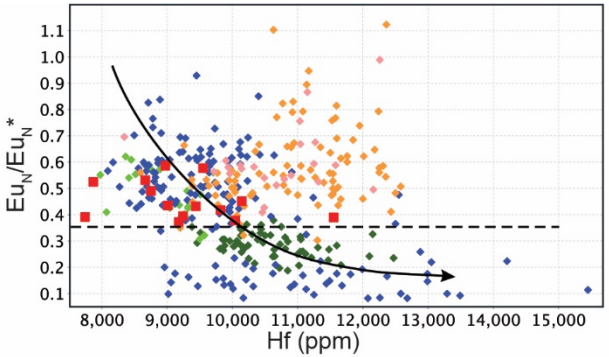

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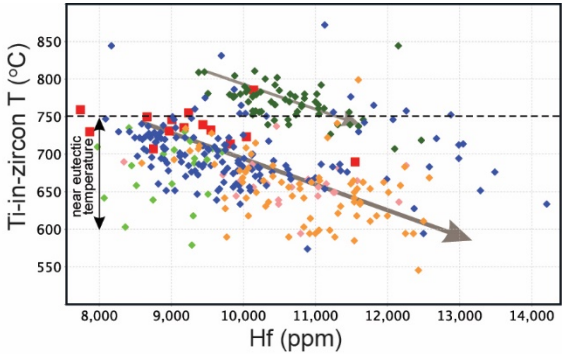


weakly-mineralized
mineralized
un-mineralized

- Qz-feldspar porphyry
- Schoolhouse Lake
- Woodjam Creek
- Boss Creek
- Buster Lake
- Spout Lake

Youngest ↑ Oldest

Bouzari et al. (2020)

Sampling – Quesnellia Plutonism

Western Axis (1)

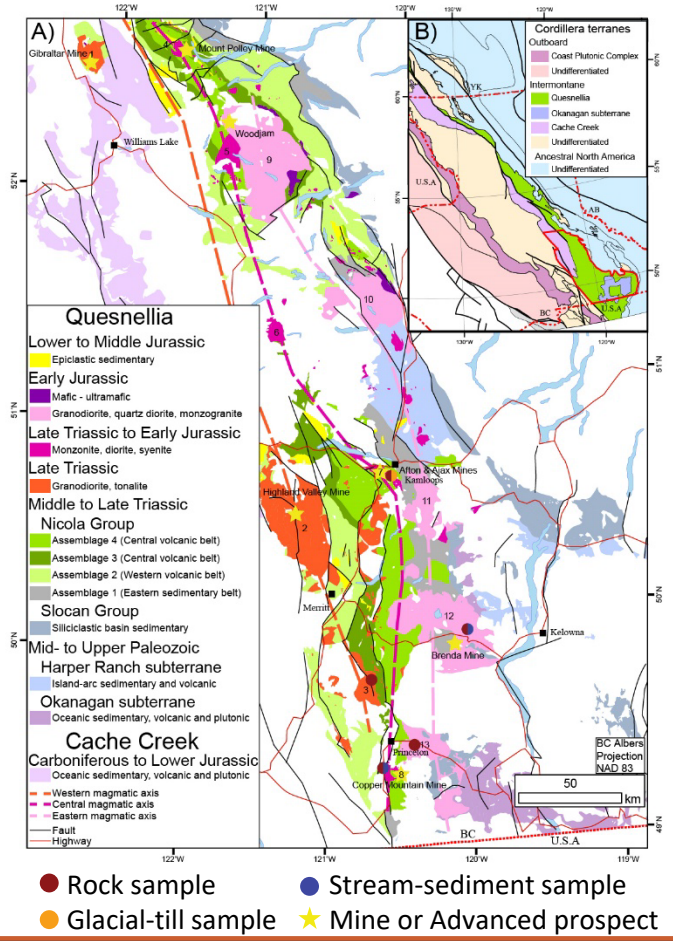
- Alison lake pluton – 1 rock

Central Axis (8)

- Copper Mountain intrusive complex – 2 rock and 1 stream
- Iron Mask batholith – 2 rock and 3 glacial-till

Eastern Axis (3)

- Pennask batholith – 1 rock and 1 stream
- Bromley batholith – 1 rock



Future Work

After completion of the analytical work, we will:

1. **characterize the magmatic fertility** of each intrusion, batholith and magmatic axes;
2. identify evidence of **magmatic processes** such as magma mixing, fractionation, mafic magma recharge, and volatile saturation;
3. attempt to determine how these magmatic processes **influence the formation of porphyry copper deposits**; and
4. determine what **mineral chemistry signatures** in zircon are expressed by these processes.

Thanks for listening

SEG Canada Foundation

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