# RAGLAN THEMATIC:

## Localization of Ni-Cu-(PGE) mineralization in an early Proterozoic trans-crustal dike-sill-lava channel system, Cape Smith Belt, Nunavik


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TGI Ore Systems

CANADA 1842 GEOLOGICAL SURVEY - COMMISSION GÉOLOGIQUE

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A new Canadian research initiative funded by Canada First Research Excellence Fund.

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# Research

## Problems

Some work on settings of Abitibi Ni-Cu-PGE deposits… but too deformed and poorly-exposed to properly evaluate plumbing systems

*In contrast,* the 2.0-1.8 Ga Cape Smith Belt is:

- well-exposed
- 'weakly' metamorphosed

## Objectives

Understand the evolution of the mineralized Expo-Raglan magmatic plumbing system

- temporal – geochemical – physical

Why?

- guide regional exploration – target specific locations within ultramafic-mafic units
- insight into early Proterozoic tectono-magmatic systems

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# Research

## Tools

- **Field work, mapping**
- Geophysics
- **Geochronology**
- **Geochemistry** and **Petrology**
- *Later*… geochemical & dynamic modelling

## Goals and Outcomes

- Understand the **architecture** and **evolution** of an early Proterozoic mineralized magmatic plumbing system
  - magma source, emplacement
  - controls on sulfide mineralization, localization
  - insight into subcontinental lithosphere
- Findings applicable to:
  - Archean greenstone belts in the Superior Province
  - Archean greenstone belts and Proterozoic volcanic belts worldwide

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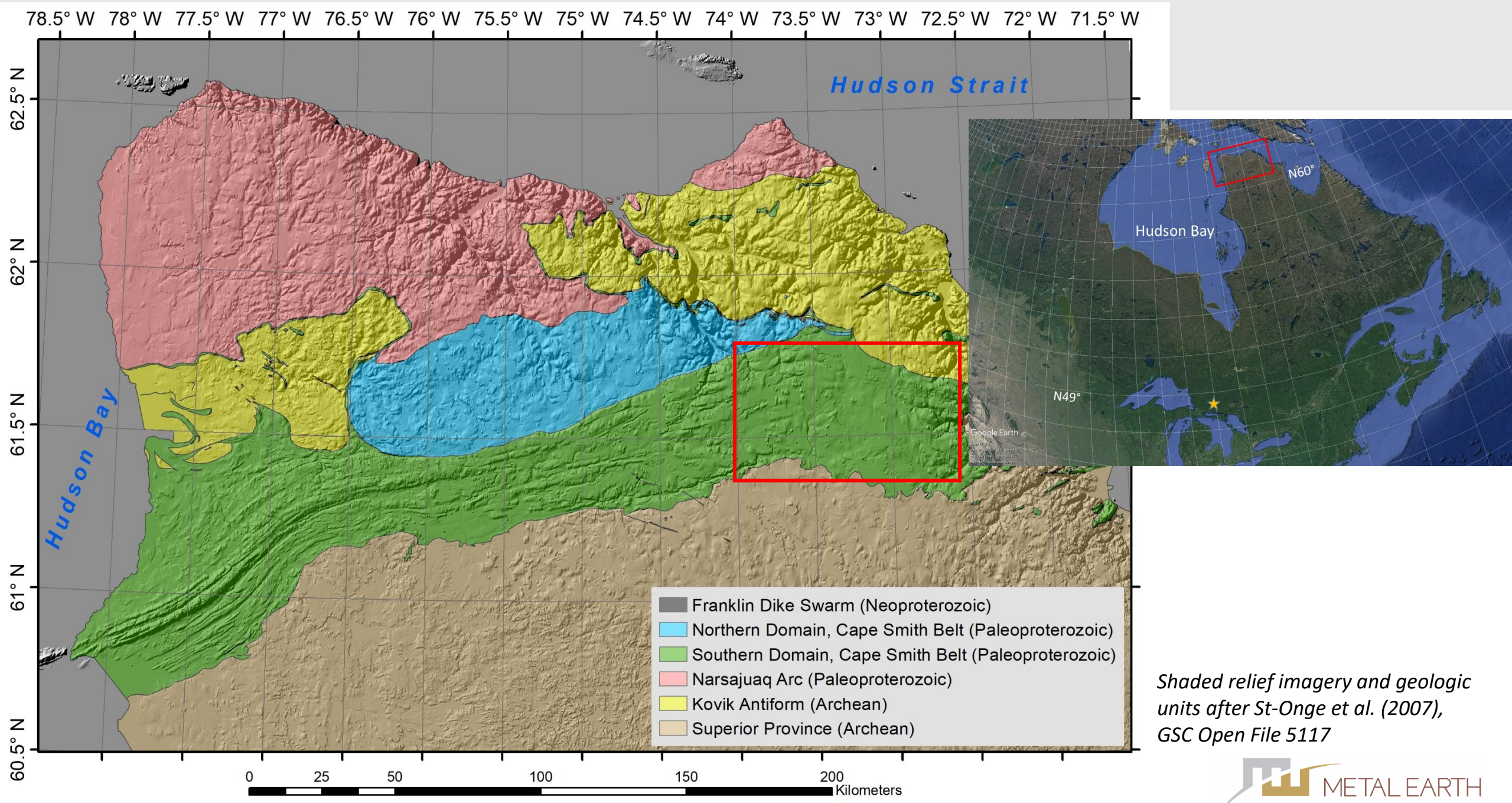


*Shaded relief imagery and geologic units after St-Onge et al. (2007), GSC Open File 5117*

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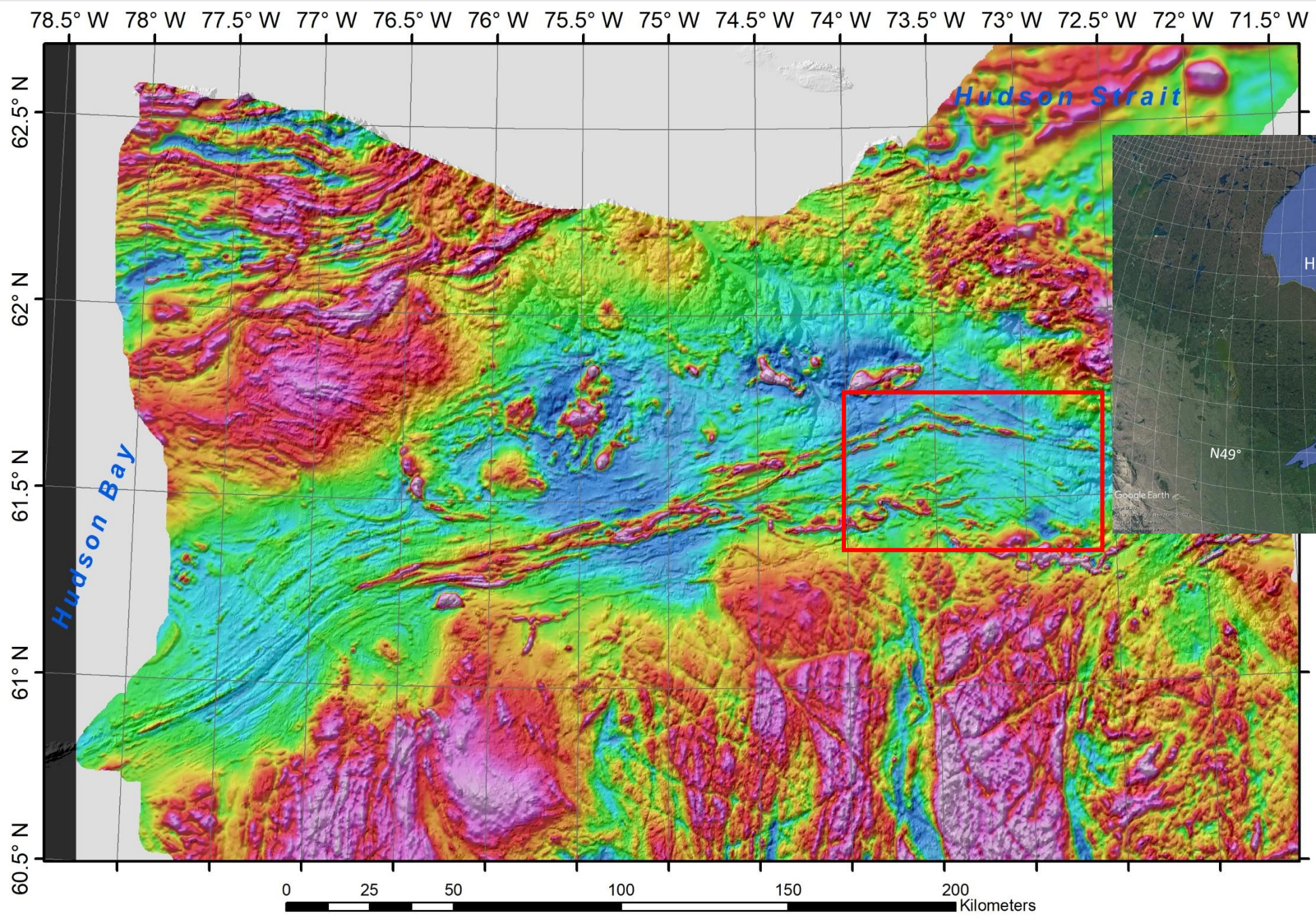


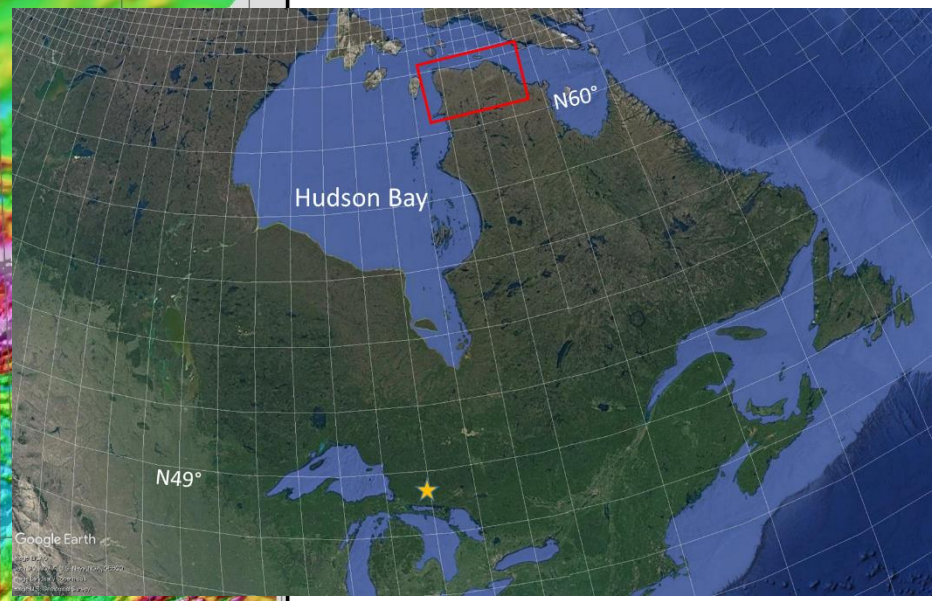


*Regional total magnetics from St-Onge et al. (2007), GSC Open File 5117*

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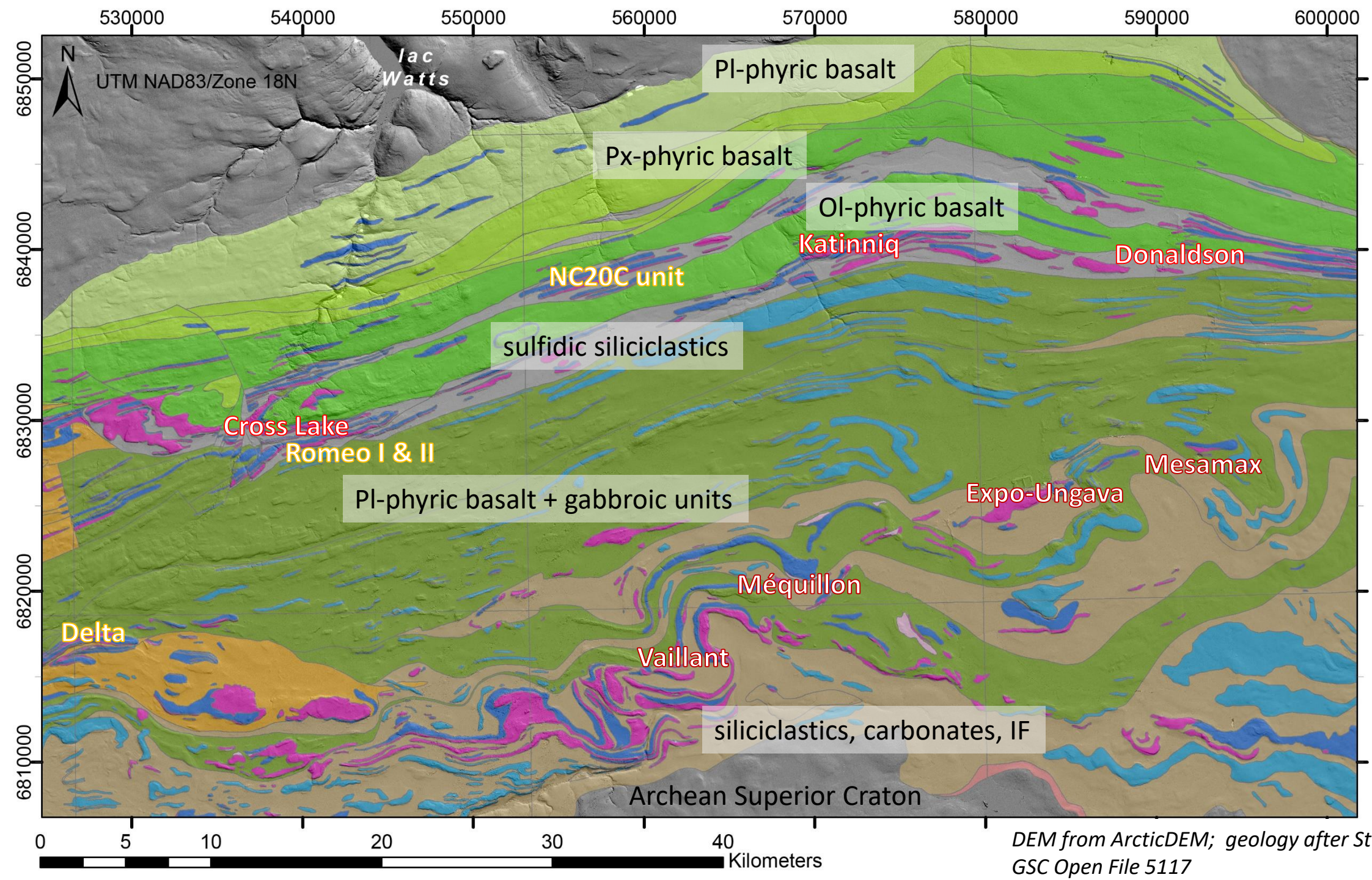
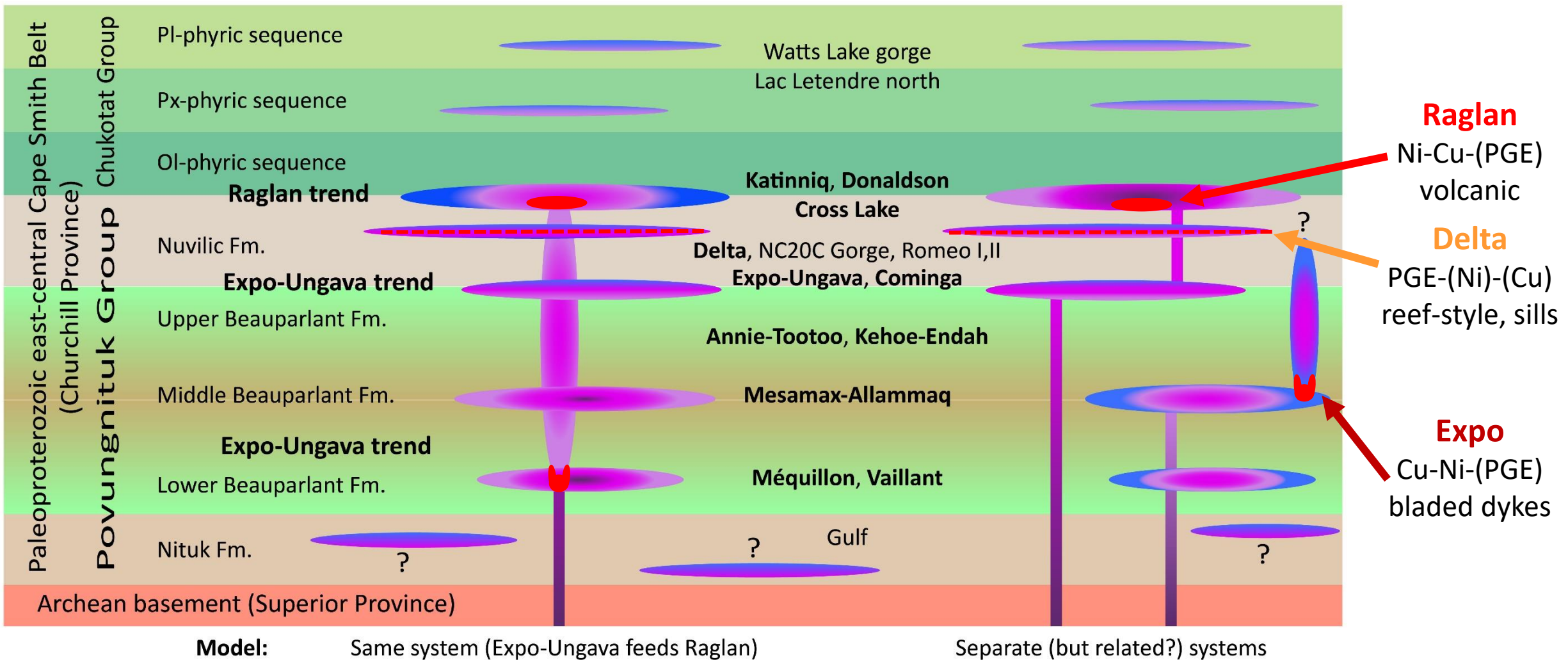



**Raglan**
volcanic Ni-Cu-(PGE) lava channels / sheet flows

**Delta**
PGE-(Ni)-(Cu) reef-style mineralized sills

**Expo**
Cu-Ni-(PGE) bladed dykes

*DEM from ArcticDEM; geology after St-Onge et al. (2007), GSC Open File 5117*




**Lithological legend** for intrusive dikes/sills and extrusive/invasive lava channels/sheet flows:

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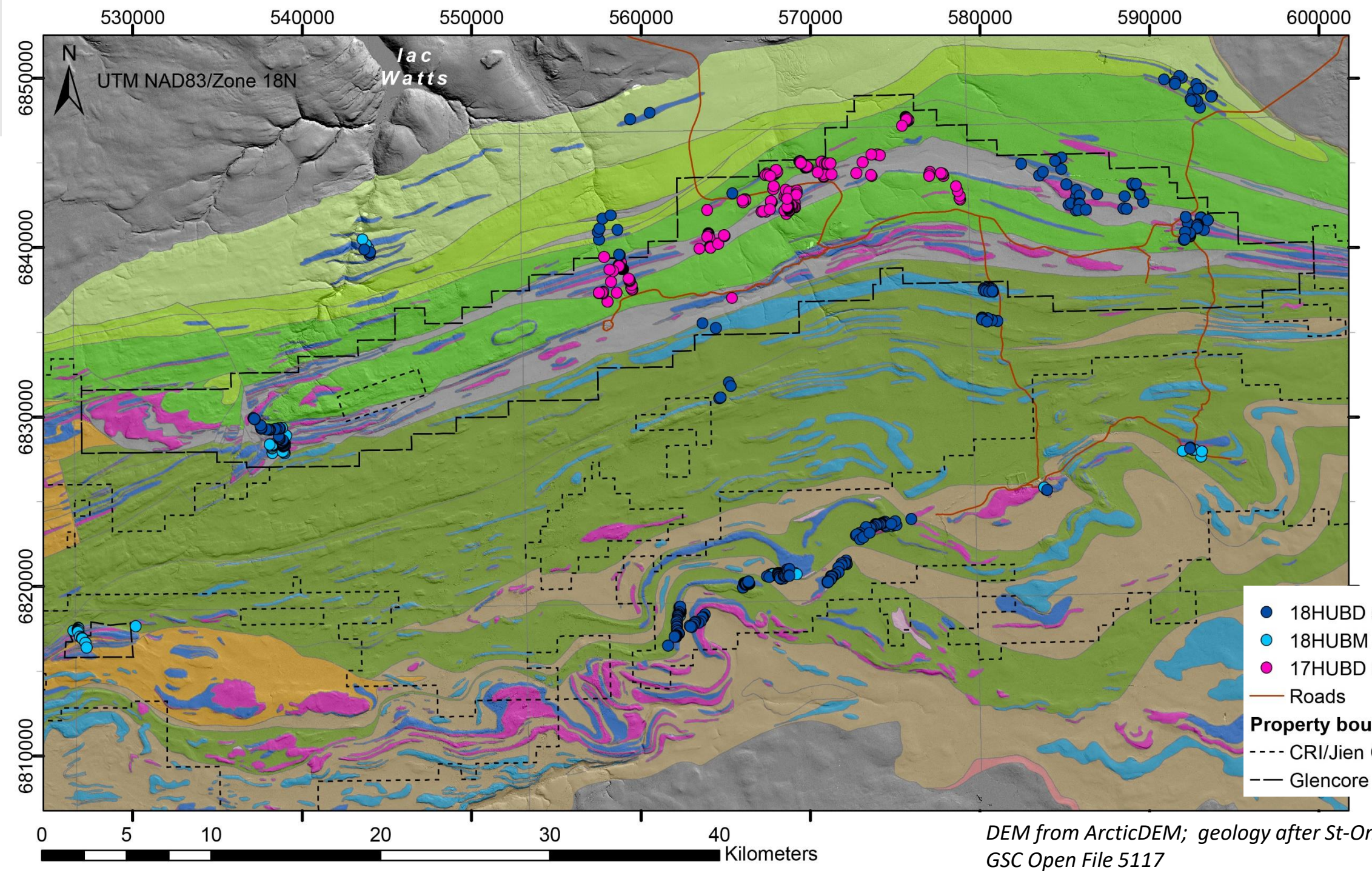


*DEM from ArcticDEM; geology after St-Onge et al. (2007), GSC Open File 5117*

# Summary of field work

## July-August 2017

- Truck support
- Glencore Raglan Mine property
- 200 stations
- 167 samples
- *Resulting in:*
  - 162 polished thin sections
  - 150 whole-rock geochemical analyses (major and trace elements by XRF, ICP-MS, INAA)

## July-August 2018

- Helicopter & truck support
- Glencore Raglan Mine and CRI Nunavik Nickel Project properties, off-property
- 337 stations
- 181 samples
- *Resulting in:*
  - 130 polished thin sections
  - 130+ whole-rock geochemical analyses (major and trace elements by XRF, ICP-MS, INAA)

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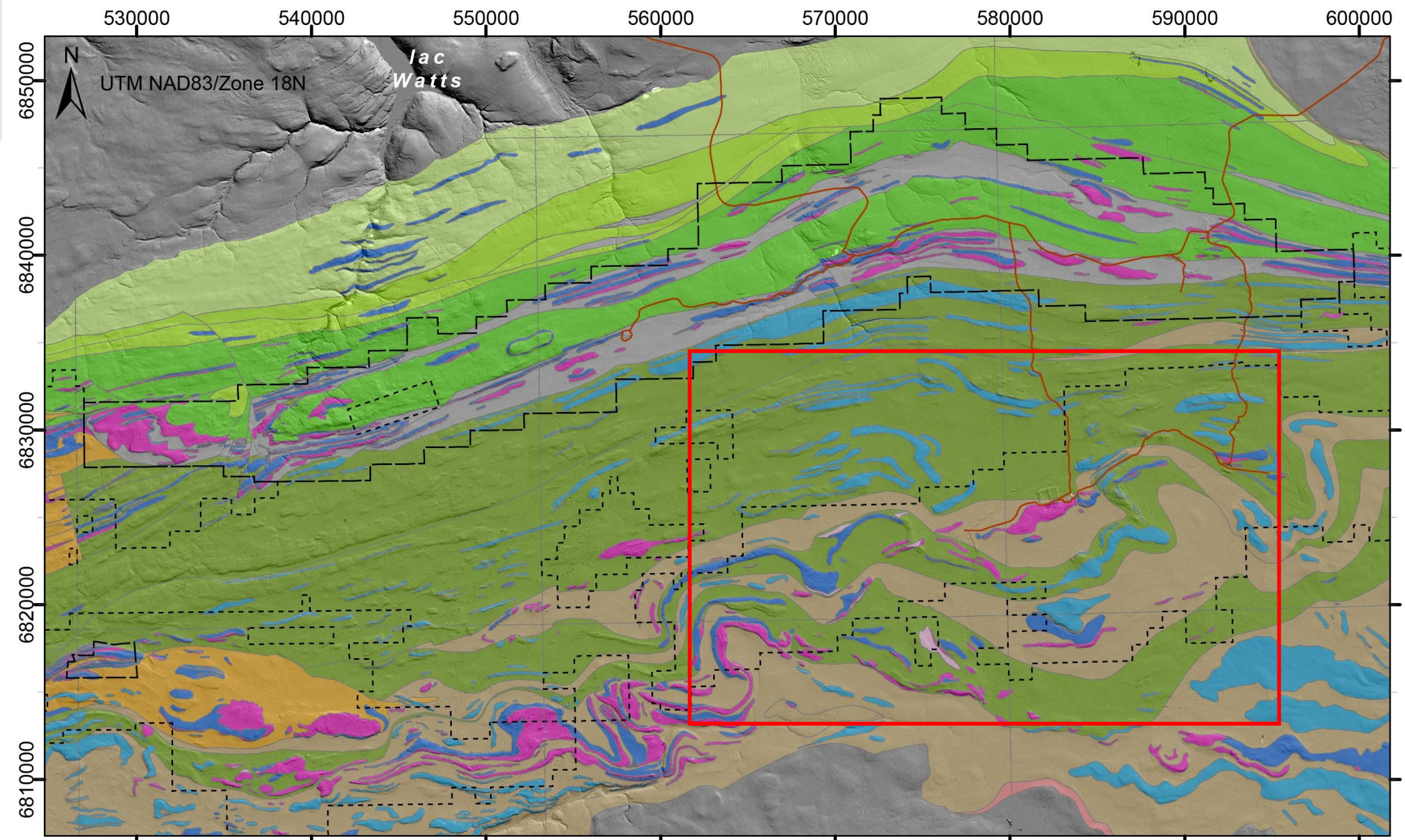


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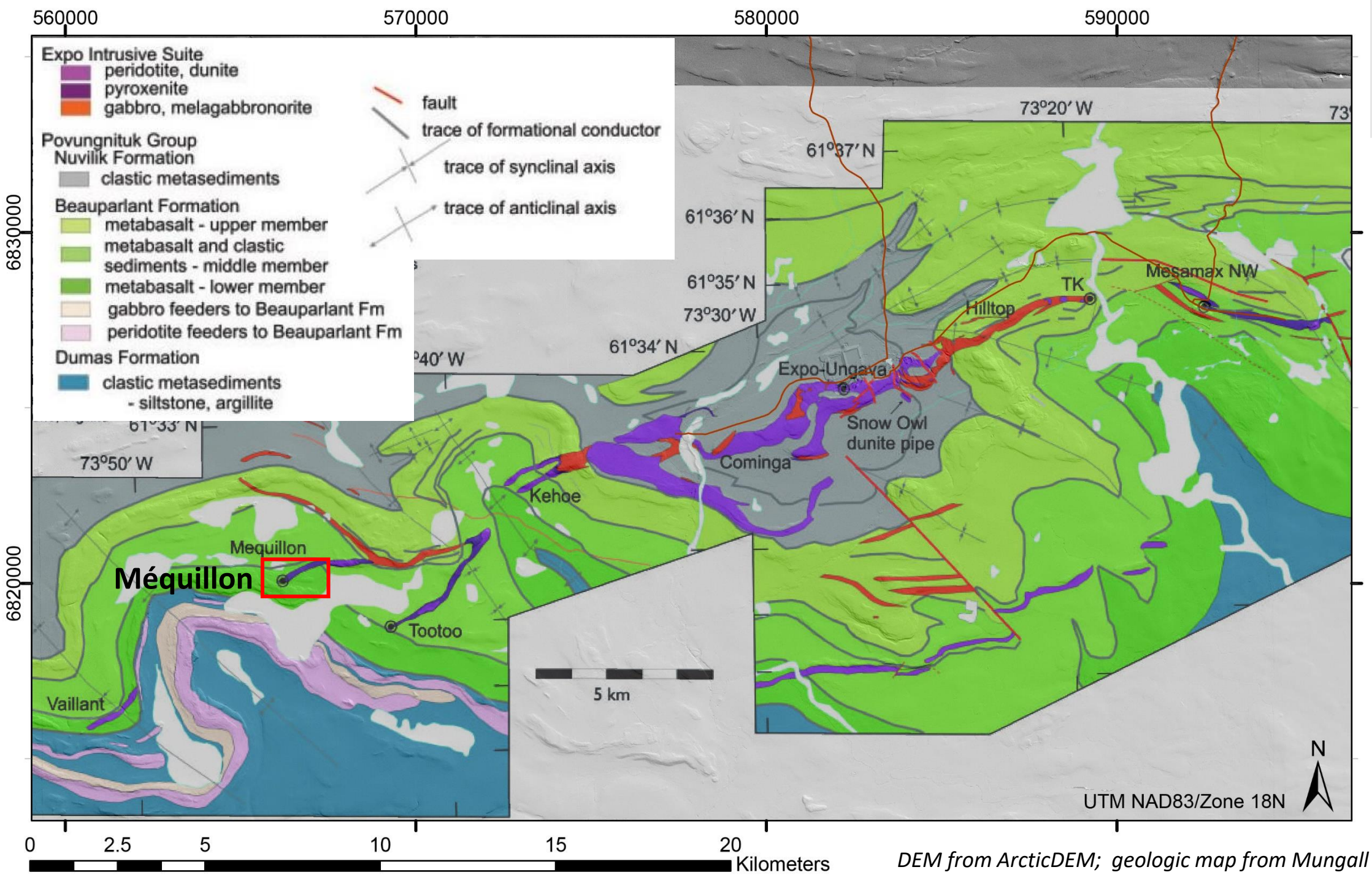
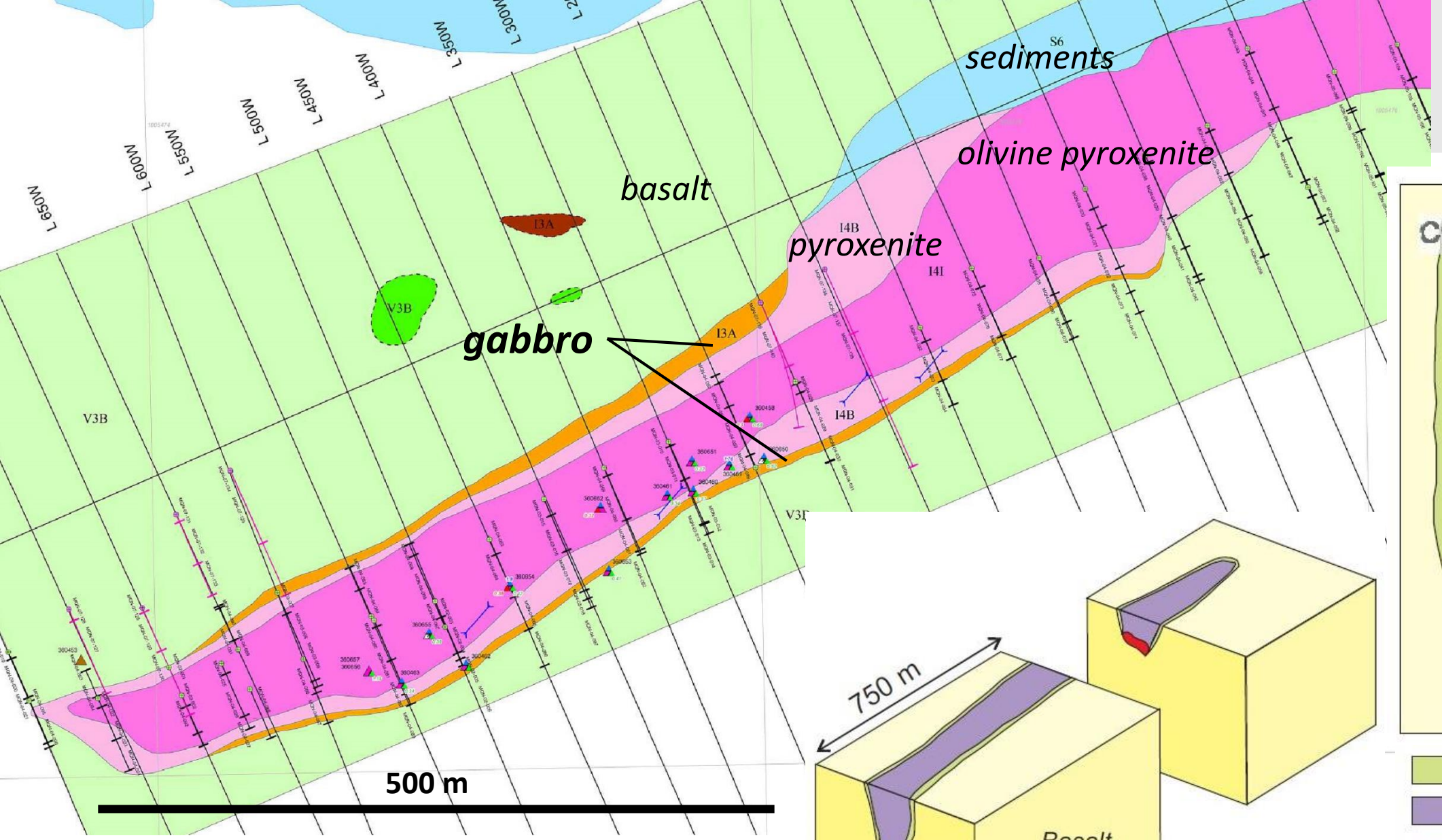
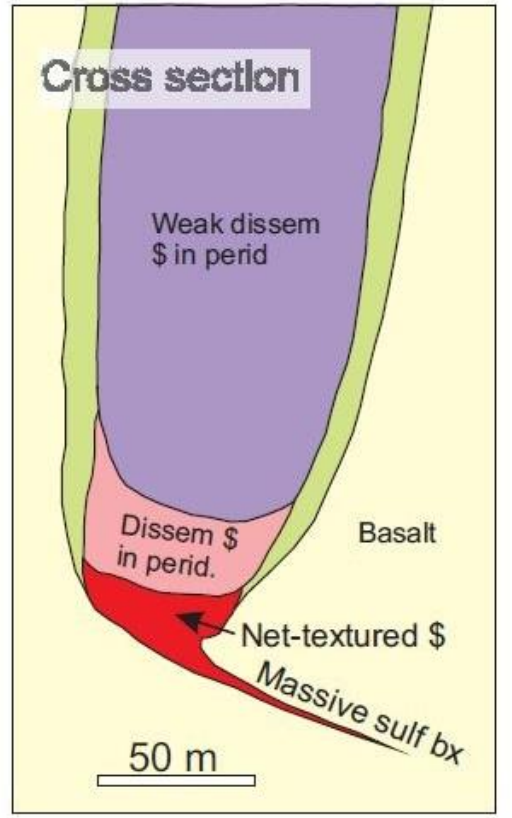



**Expo**
Cu-Ni-(PGE)
bladed dykes

*DEM from ArcticDEM; geologic map from Mungall (2007, JPET fig. 2)*





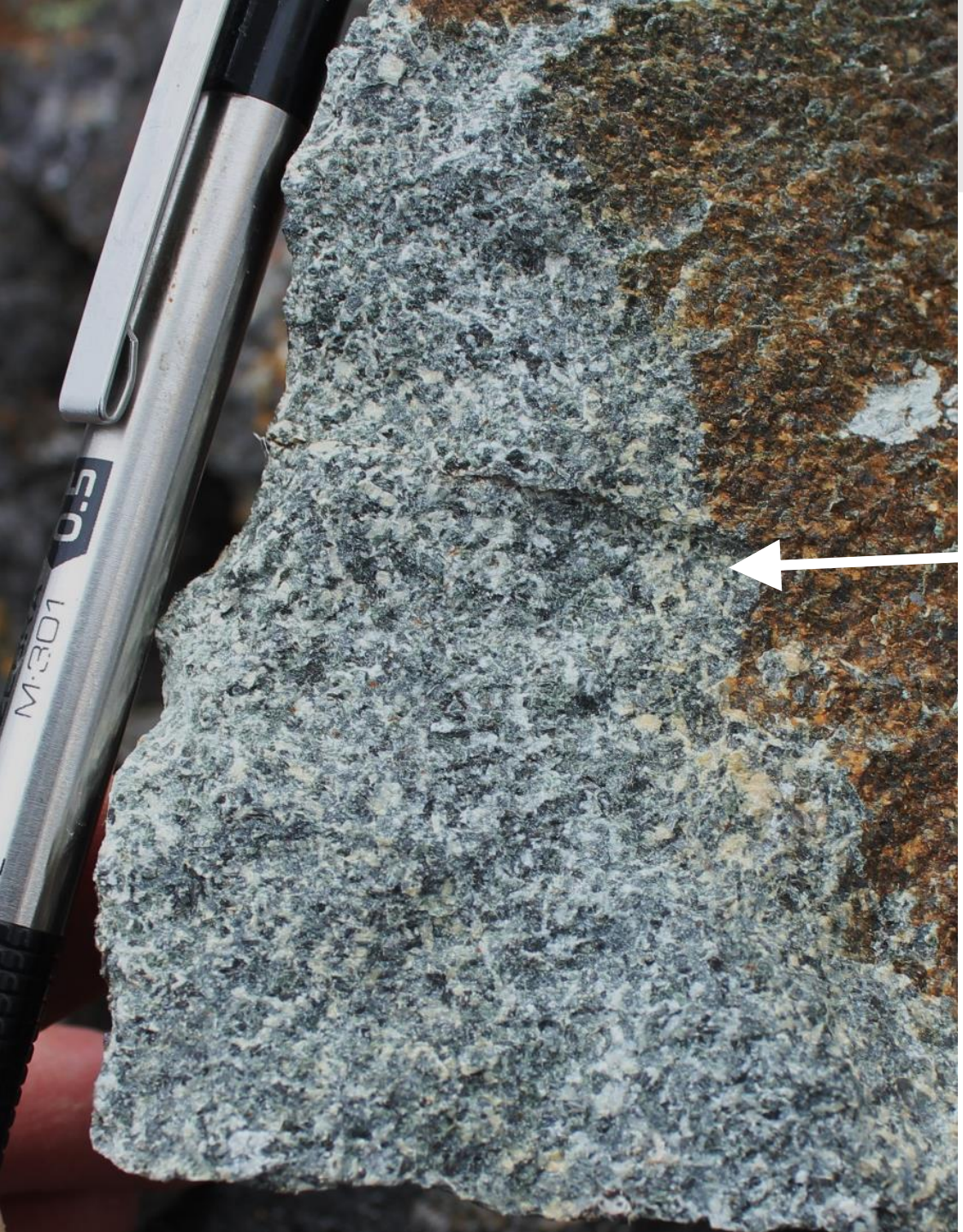


Mafic intrusive rocks
Ultramafic +olivine-rich cumulates
Dissem+matrix sulfides
Massive + bx sulfides
Country rocks

*Geologic map from GM64611 map no. 15 (Canadian Royalties assessment report, 2009)*

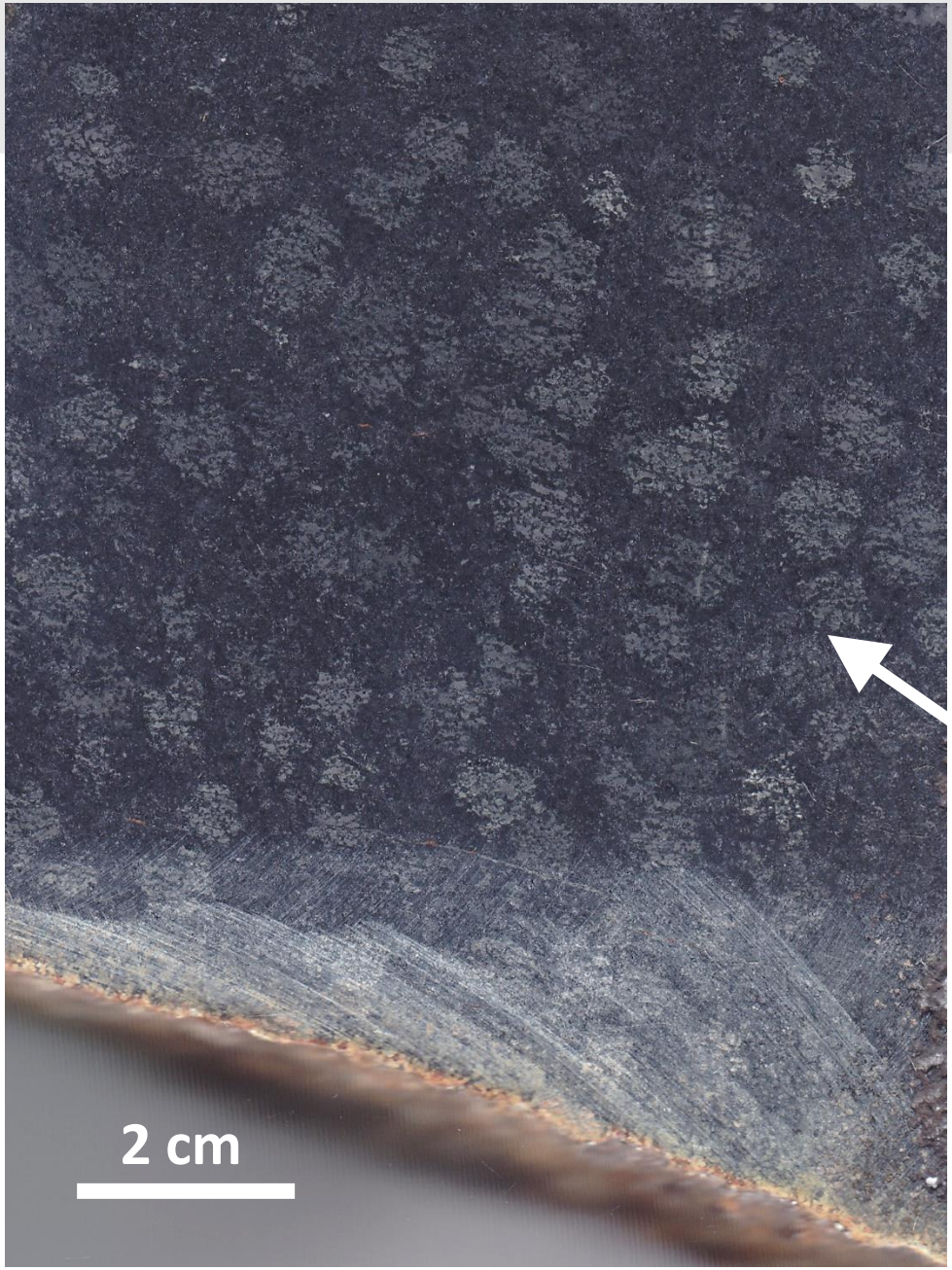
*Barnes and Mungall (2018, Economic Geology fig. 1A)*

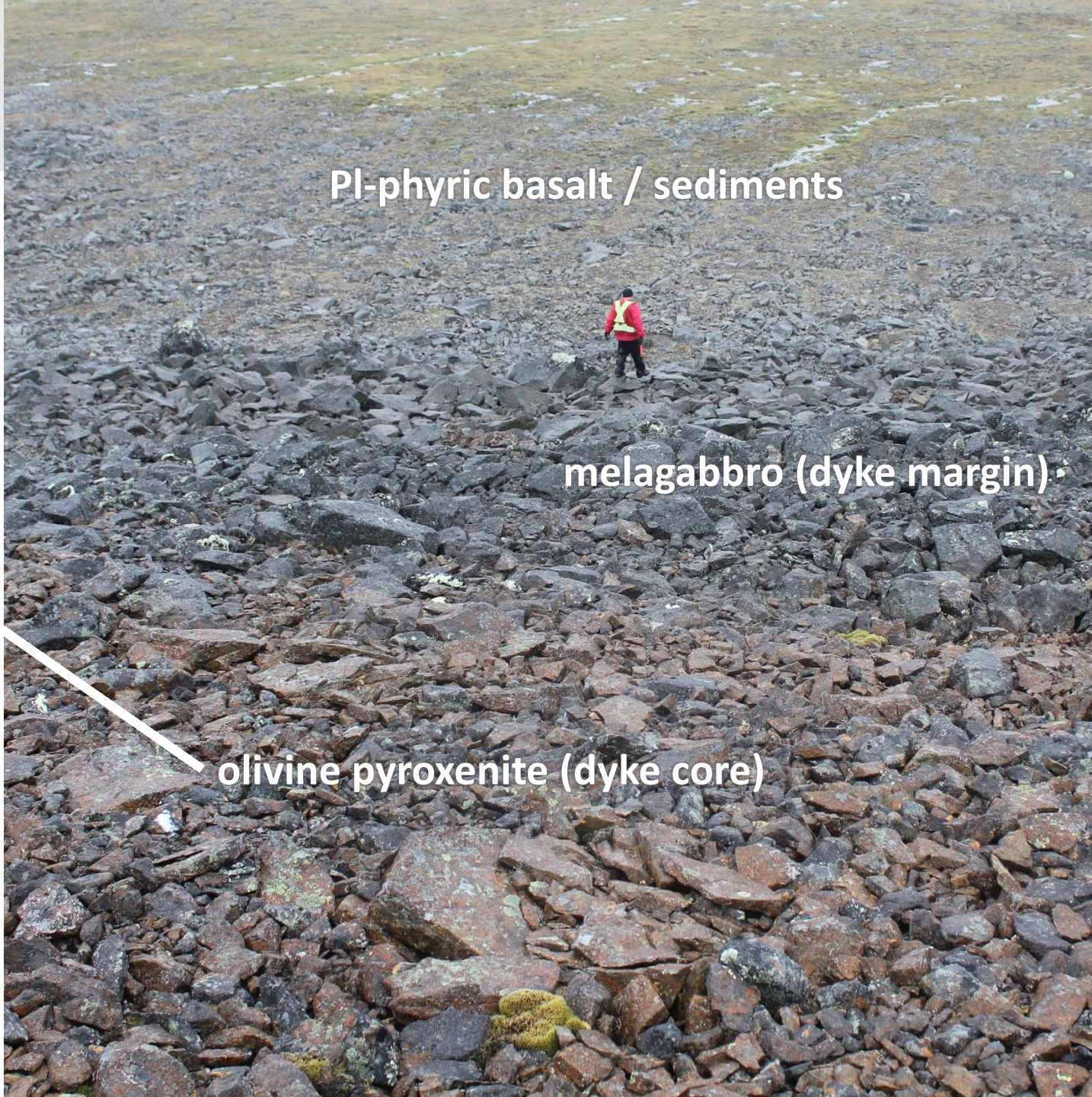
**Méquillon bladed dyke, Expo-Ungava trend**

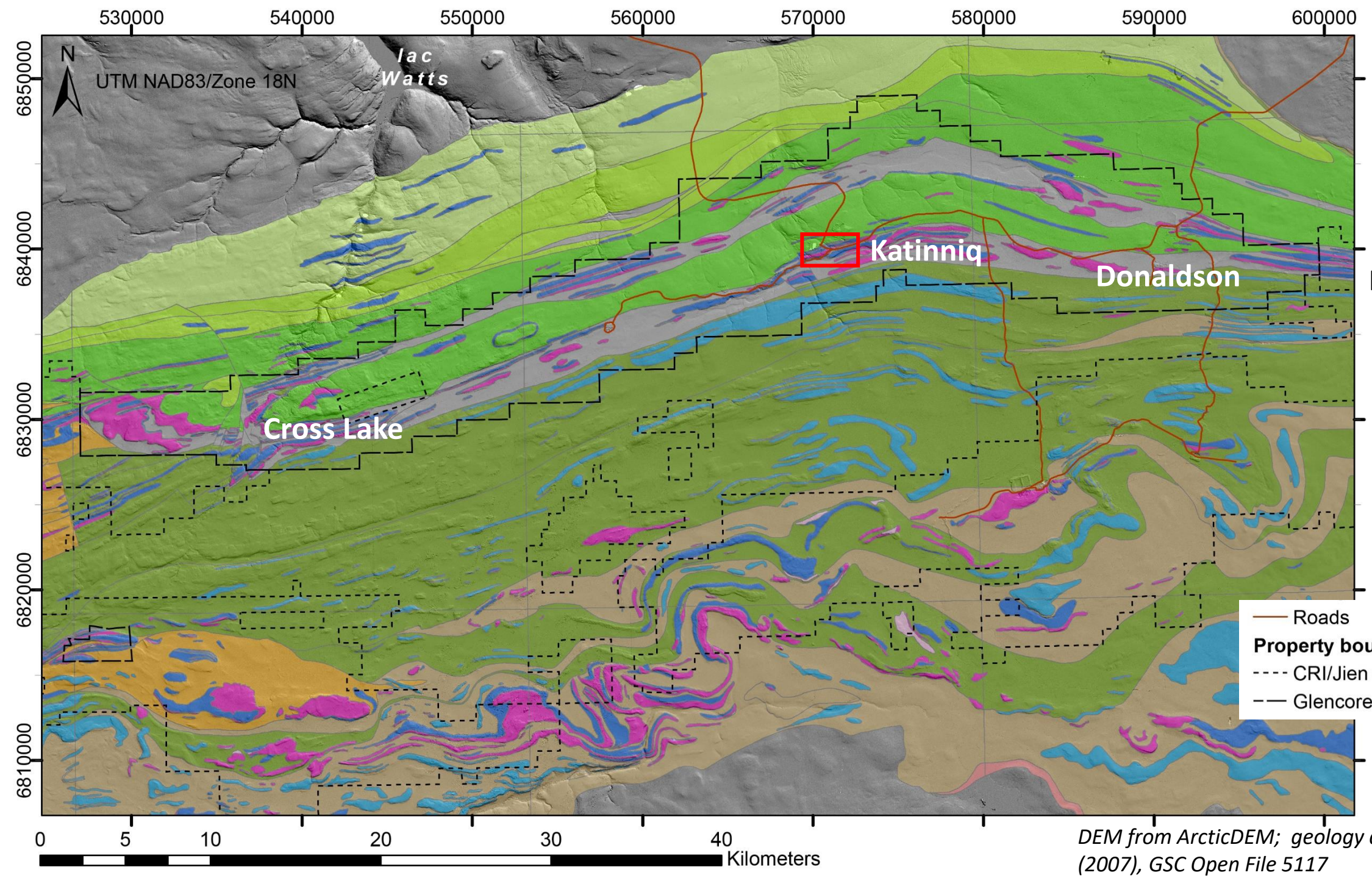



Pl-phyric basalt / sediments
melagabbro (dyke margin)
olivine pyroxenite (dyke core)


Pl-phyric basalt / sediments
melagabbro (dyke margin)
olivine pyroxenite (dyke core)
Canon


2 cm

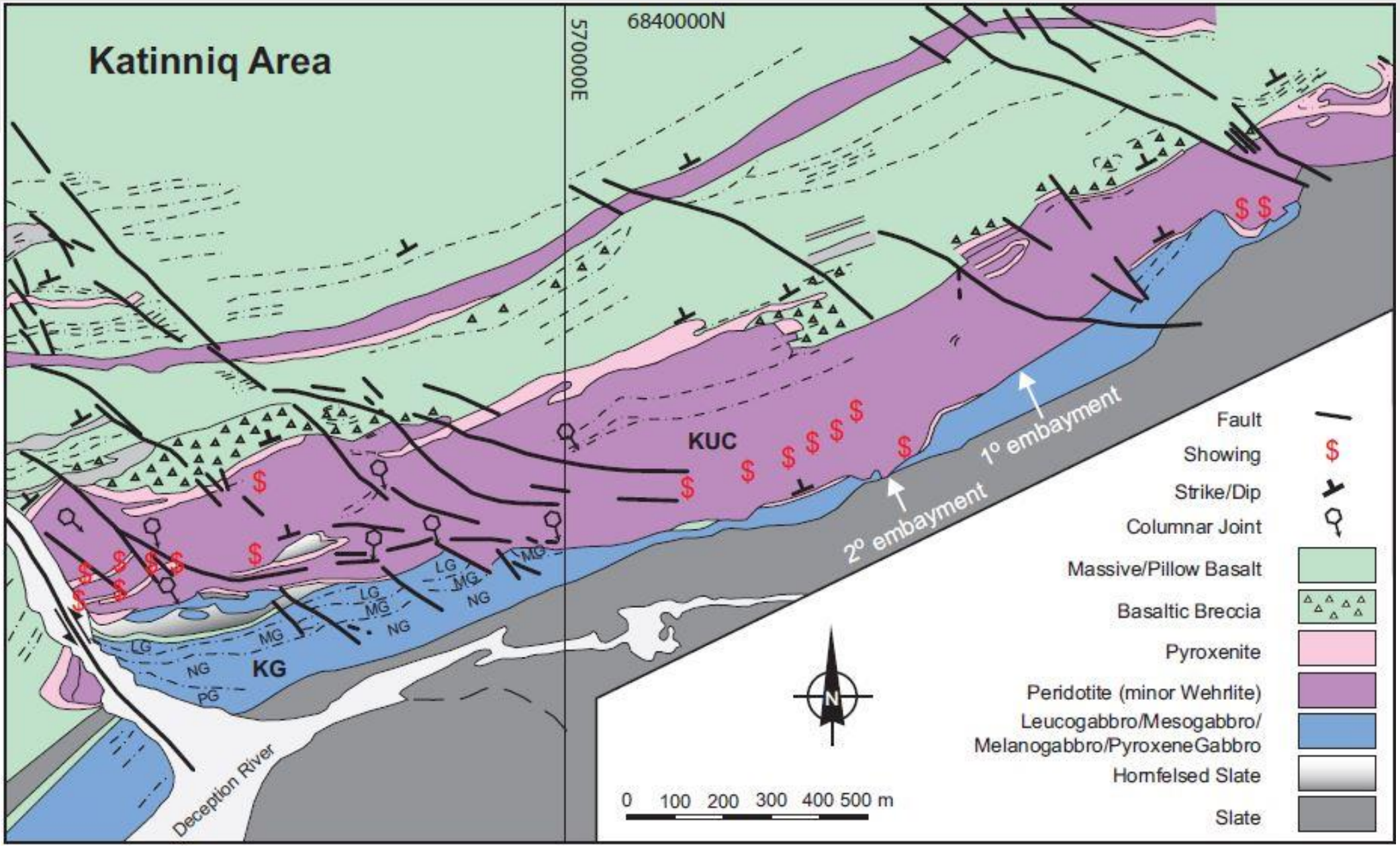

Pl-phyric basalt / sediments
melagabbro (dyke margin)
olivine pyroxenite (dyke core)




**Raglan**

Ni-Cu-(PGE) lava channels / conduits / sheet flows

*DEM from ArcticDEM; geology after St-Onge et al. (2007), GSC Open File 5117*




**peridotite** lava channels, mineralized embayments

*Lesher (2007, GAC-MDD) fig. 8*

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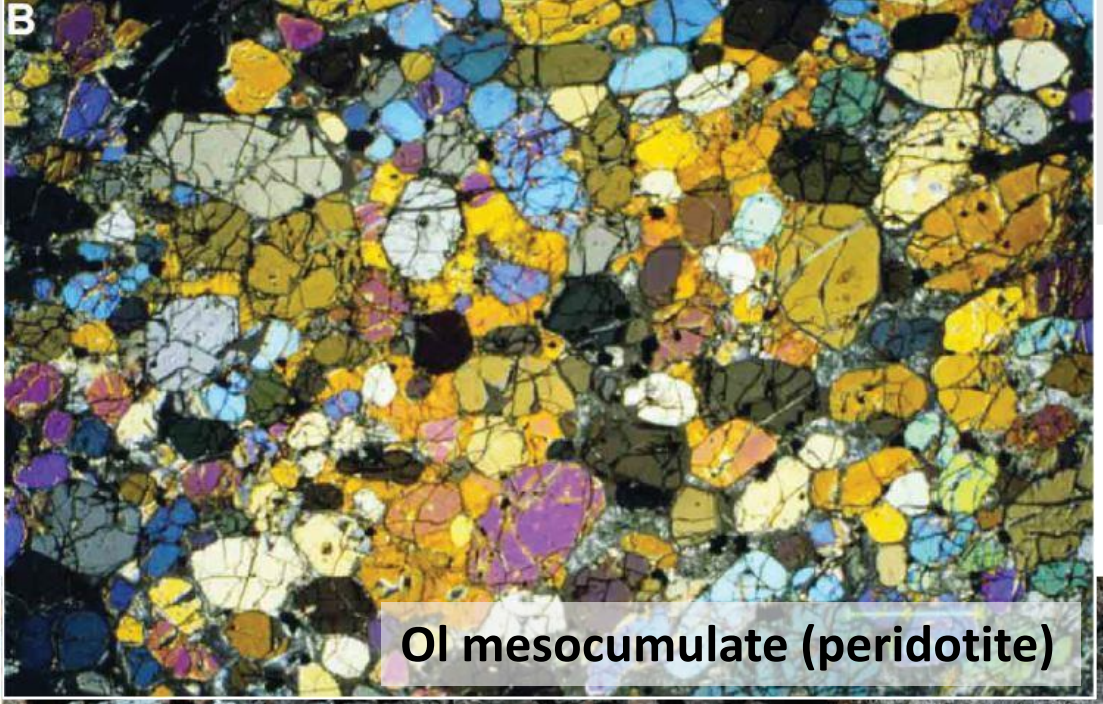


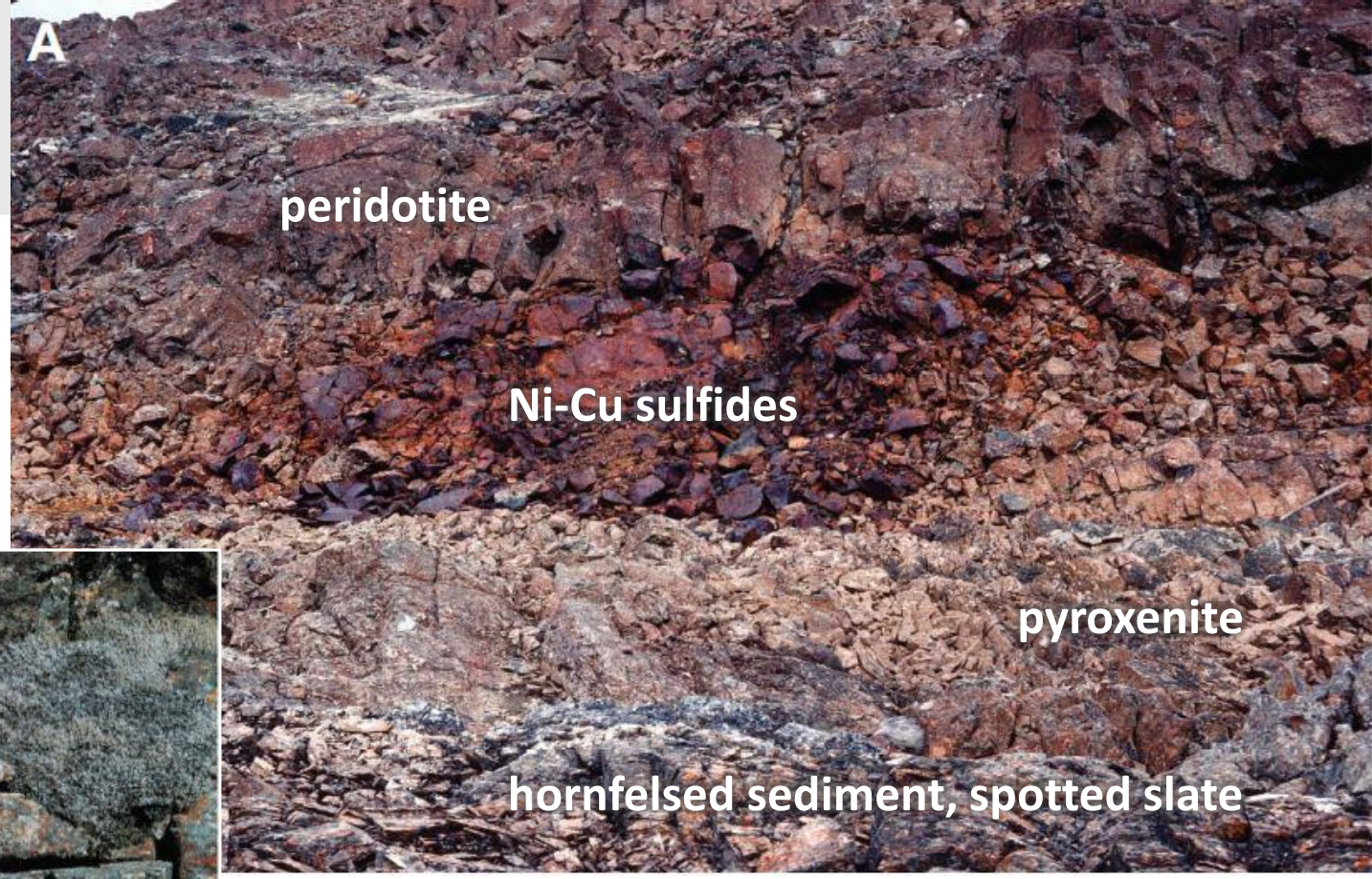


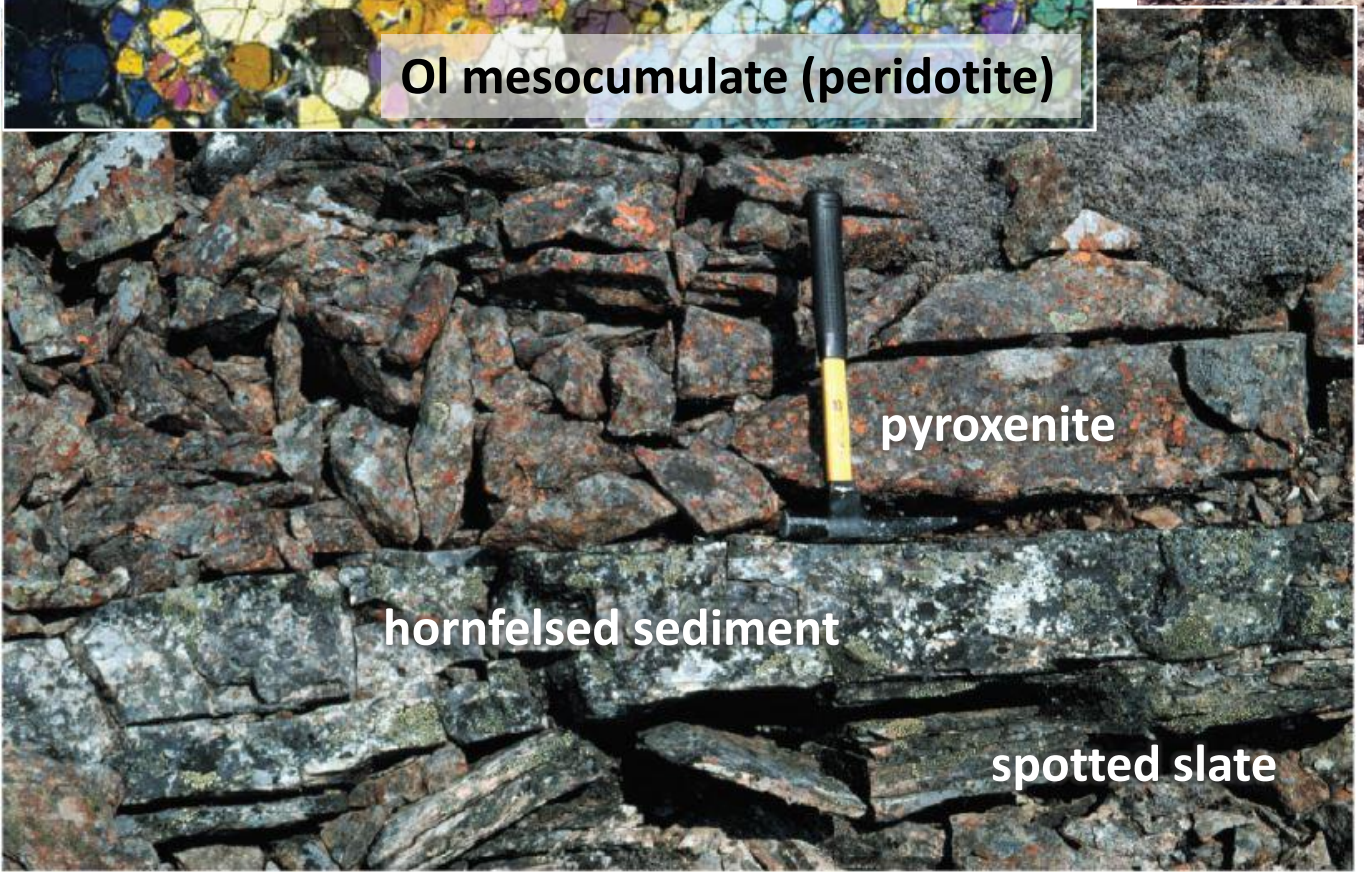


*Lesher (2007, GAC-MDD) figs. 4B, 4D, 19A*

## Katinniq lava channel/conduit facies

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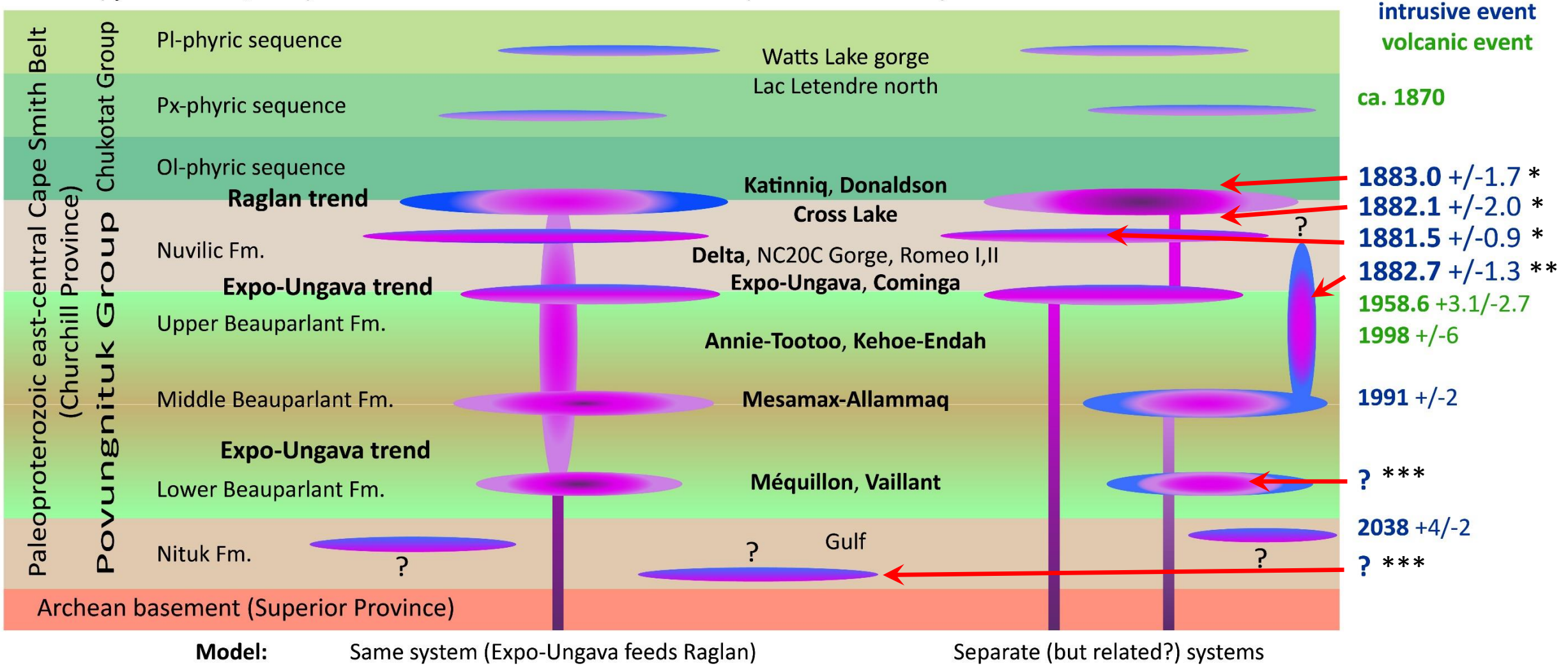


* Bleeker & Kamo (2018), *TGI 2017 Report of Activities.* ID-TIMS on chemically-abraded zircons
** Randall (2005), *U of Toronto MSc thesis.* Zircons, dissolution & mass spectrometer
*** ***This study (pending)***

**Lithological legend** for intrusive dikes/sills and extrusive/invasive lava channels/sheet flows:

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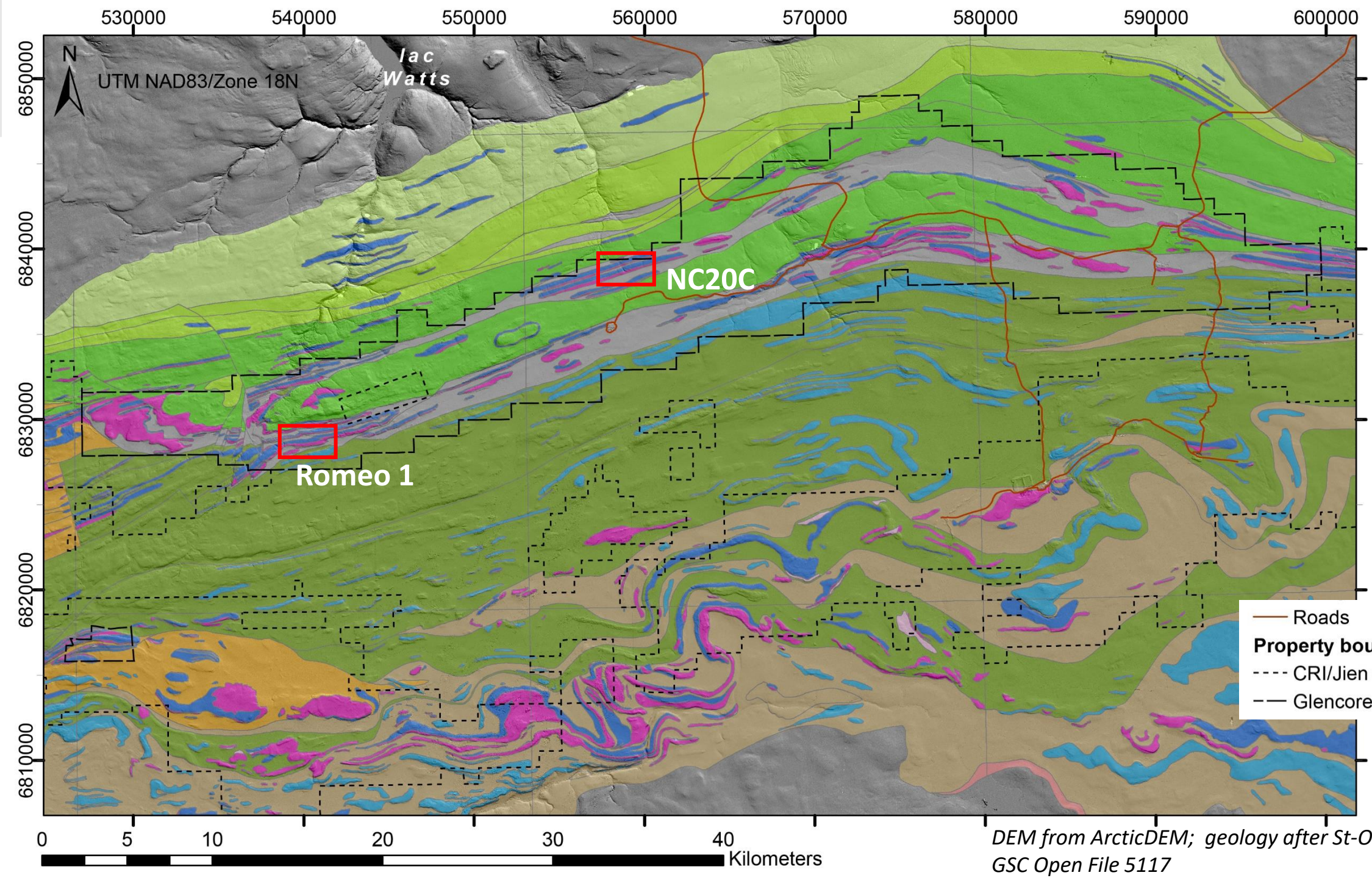
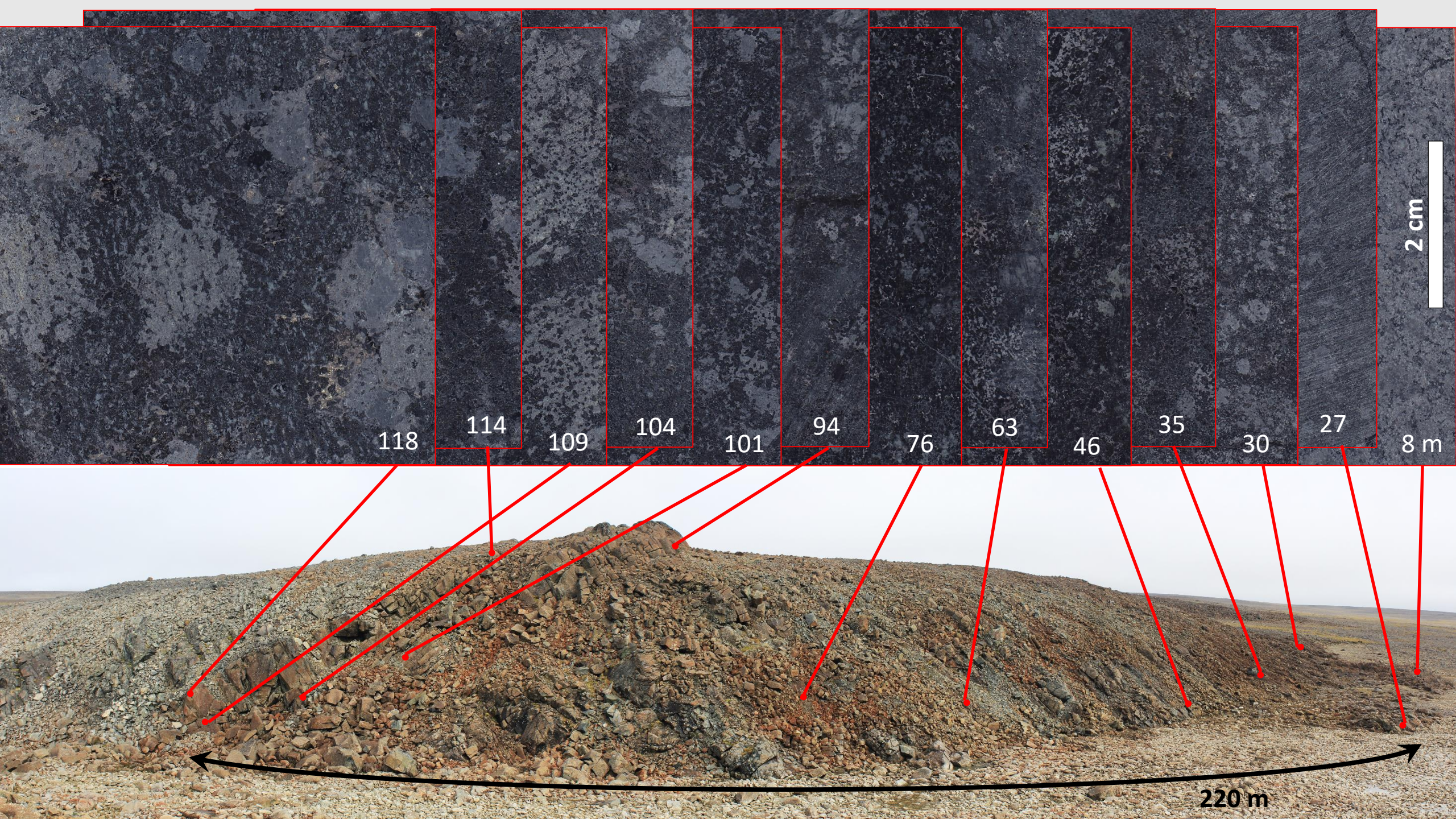


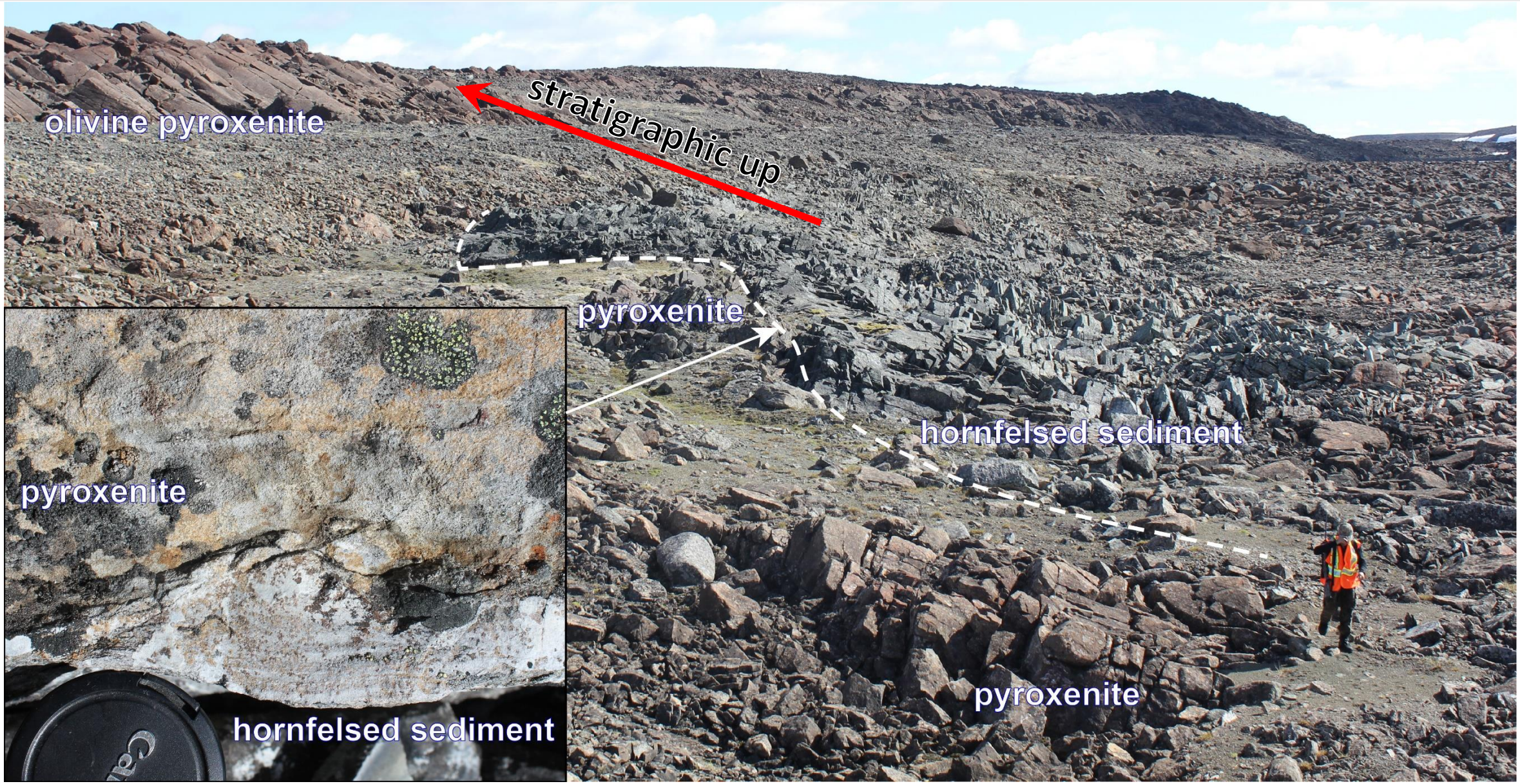

**Delta 'style'** subvolcanic differentiated sills

*DEM from ArcticDEM; geology after St-Onge et al. (2007), GSC Open File 5117*

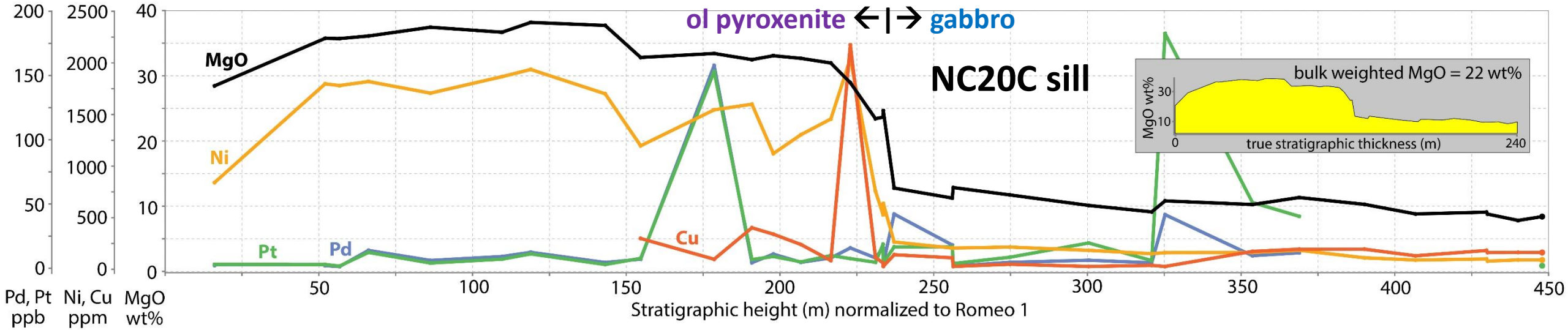
# NC20C ultramafic-mafic differentiated sill

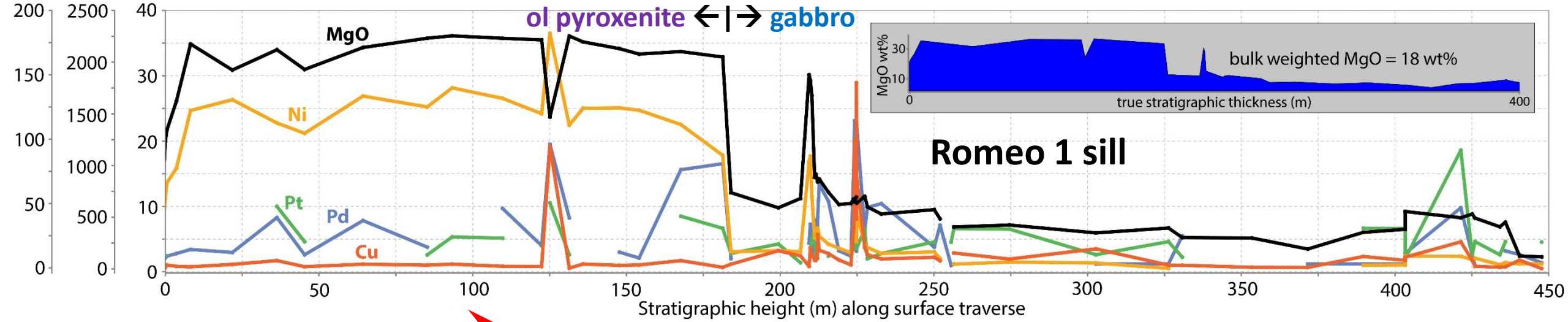

118
114
109
104
101
94
76
63
46
35
30
27
8 m
2 cm
220 m

# Romeo 1 ultramafic-mafic differentiated sill (lower part)



# NC20C vs. Romeo 1 ultramafic-mafic differentiated sills




stratigraphic up

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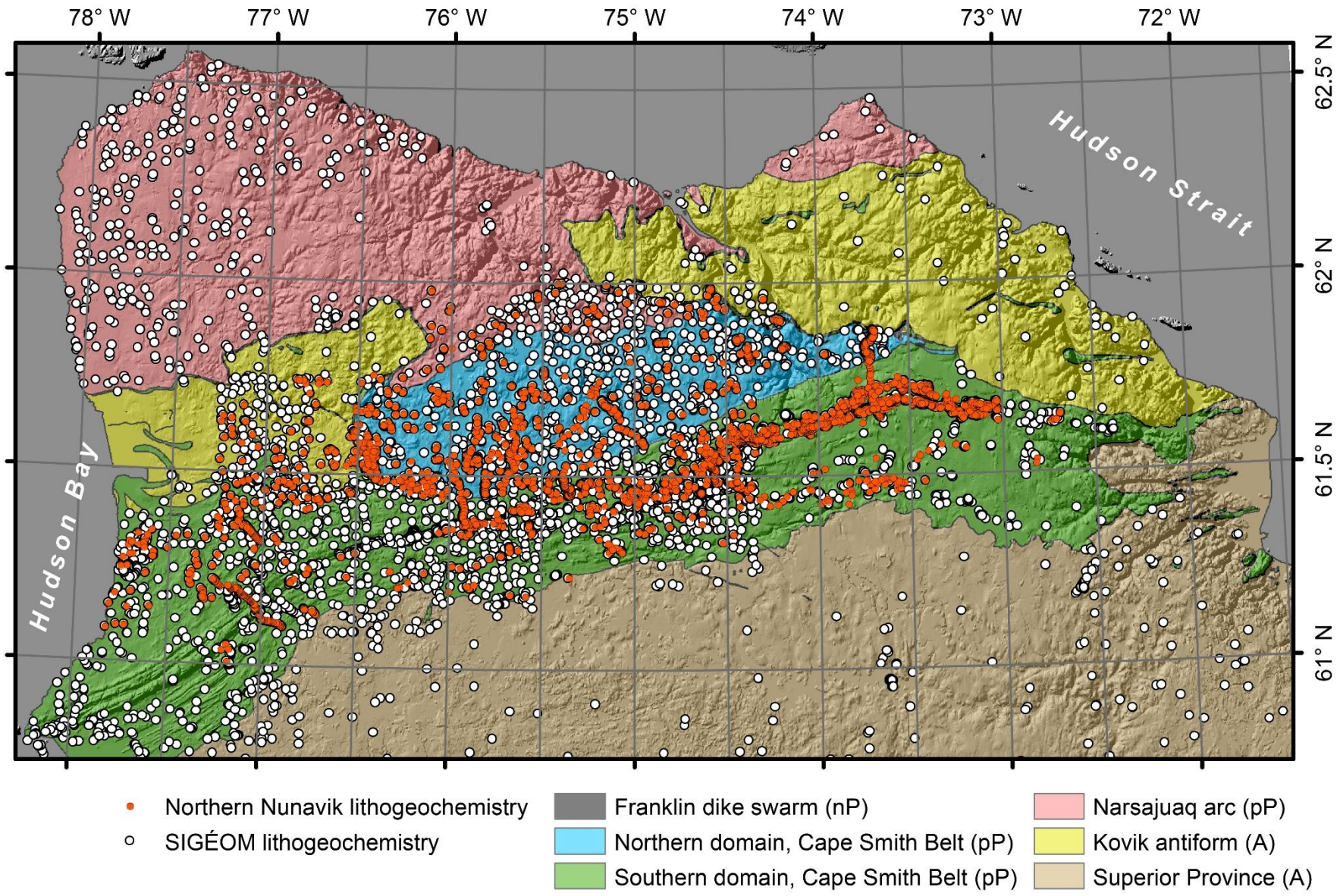
# Regional Cape Smith Belt geochemistry compilation




## Regional whole-rock lithogeochemistry

- Major ± trace elements
- >9600 sample records
  - ~100 unique sources
  - ~7100 public/pending
  - ~8200 CSB S. Domain
- Additionally, ~15000 samples from SIGÉOM above lat. 60°N
  - undergoing validation

*Next:* mineral geochemistry

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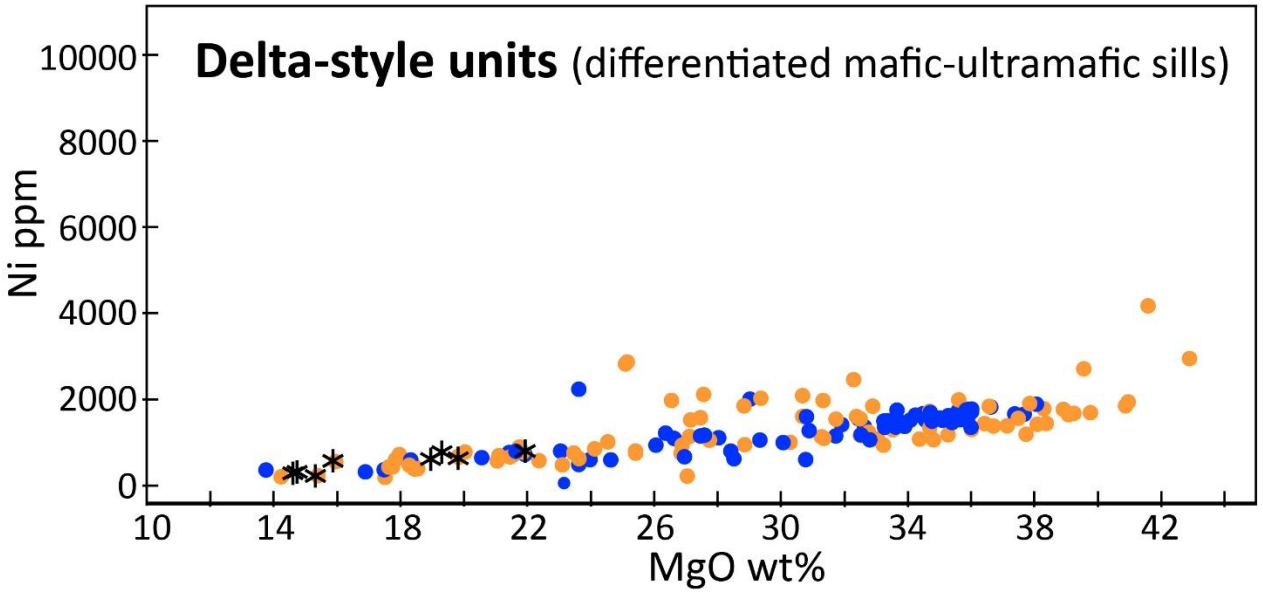
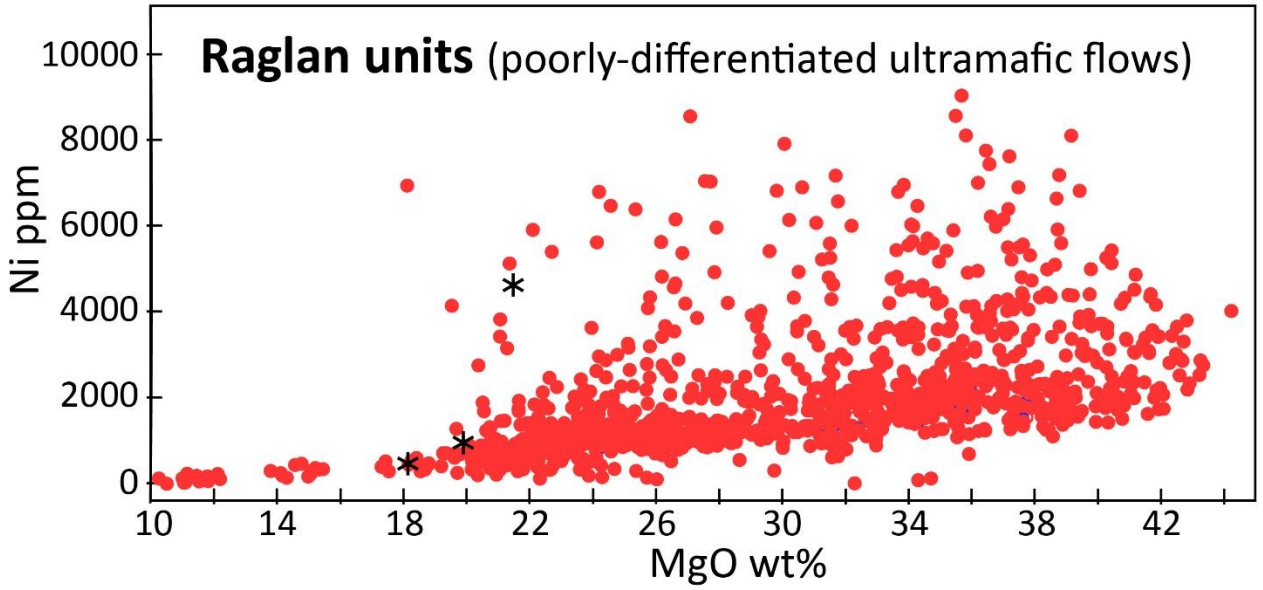
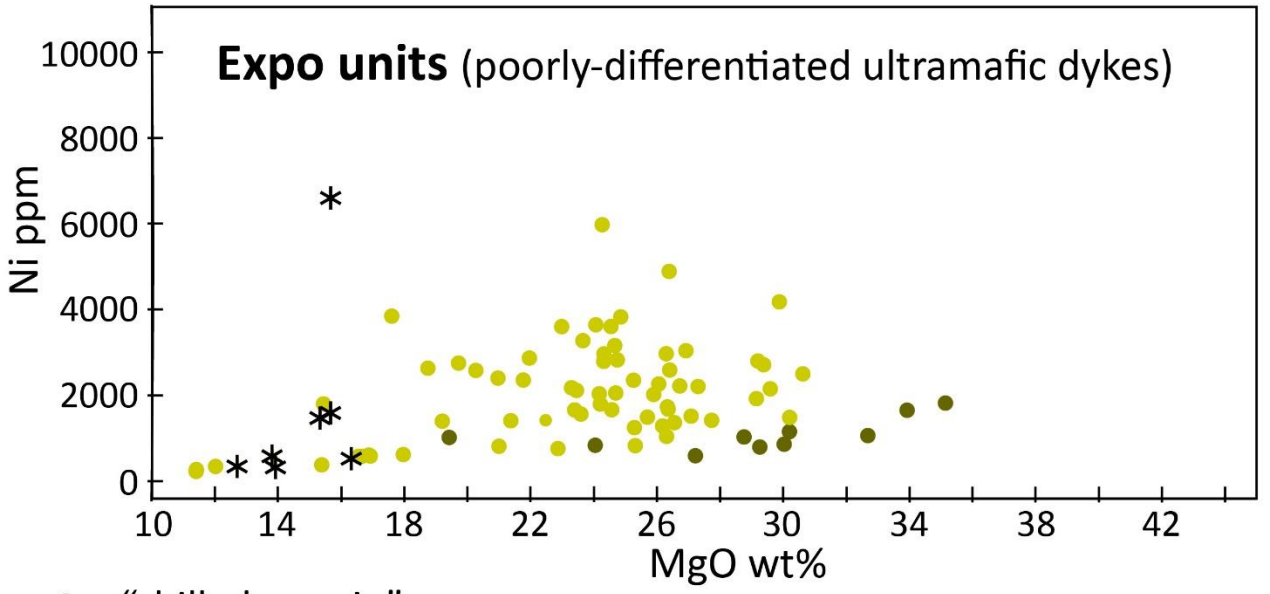
# **Ultramafic rocks** (pyroxenite – olivine pyroxenite – peridotite)




*filtered to <3 wt% S*

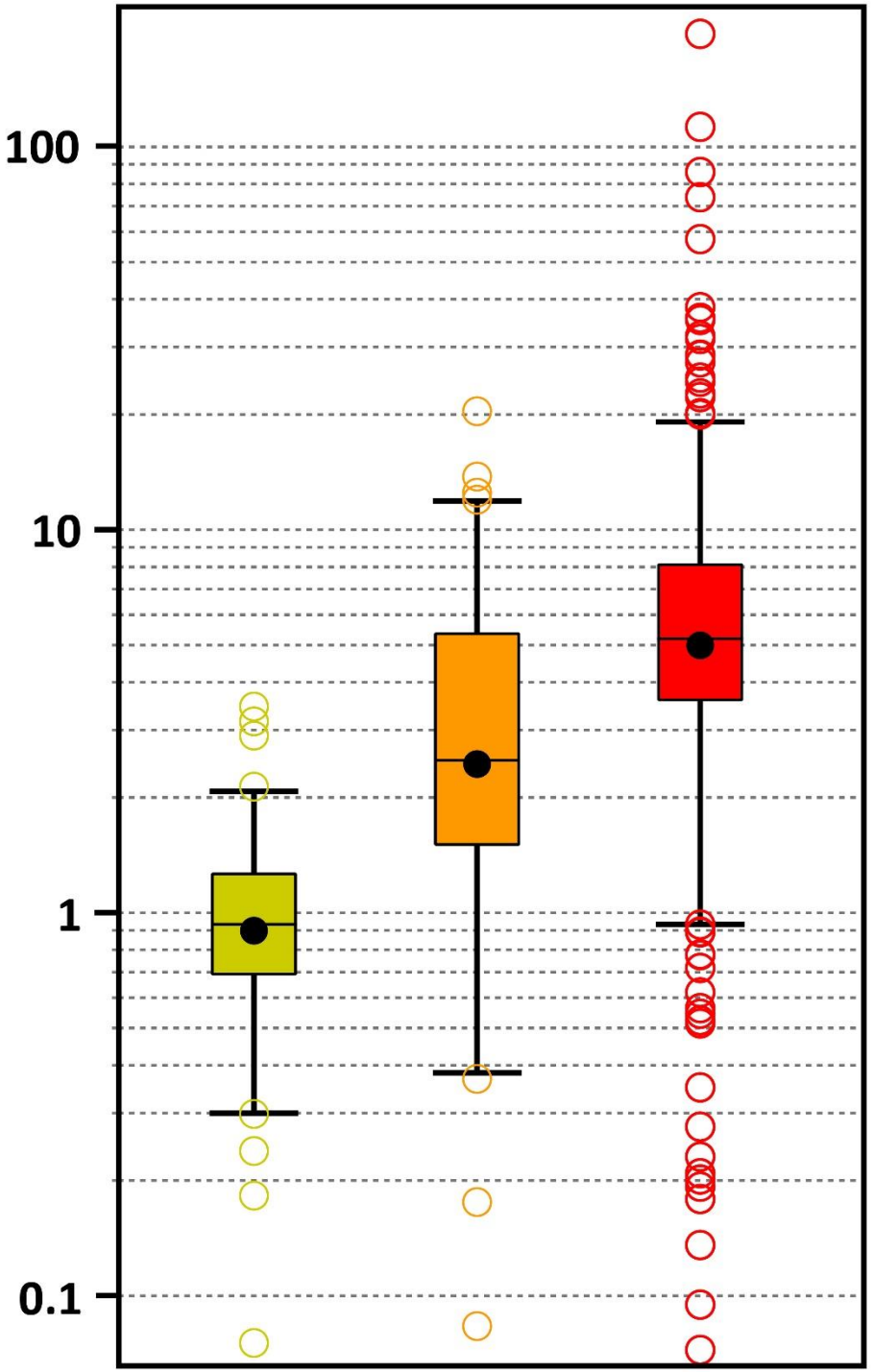


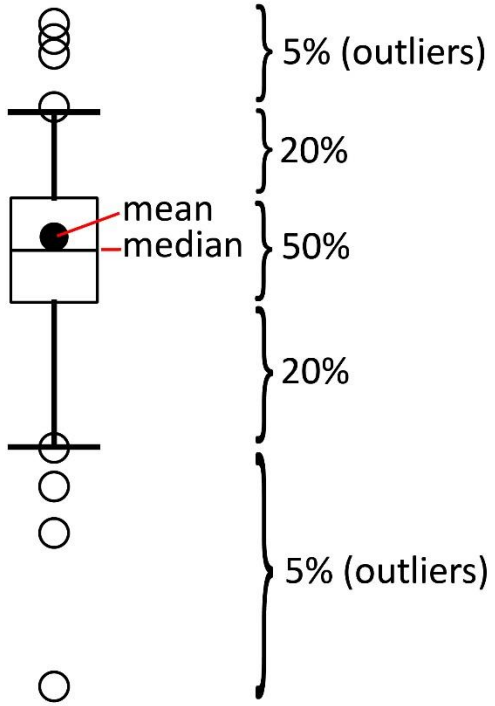

✱ = "chilled margin"

- Delta
- Romeo 1 and 2, NC20C gorge, Tiriganiaq
- Vaillant, Méquillon, Tootoo, Mesamax, TK deposit, Hilltop
- Expo-Ungava
- Cross Lake, East Lake (Kikialik), Zone 2-3 (Mines 2 & 3), Katinniq, Quakimajurq, Zone 13-14, West Boundary, Boundary, Donaldson

Raglan *cumulates* ***more magnesian*** than Expo
Raglan *margins* ***more magnesian*** than Expo

# Ni/Cu percentile box plot, mineralized samples



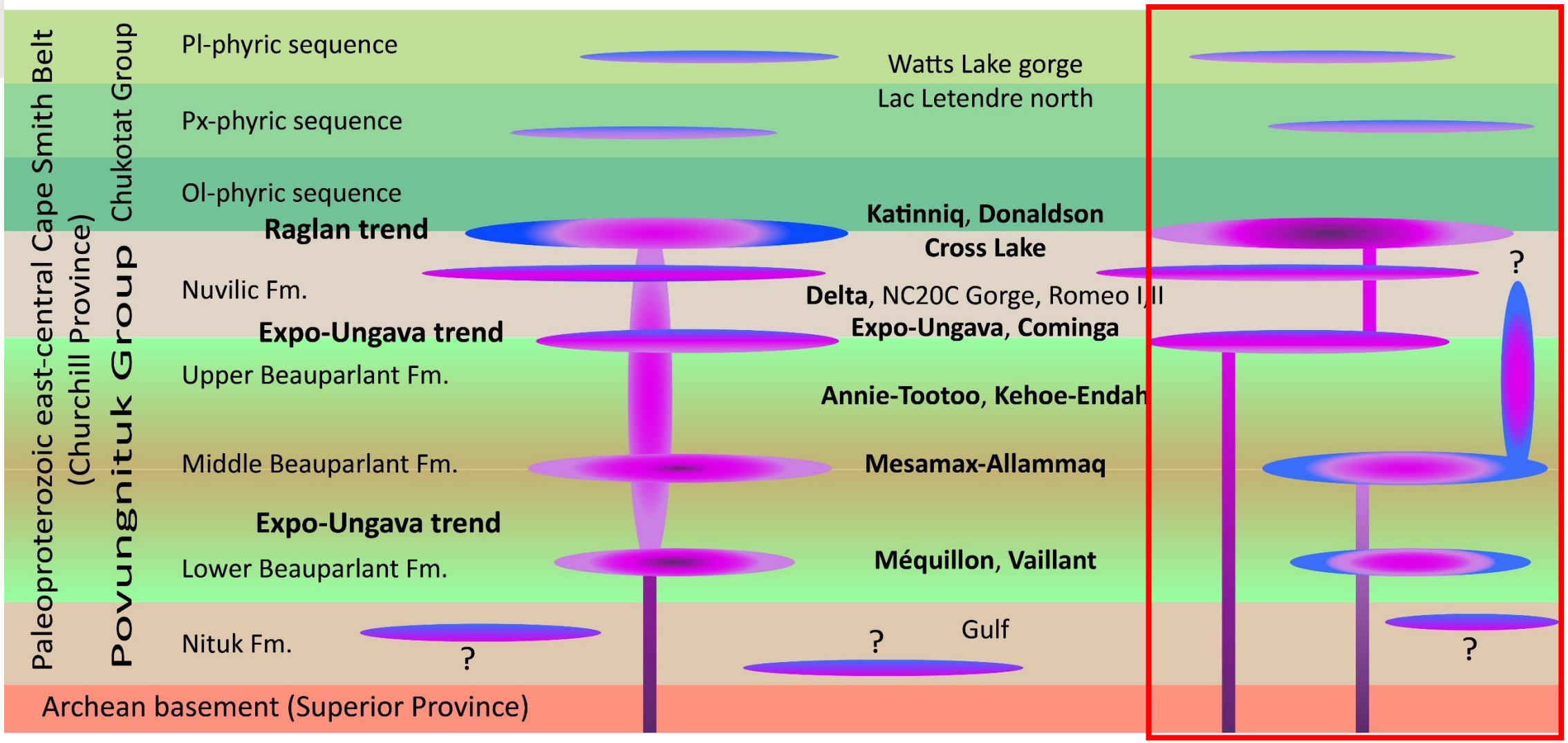

Ores of Expo units have significantly different Ni/Cu than ores of Raglan units.

**1.0 ± 0.4** (n=89) — **Expo units** (bladed dykes): Vaillant, Tootoo, TK deposit, Mesamax, Méquillon, Expo-Ungava

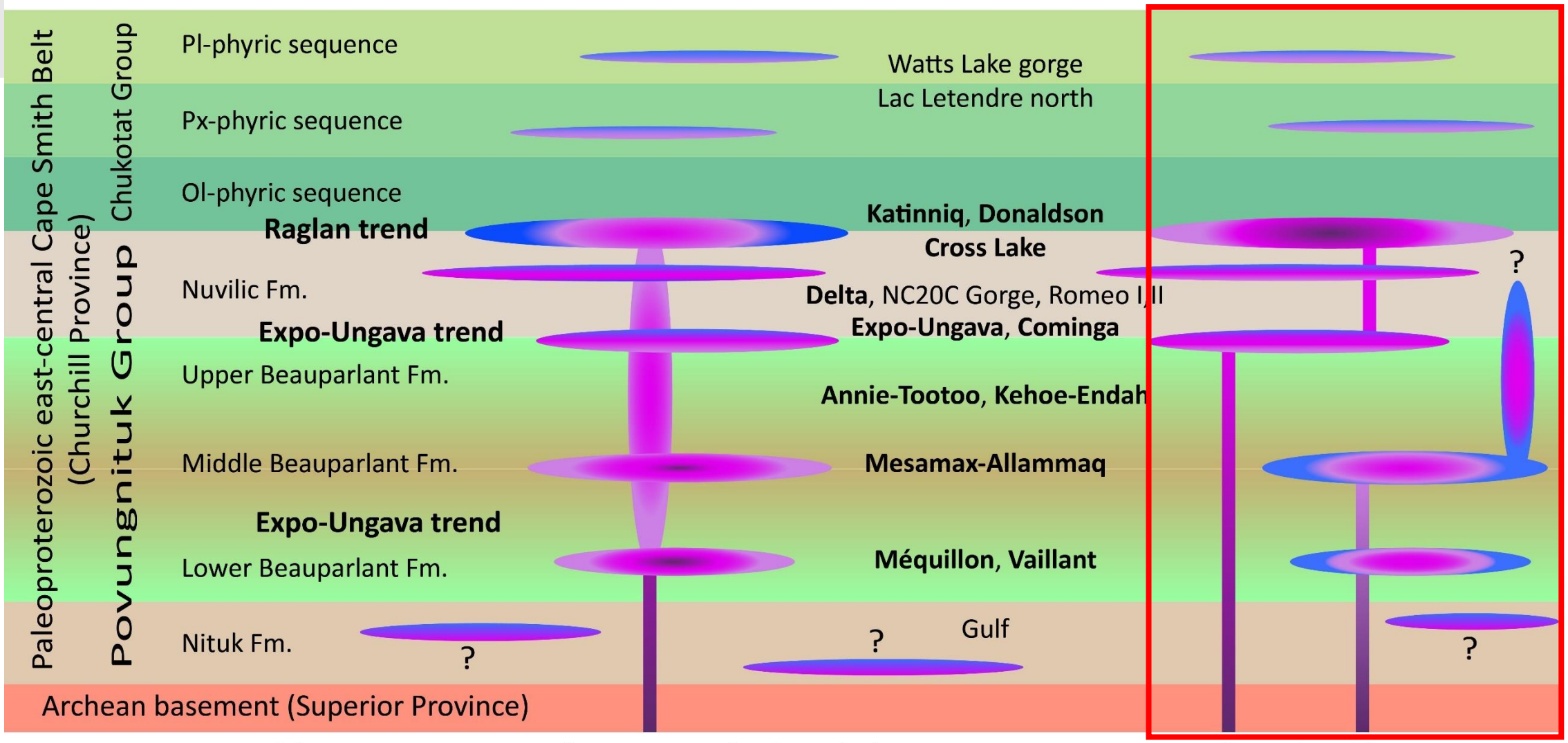
2.6 ± 2.0 (n=88) — **Delta** (differentiated sills)

**5.2 ± 3.1** (n=461) — **Raglan units** (lava channels / sheet flows): Boundary, West Boundary, Cross Lake, Donaldson, Katinniq, Zone 13-14, Zone 2-3, Zone 5-8, Kikialik

*Arithmetic mean ± 1 std dev, ignoring outliers*




| | | |
|---|---|---|
| **Model:** | Same system (Expo-Ungava feeds Raglan) | Separate (but related?) systems |
| **Expected observation:** | Systematic relationships, including: | No systematic relationships, or: |
| (observed in **bold**) | Raglan lower Mg (margins and cumulates) than Expo | **Raglan higher Mg (margins and cumulates) than Expo** |
| | Raglan lower Ni-Cu-PGE tenors than Expo | **Raglan higher Ni-Cu-PGE tenors than Expo** |
| | Raglan lower Ni/Cu than Expo | **Raglan higher Ni/Cu than Expo** |




Various parts of the magmatic plumbing system are **temporally & petrogenetically related**, BUT Expo parts are derived from **less magnesian magmas** with **lower Ni/Cu**, and cannot represent direct feeders to Raglan parts of the system.

# Thank you

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