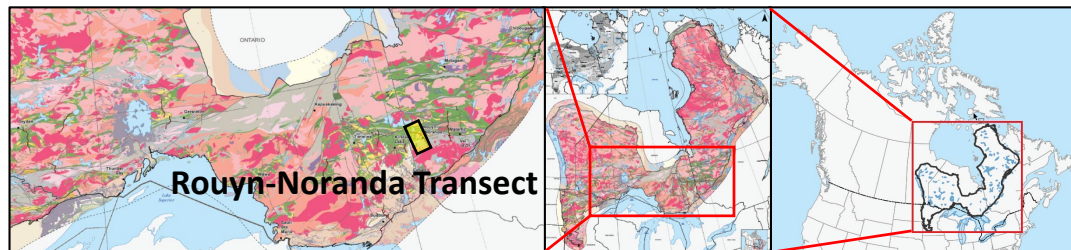
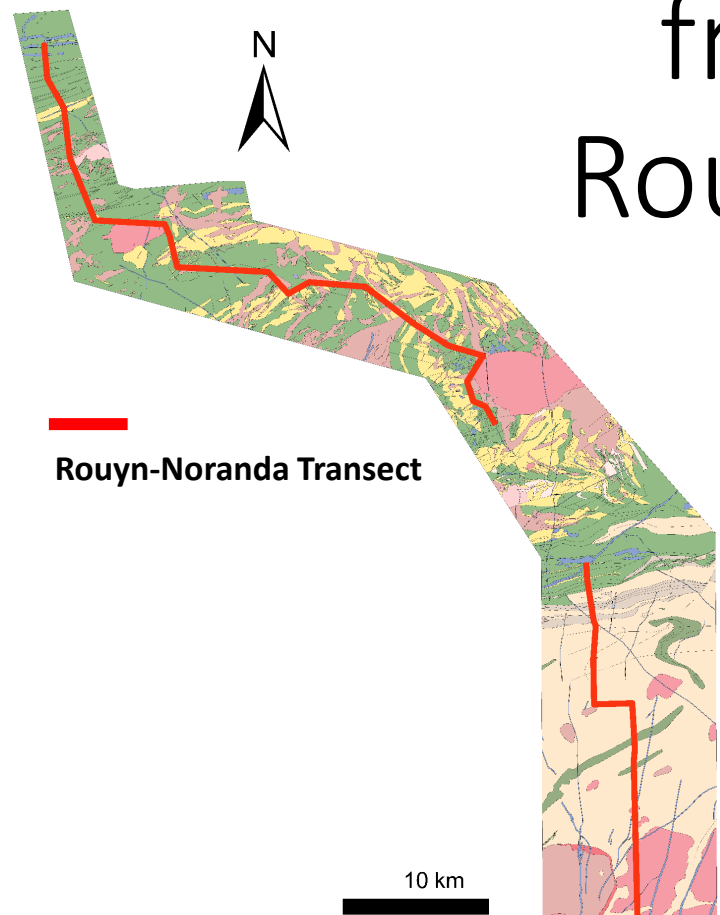


Overview and new findings from the Metal Earth Rouyn-Noranda Transect

MERC Short Course

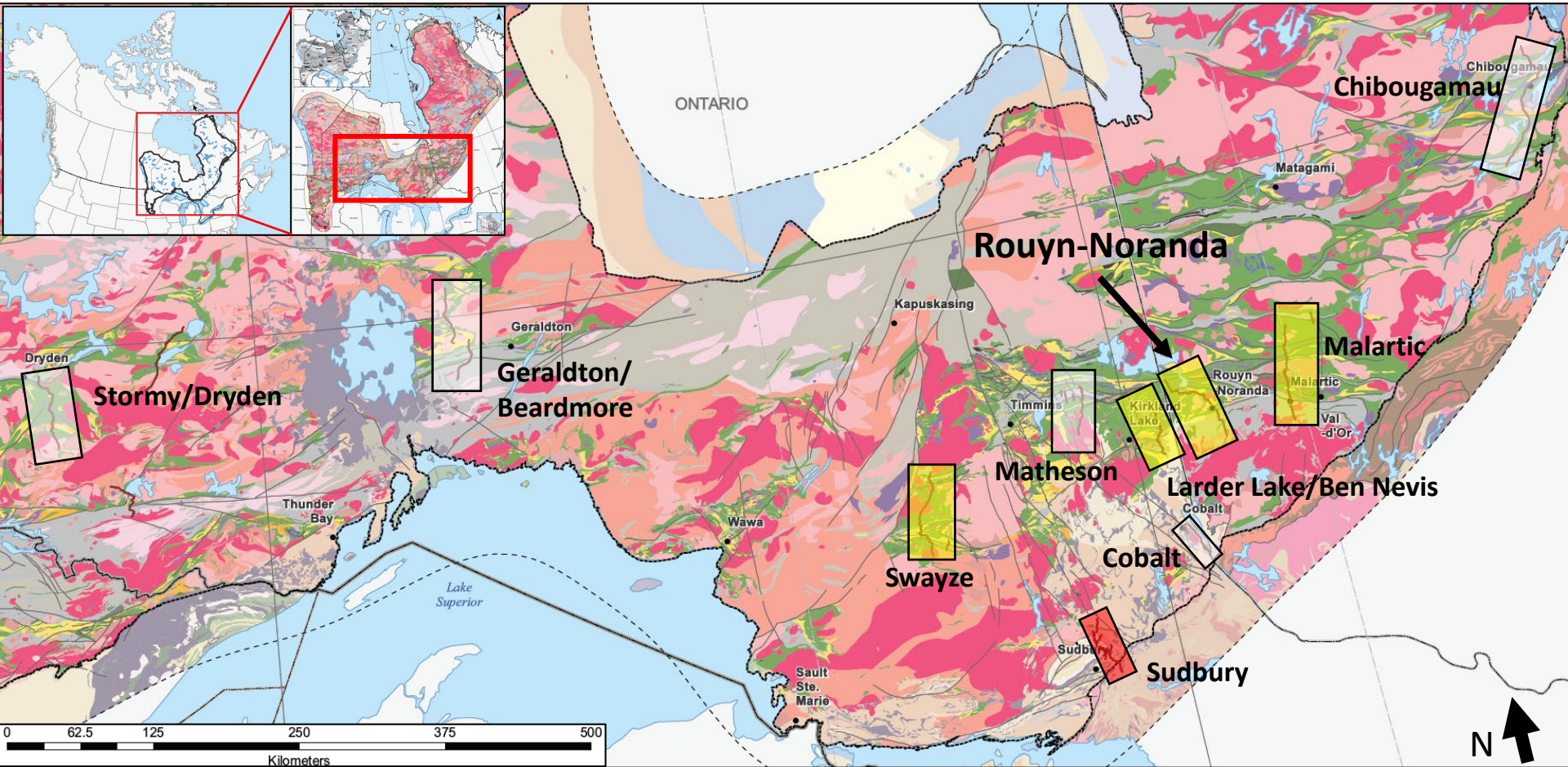
Thursday, October 18th, 2018

Taus R. C. Jørgensen



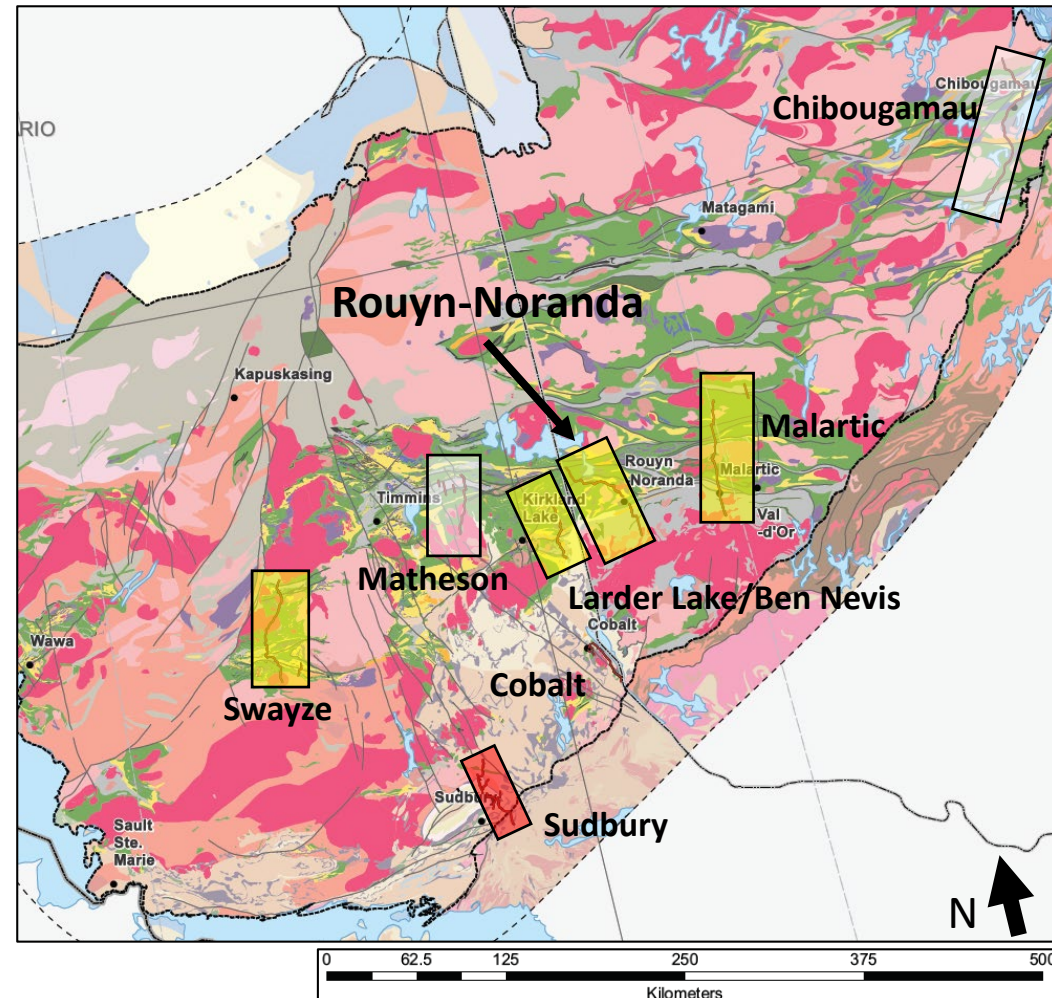
- Introduction
 - Location and research activities
- Transect overview
 - Stratigraphy
 - Structures
 - Mineralization
- Transect mapping
 - Transect and seismic section
- Transect projects
 - Kinojevis Group – new U-Pb zircon age and geochemistry
 - Powell Block
 - Emplacement mechanism for ultramafic and mafic rocks in the Pontiac Subprovince
 - New Zn occurrence in the Pontiac Subprovince

Location



Research activities

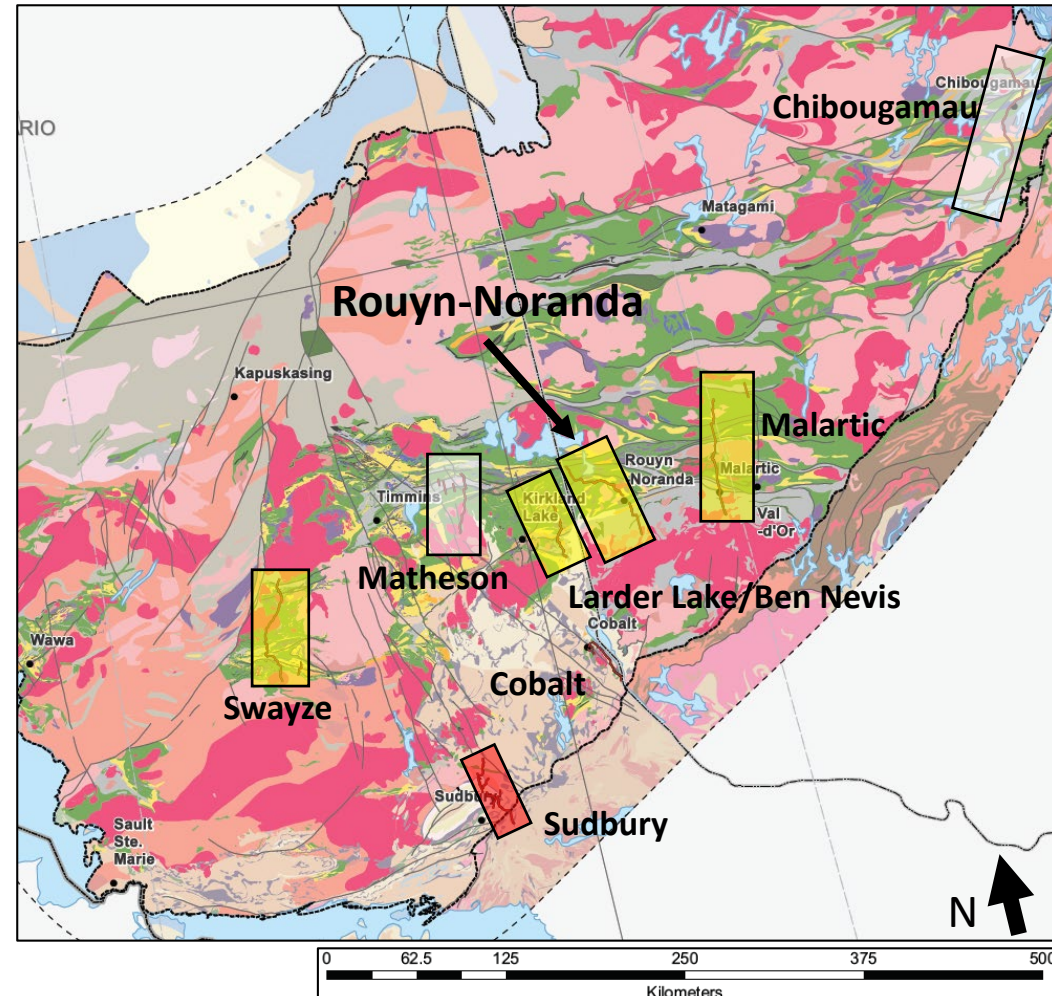
- **Collect geological data** (lithological, structural, geochemical, geochronological, mineralization, alteration, compile previous work)
- **Integrate** newly acquired geological and geophysical data (seismic, MT, gravity) with historical data, to produce a **crust to mantle cross-section** through the transect
- **Compare** the Rouyn-Noranda cross-section **to other transects** to **establish differences between endowed and less-endowed greenstone belts**



Research activities

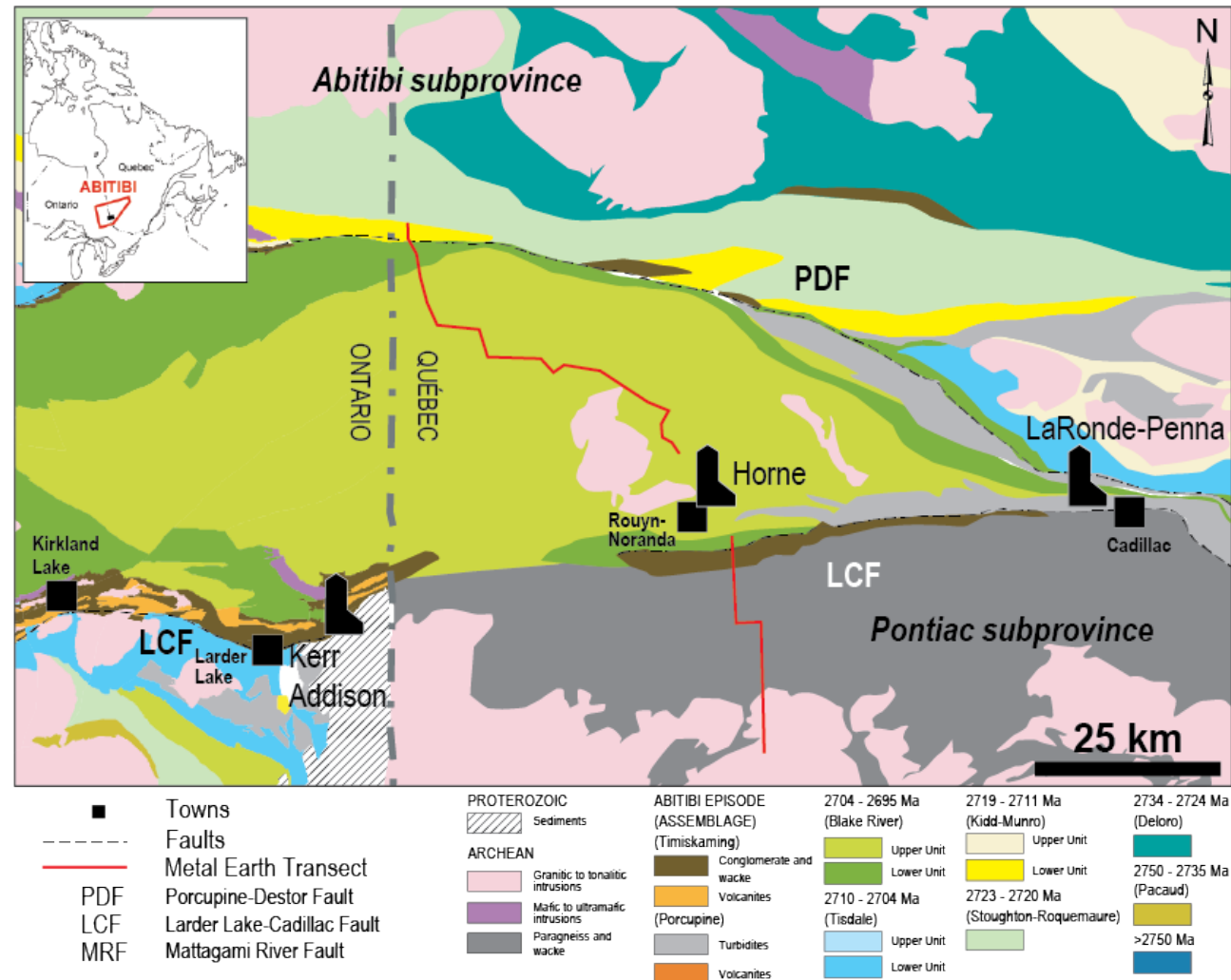
- **Outstanding geologic problems in transect area**
 - PhD Candidate Marina Schofield (started in 2017)
 - MSc Candidates Adrian Rehm and Jonathan Sutton (started in 2017)
 - BSc candidates Andrew Bradley and Aidan Paleczny (started in 2018)
- **Publications**
 - One poster at Québec Mines fall 2017
 - Four 2017 summary of fieldwork (SoFW) in MERN publications (<https://merc.laurentian.ca/>)
 - Three posters at PDAC 2018
 - Two posters at the SEG 2018 Keystone Conference (<http://www.segabstracts.org/>)
- **Upcoming publications**

Five-six SoFW to become available fall 2018



Stratigraphy

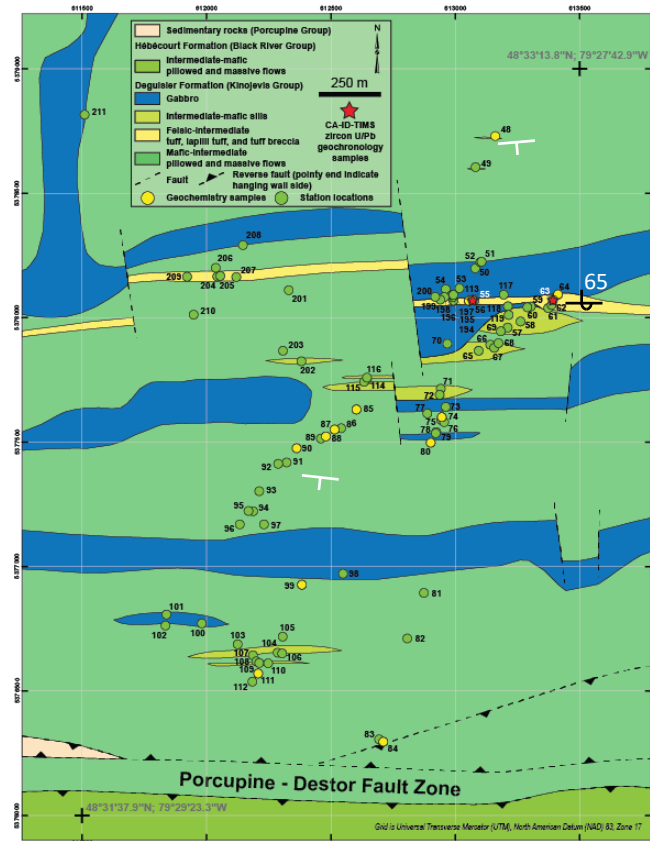
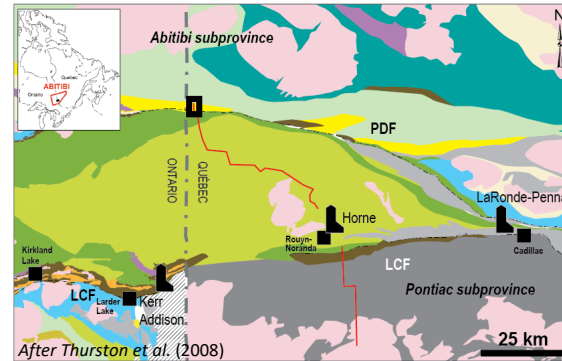
- **ABITIBI SUBPROVINCE**
- Kinojevis Group (ca. 2718-2722 Ma)
 - Fe- and Mg-tholeiites, basalts, andesites, rhyolites, and komatiites
 - Note the age overlap with Kidd-Munro and Stoughton-Roquemaure
- Blake River Group (ca. 2704-2695 Ma)
 - Tholeiitic, transitional, and calc-alkaline volcanic successions, several generations of plutons and mafic to intermediate dikes and sills
- Timiskaming Group (ca. 2679-2669 Ma)
 - Conglomerate and wacke
- **PONTIAC SUBPROVINCE**
- Pontiac Group (ca. 2682 Ma)
 - Graywacke and minor mafic- to ultramafic volcanic rocks
- **MAJOR CRUSTAL SCALE STRUCTURES**
- Porcupine-Destor Fault
- Cadillac-Lader Lake Deformation Zone (and Piché Structural Complex)



Transect overview

Structures

- **Kinojevis Group (ca. 2718-2722 Ma)**
 - E-trending, steep to subvertical, and southward younging
- Strongly deformed near Porcupine-Destor Fault
- **Porcupine-Destor Fault**
 - E-trending, subvertical schistosity resulting from N-S shortening
 - Subhorizontal slickenlines and S-C fabric indicating a late dextral overprint



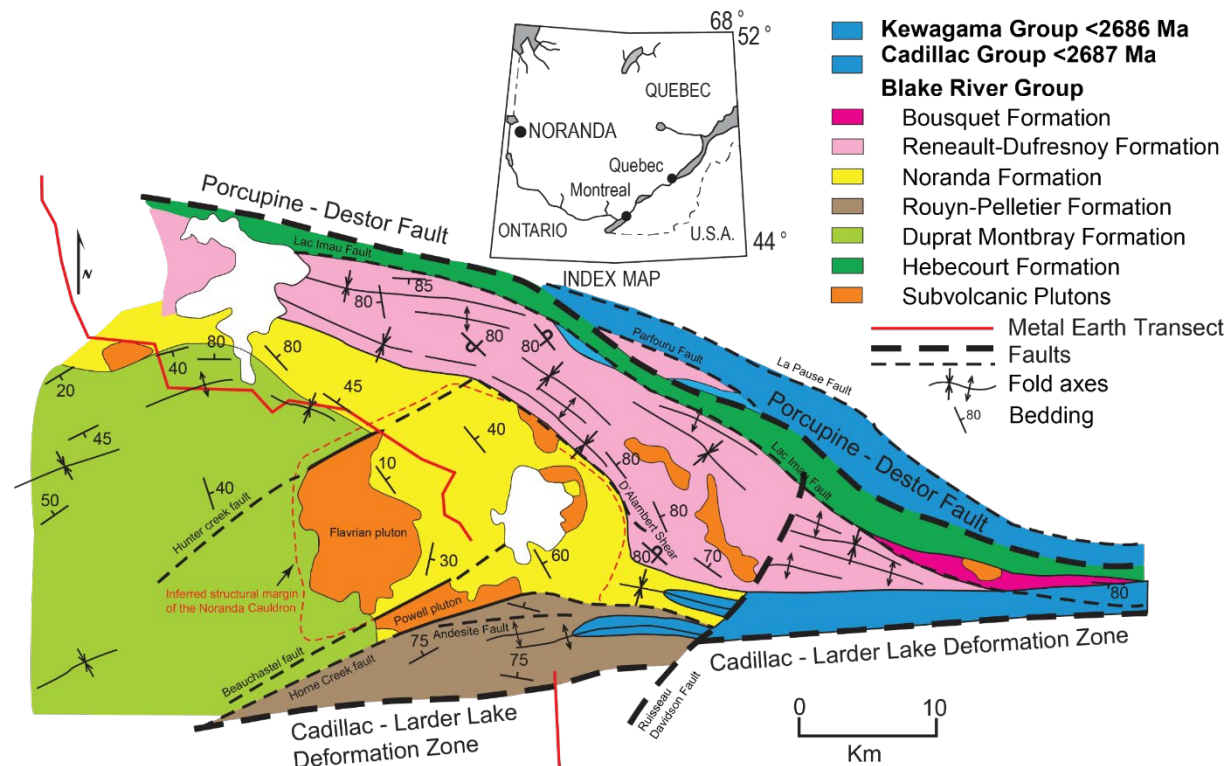
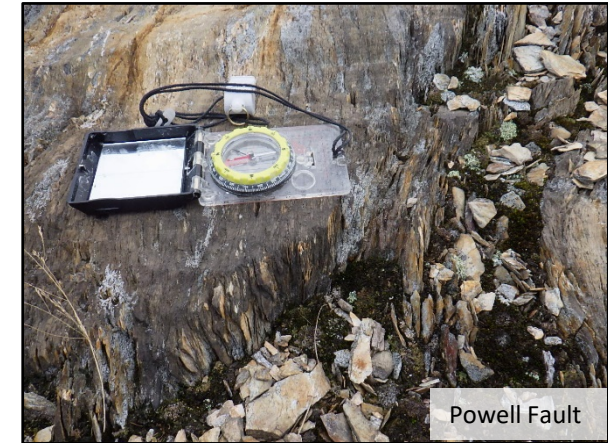
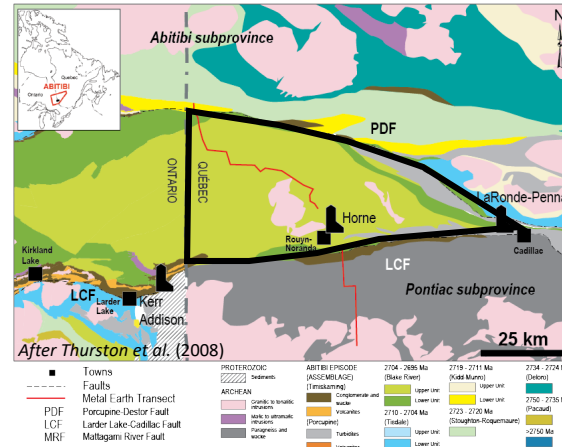
Modified from Système d'information géomineire of Québec (2017)



Transect overview

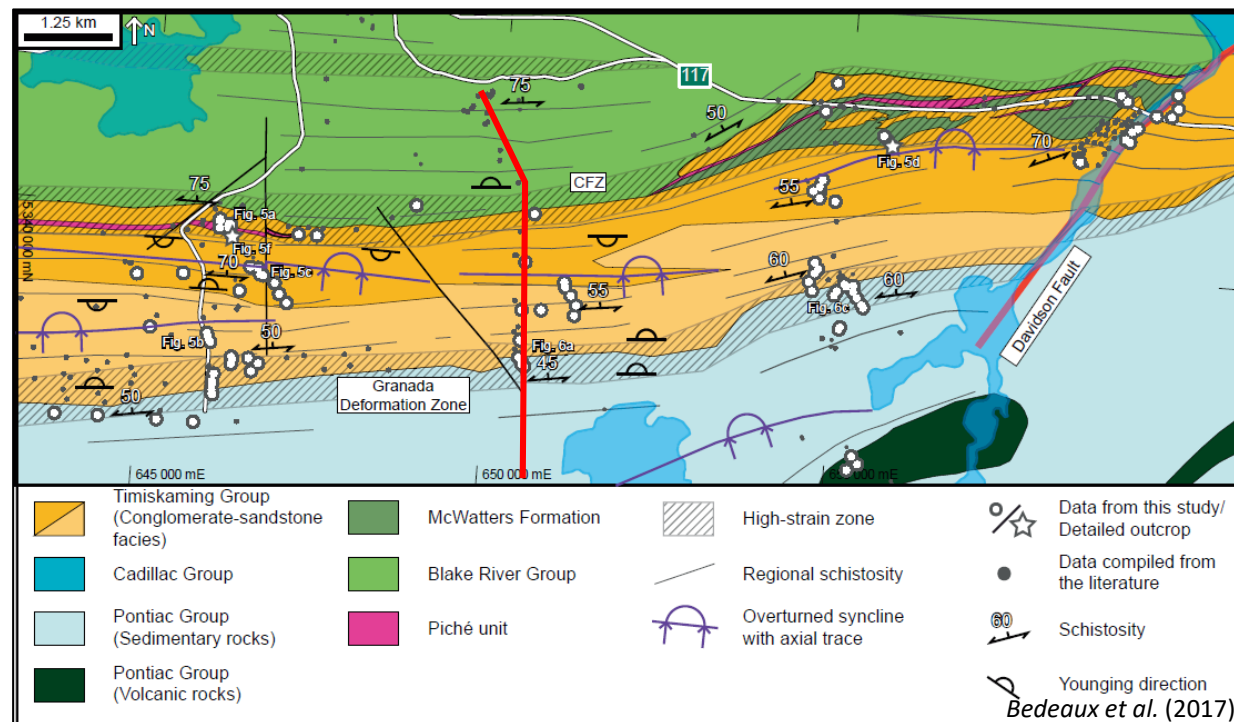
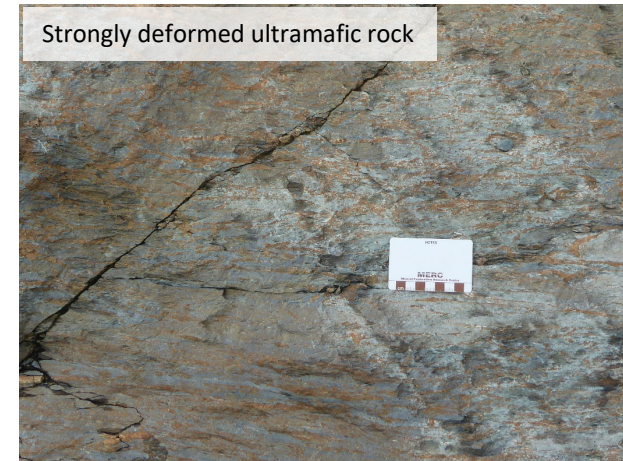
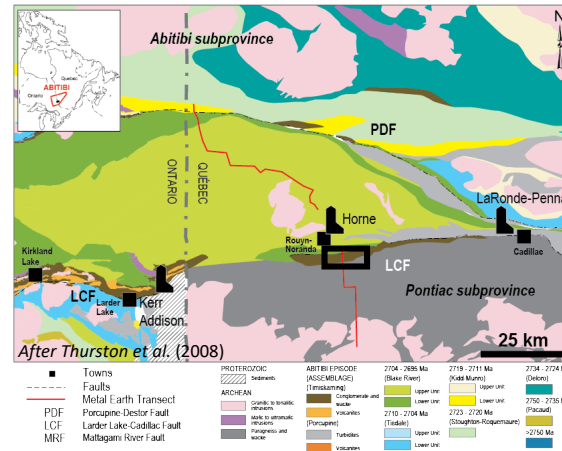
Structures

- **Blake River Group (ca. 2704-2695 Ma)**
 - Generally, E-facing and shallow east-dipping strata, northeast-trending open folds in the central part
- The peripheral part is characterized by steep faults and steep, isoclinal, west-verging folds whose fold axes strike parallel to the adjacent major faults
- Several structural blocks, e.g., the Powell Block



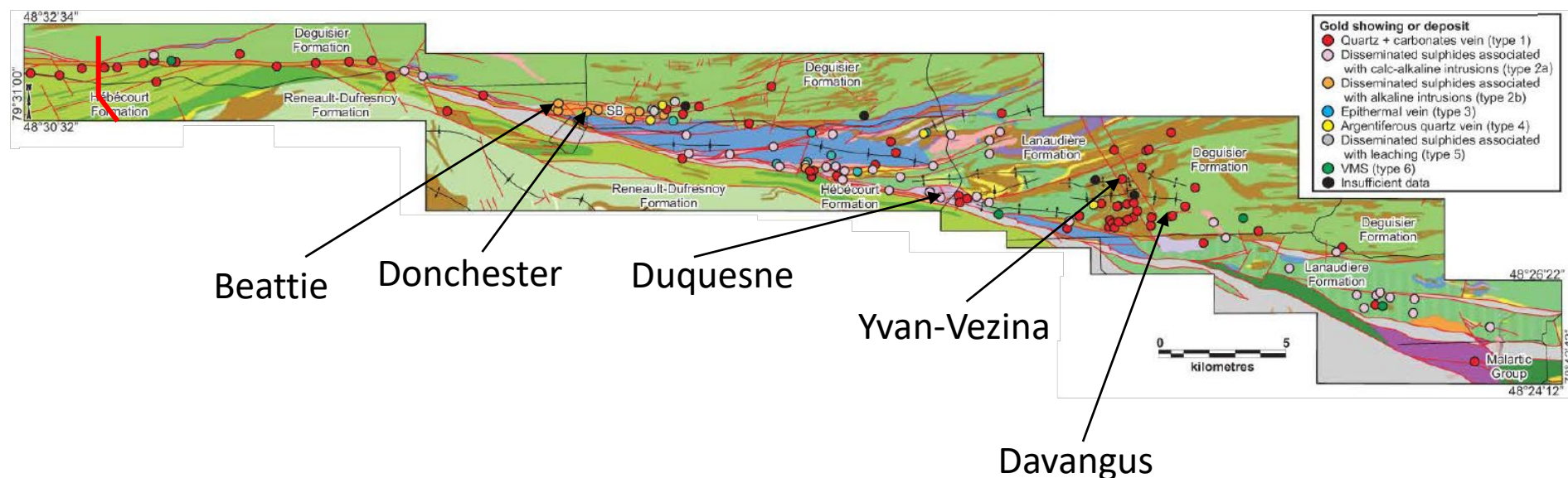
Structures

- **Timiskaming (ca. 2679-2669 Ma) and Pontiac groups (ca. 2682 Ma)**
 - E-trending (ENE to the south) and moderate to steep N-dipping strata
- **Cadillac-Lader Lake Deformation Zone**
 - E-trending and moderate to steep N-dipping
 - E-trending, moderate to steep N-dipping schistosity and down-dip lineation resulting from the main N-S shortening
 - NE-trending vertical cleavage axial planar to asymmetric Z-shaped folds, C-S fabric, shear bands, and sigmoid objects indicating a NW-SE shortening and strike-slip event



Mineralization

• Gold showings and deposits along the Porcupine-Destor Fault

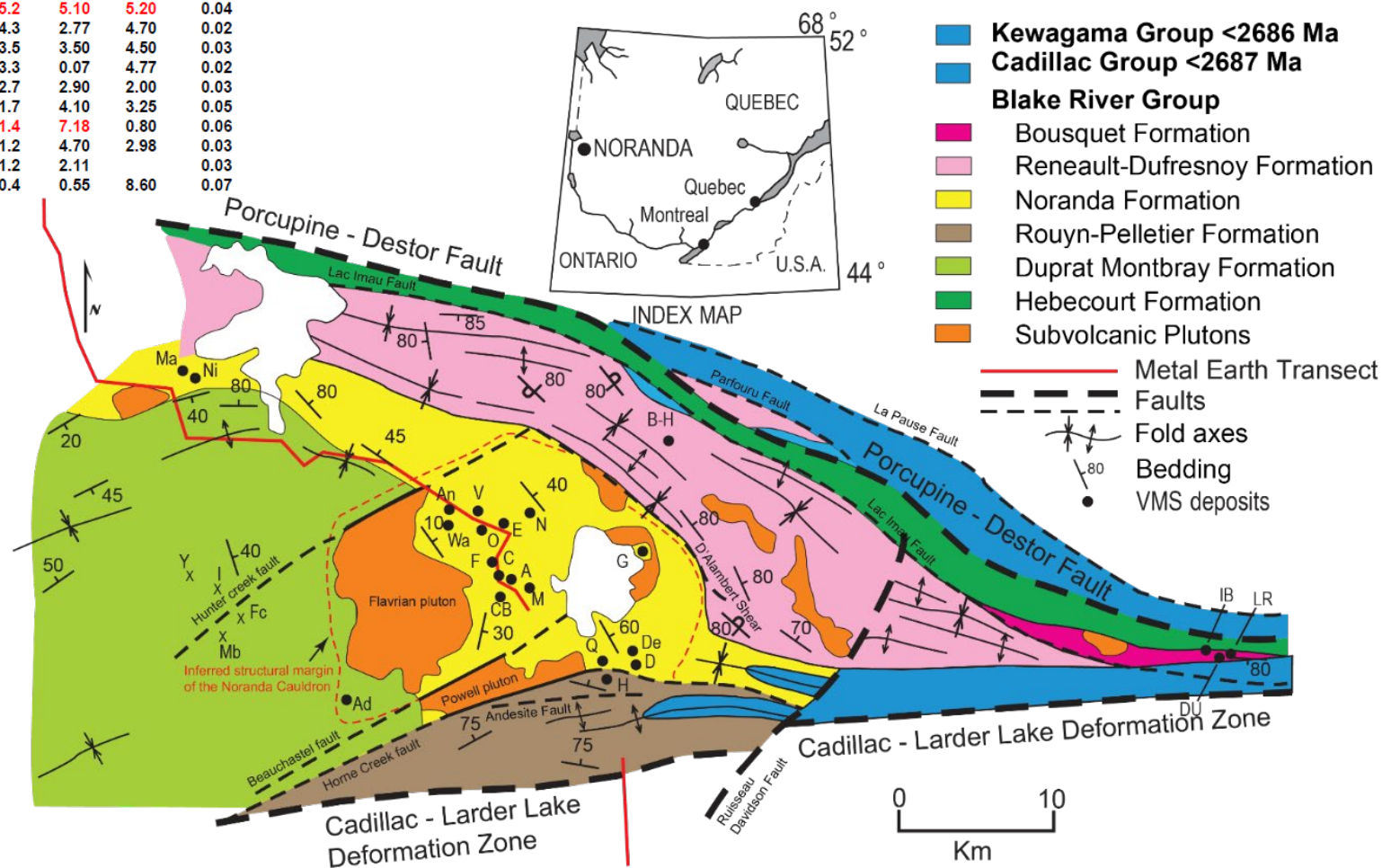


Mine	Exploitation	Tonnes exploitées	Teneur (g/t)	Type	Orientation	Références
Beattie ⁱ	1933-1956	8 404 628	3,52	2b	090°/SV	Graham, 1954; Bevan, 1996; rapports internes
Donchester	1943-1956	1 224 712	9,26	2b	090°/SV	Graham, 1954; Bevan, 1996; rapports internes
Duquesne ⁱⁱ	1949-1952; 1989-1990	99 912	10,31	2a	090°/75°	Rapports internes; Radisson, rapport annuel, 1989, 1990
Yvan-Vézina	1983-1988	1 095 191	3,72	1	140°/60°	Goutier, 1997; Faure, 1998
Davangus ⁱⁱⁱ	1987-1988	32 120	4,31	1	060°/45° et 090°/45°	Goutier, 1997; Faure, 1998

- **Grade and tonnage for 13 of the VMS deposits in the Noranda District – 20 VMS deposits have been discovered over 85 years**

	DEPOSIT	Mt	%Cu	%Zn	Opt Au
H =	Horne (H-G-E)	54.0	2.20		0.18
Q =	Quemont	15.0	1.22	1.90	0.12
B-H =	Bouchard-Hebert lens 1100	10.2	0.72	5.39	0.04
A =	Amulet Lower A	5.2	5.10	5.20	0.04
N =	Norbec	4.3	2.77	4.70	0.02
M =	Millenbach	3.5	3.50	4.50	0.03
G =	Gallen	3.3	0.07	4.77	0.02
Cb =	Corbet	2.7	2.90	2.00	0.03
E =	East Waite	1.7	4.10	3.25	0.05
An =	Ansil	1.4	7.18	0.80	0.06
O =	Old Waite	1.2	4.70	2.98	0.03
Ni =	Fabie Bay (former New Insco)	1.2	2.11		0.03
D =	Delbridge	0.4	0.55	8.60	0.07

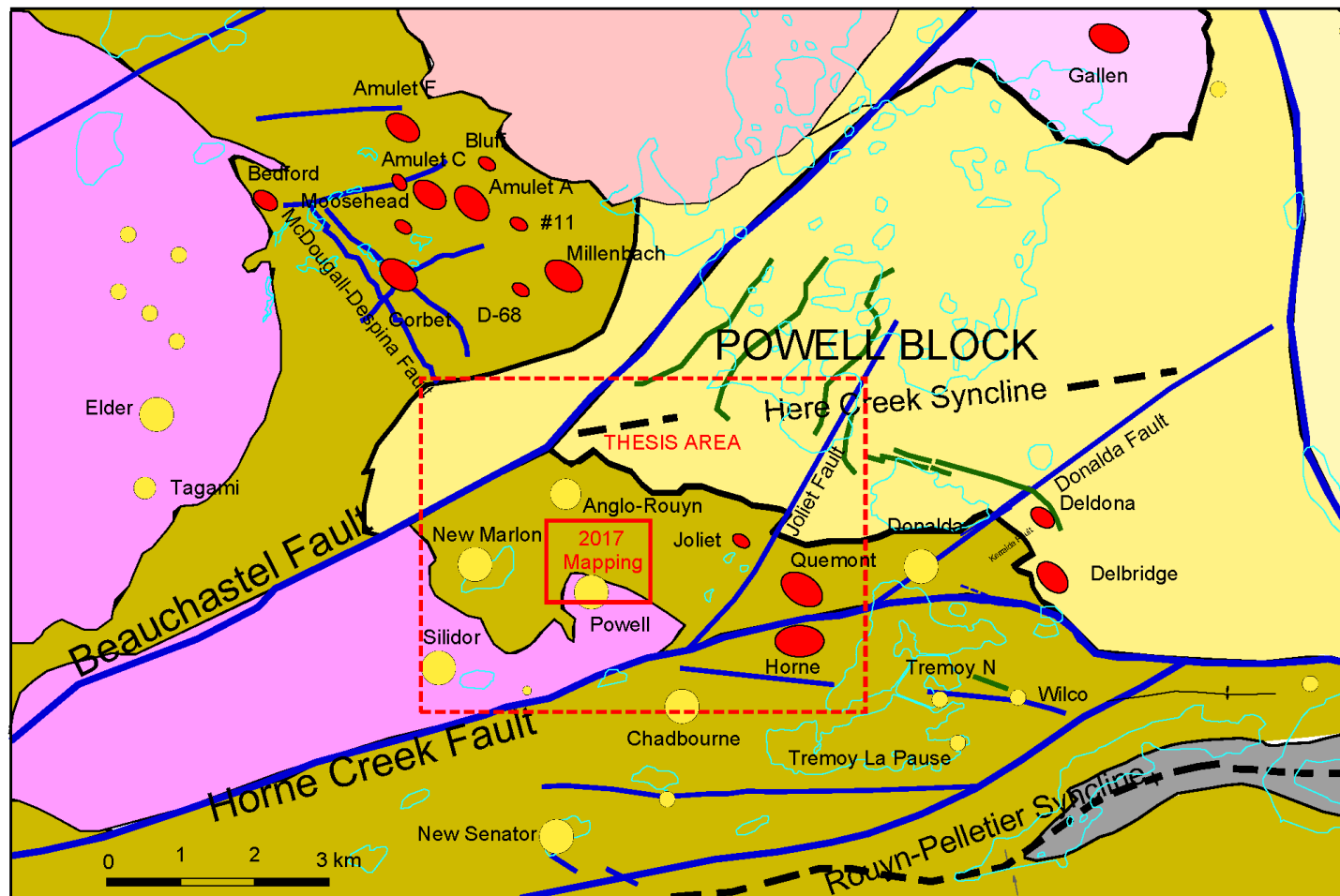
Falco Resources (2017)



Modified from Gibson and Galley (2007)

Mineralization

- **Not only a VMS District**
- 19 orogenic Au deposits and several intrusion-hosted Cu-Mo deposits (e.g., Don-Rouyn and St. Jude)
- VMS/Cu-vein deposits shown in red oval shapes
- Quartz-gold veins in yellow circles



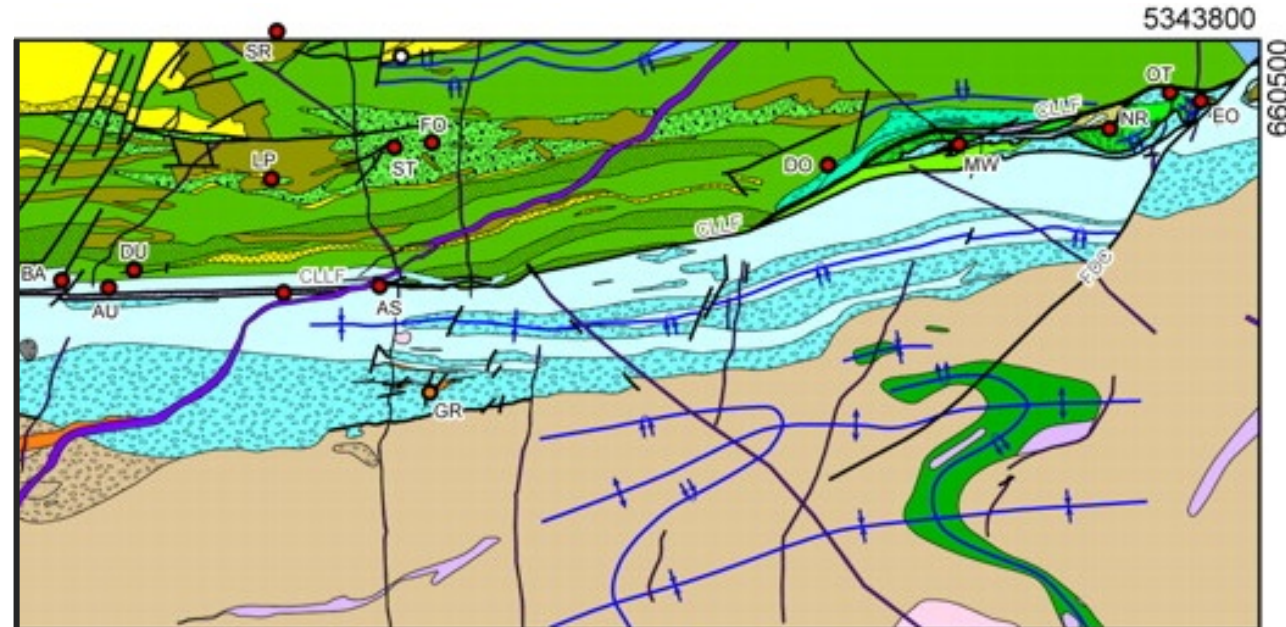
Mineralization

- **Astoria production:**
(unofficial dates are from 1987-1995)
180,000 t grading 5.15 g/t Au and ~0.5 g/t Ag
- **McWatters production:**
333,750 t grading 11.07 g/t Au and 1.44 g/t Ag

Closed mines (production years)

• Quartz-Carbonate veins (Au)

AS - Astoria (1992-95)
 AU - Augmitto
 BA - Bazooka
 DO - Dovercliff
 DU - Durbar
 EO - East O'Neill
 FO - Forbex
 LF - Lac Fortune
 LP - Lac Pelletier
 MW - McWatters (1934-44)
 NR - New Rouyn Merger (1948-49)
 OT - O'Neill-Thompson (1936)
 SR - Senator Rouyn (1940-55)
 ST - Stadacona (1936-58)



Proterozoic

Cobalt Group

Gowganda Formation

- Mudrock
- Wacke
- Wacke and polygenic conglomerate
- Polygenic conglomerate

Archean

Pontiac Subprovince

Pontiac Group

- Biotite schist
- Basalt
- Ultramafic volcanic rocks
- Sandstone
- Conglomerate

Abitibi Subprovince

Timiskaming Group

- Wacke
- Polygenic conglomerate
- Wacke and conglomerate
- Trachytic tuff

La Bruère Formation

- Conglomerate
- Sandstone, siltstone

Cadillac Group

- Wacke, mudrock

Blake River Group

- Dacite - rhyolite
- Dacitic - rhyolitic tuff
- Basalt - andesite
- Basaltic - andesitic tuff
- Variolitic basalt - andesite
- Stadacona Member
- Andesitic tuff and breccia
- Fish-roe Member
- Spherulitic dacite - rhyolite

McWatters Formation

- Andesite
- Basalt
- Basaltic tuff
- Sericite and carbonate schist

Piché Formation

- Ultramafic schist

Intrusions

Proterozoic

Archean

- Gabbro dike
- Syenite - monzonite
- Granite
- Gabbro - diorite

- Anticline, syncline
- Overturned anticline, syn
- Fault / shear zone

Important Faults

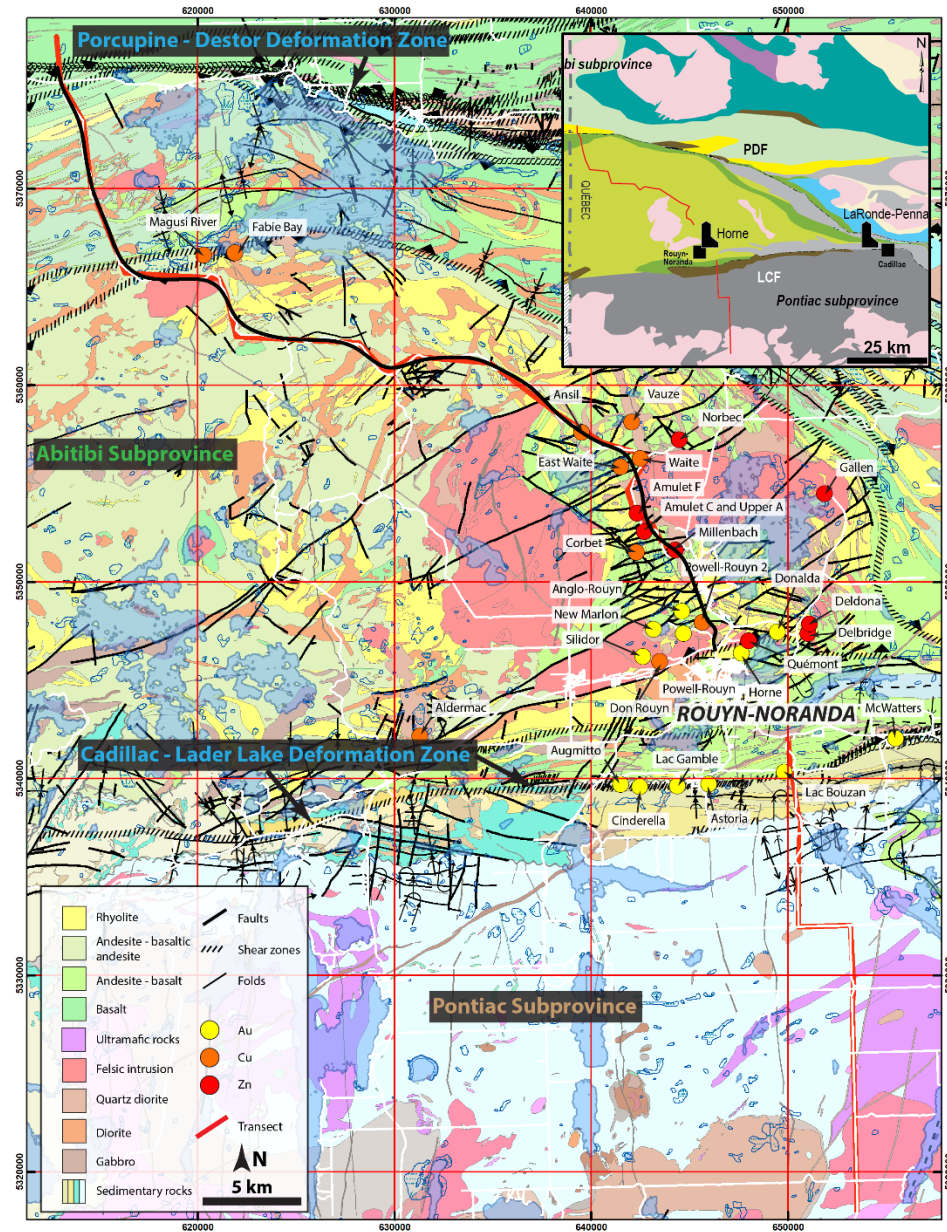
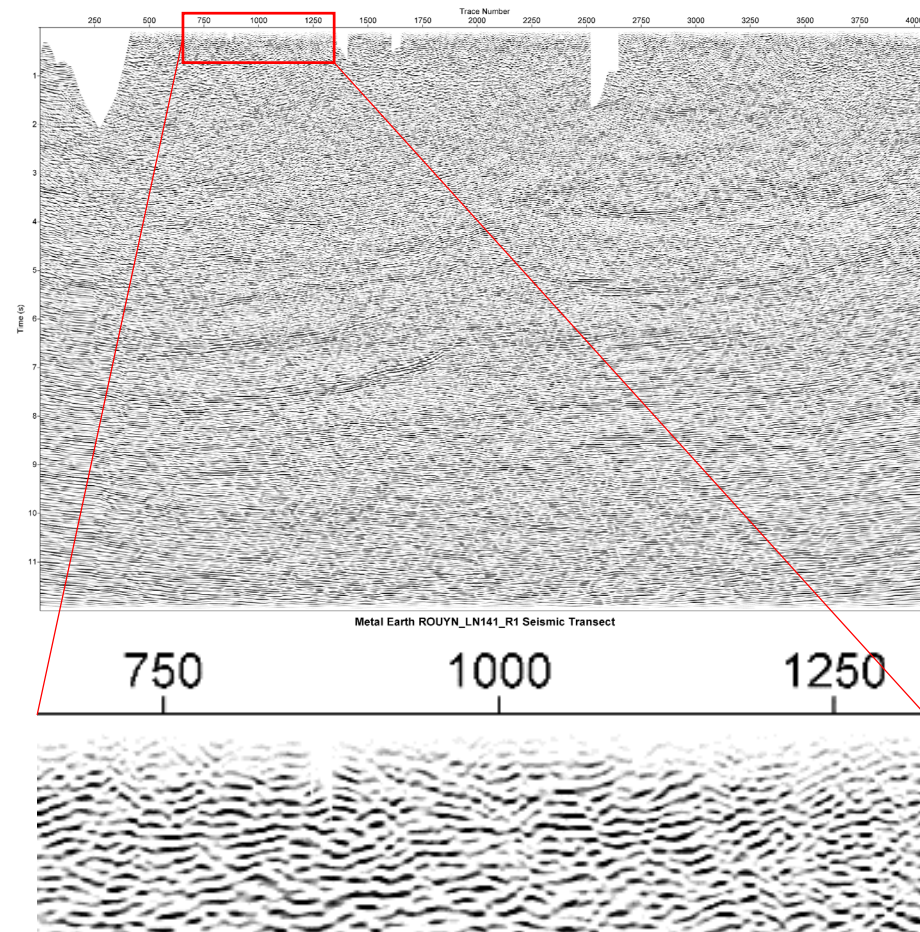
- FB - Beauchastel Fault
- CLLF - Cadillac-Larder Lake Fault
- FDC - Davidson Creek Fault
- FF - Francoeur Fault
- FHC - Horne Creek Fault
- FLD - Lac Desvaux Fault
- FLF - Lac Fortune Fault
- FMC - Milky Creek Fault
- FN - North Fault
- FW - Wasa Fault

5 km



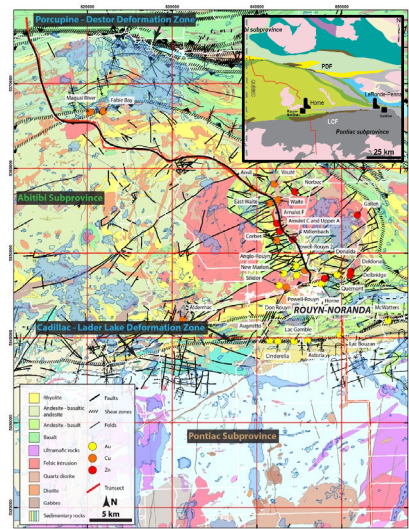
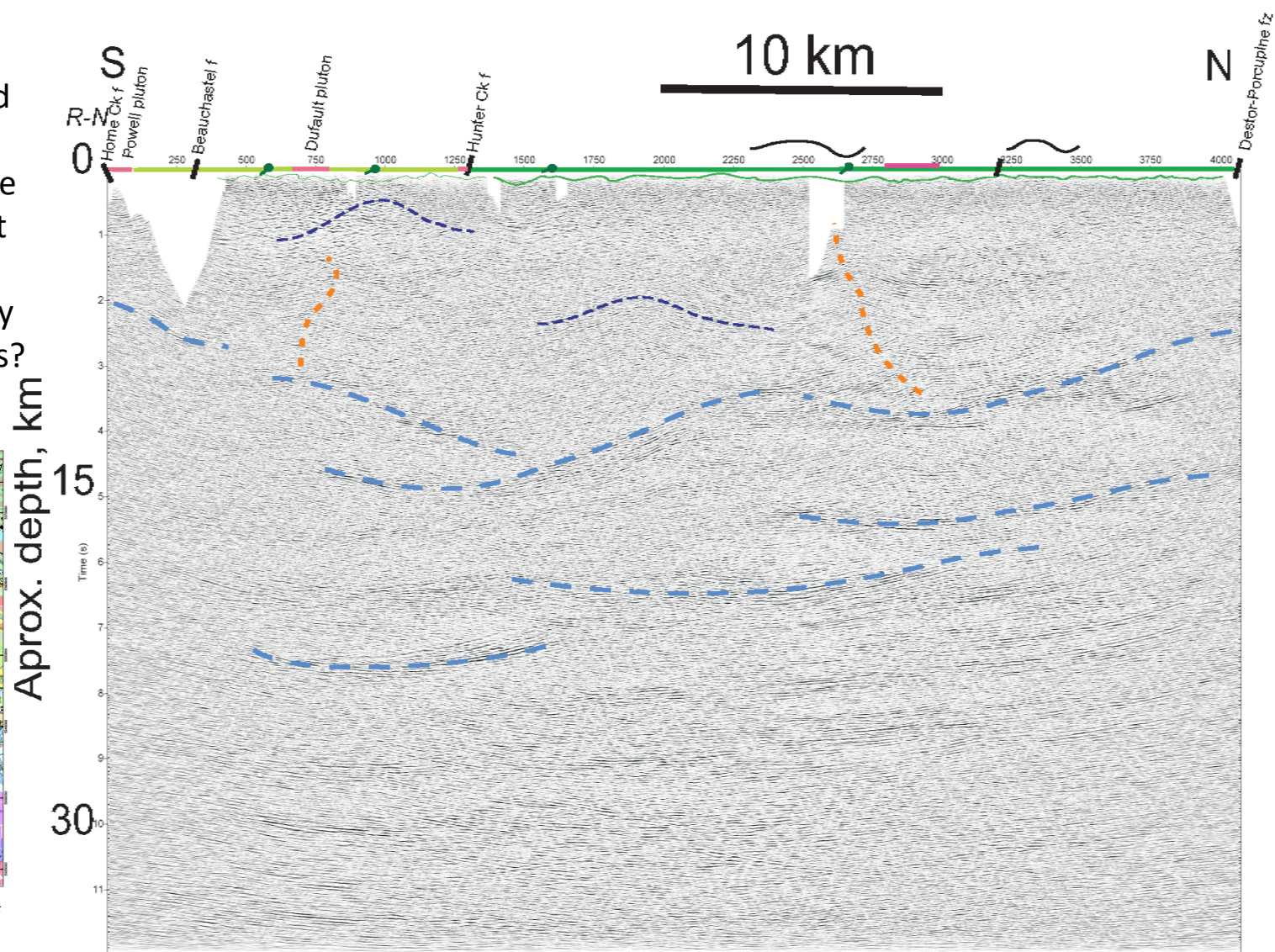
Transect and seismic section

- Data available from the Horne smelter to south of Porcupine-Destor fault
- Currently no data available across the major breaks



Transect and seismic section

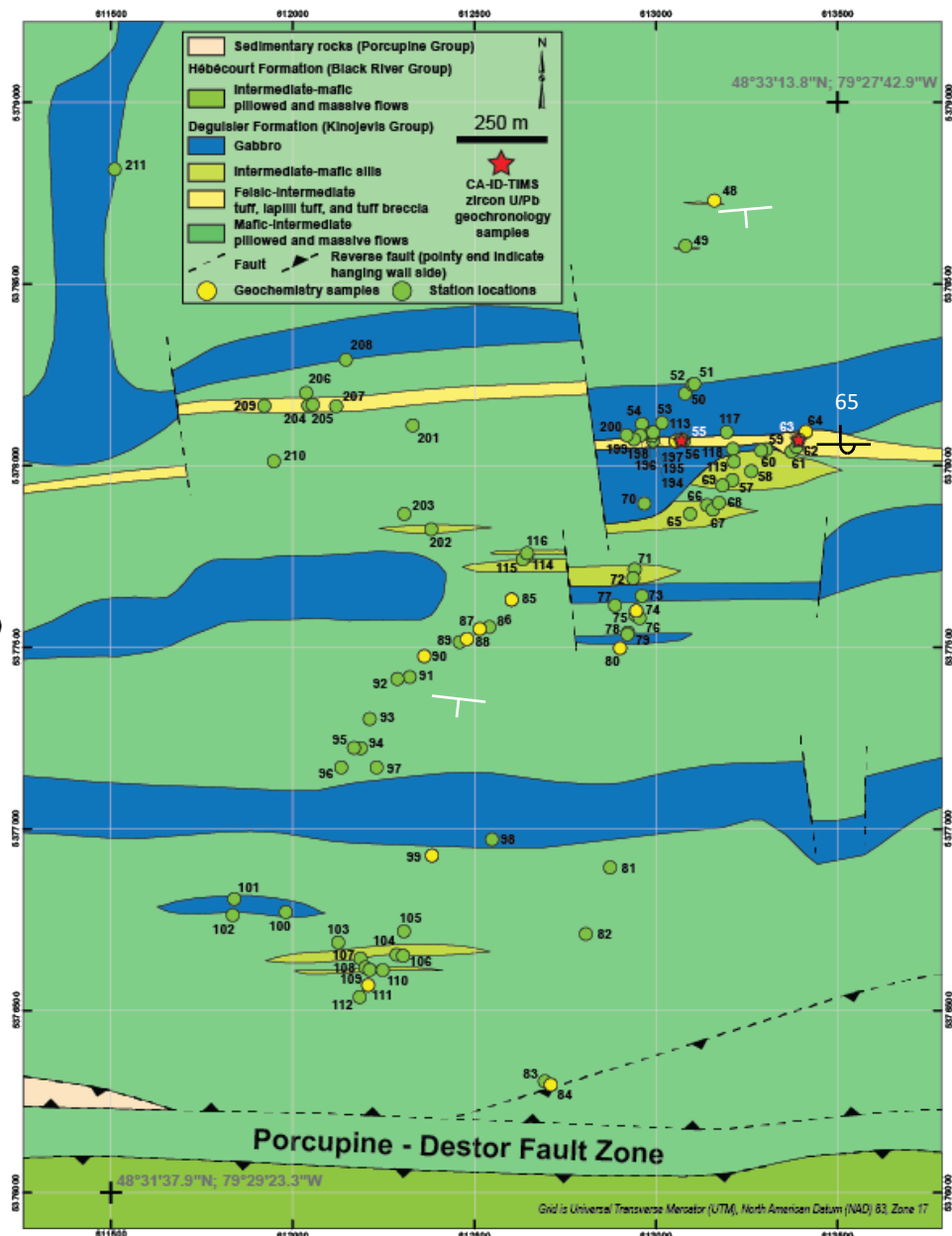
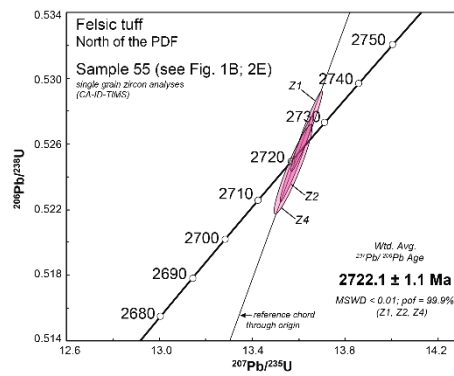
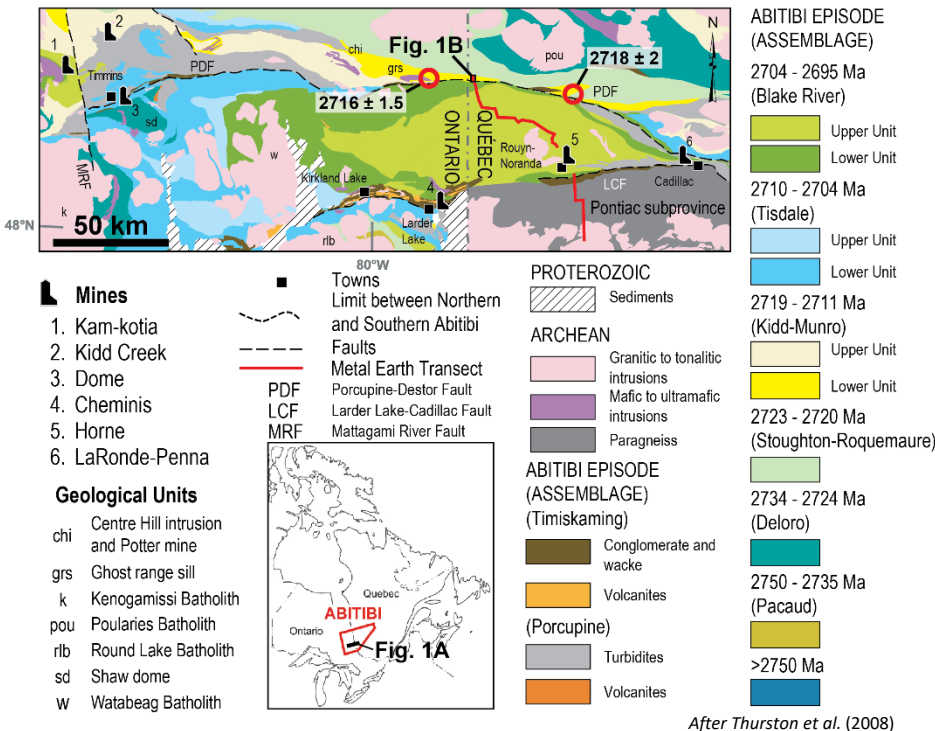
- Does the VMS prospective stratigraphy extend to depth?
- Can we observe the major structures at depth?
- Can we identify any alteration corridors?



Modified after Système d'information géomineière of Québec (2017)

Transect projects

U-Pb zircon geochronology and geochemistry of volcanic rocks in the Deguisier Formation, Kinojevis Group, Abitibi Greenstone Belt, Quebec: implications for gold and volcanogenic massive sulfide (VMS) mineralization



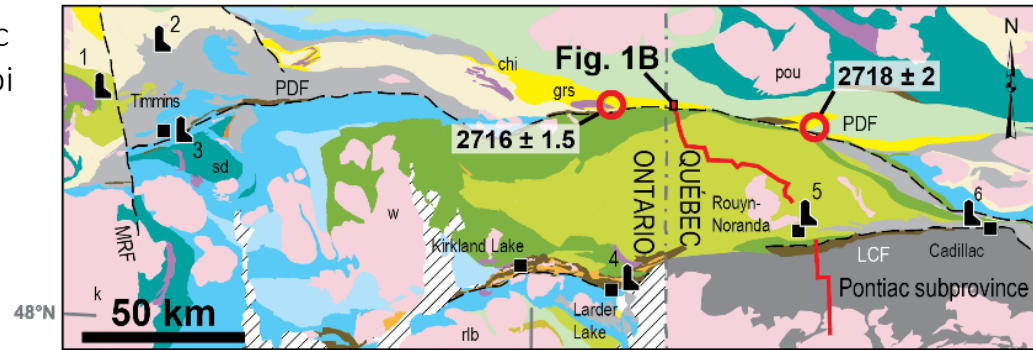
Modified after Système d'information géominère of Québec (2017)

- A weighted average $^{207}\text{Pb}/^{206}\text{Pb}$ age for three concordant fractions from sample 55 is 2722.1 ± 1.1 Ma
- Consistent with Stoughton-Roquemaure assemblage

Transect projects

U-Pb zircon geochronology and geochemistry of volcanic rocks in the Deguisier Formation, Kinojevis Group, Abitibi Greenstone Belt, Quebec: implications for gold and volcanogenic massive sulfide (VMS) mineralization

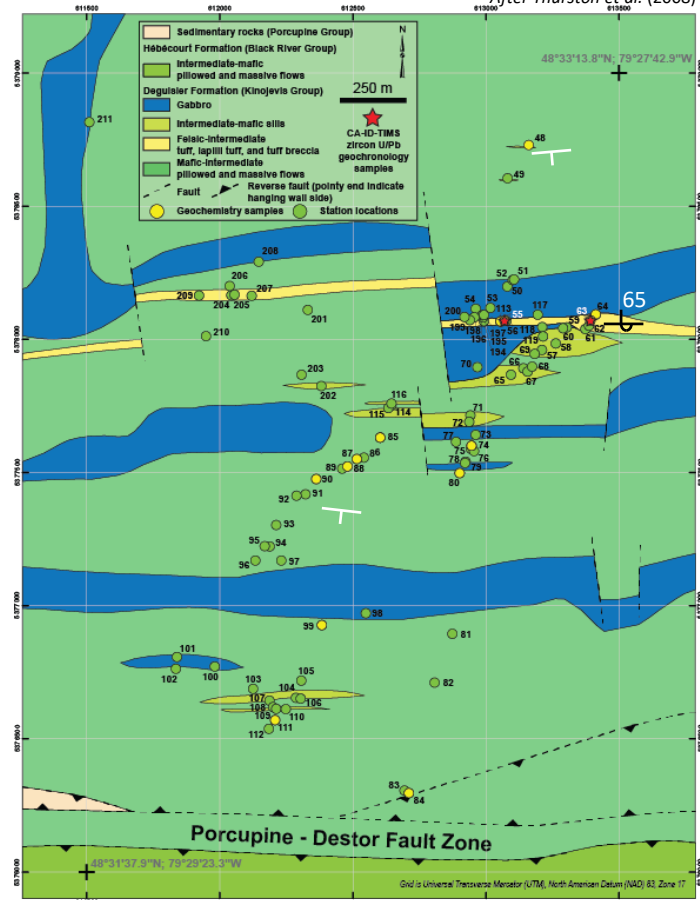
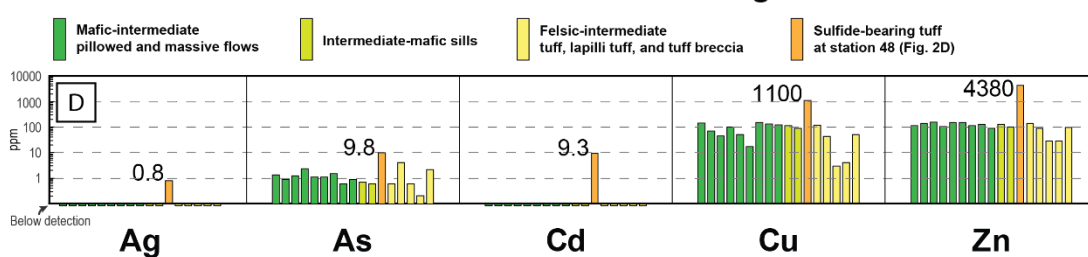
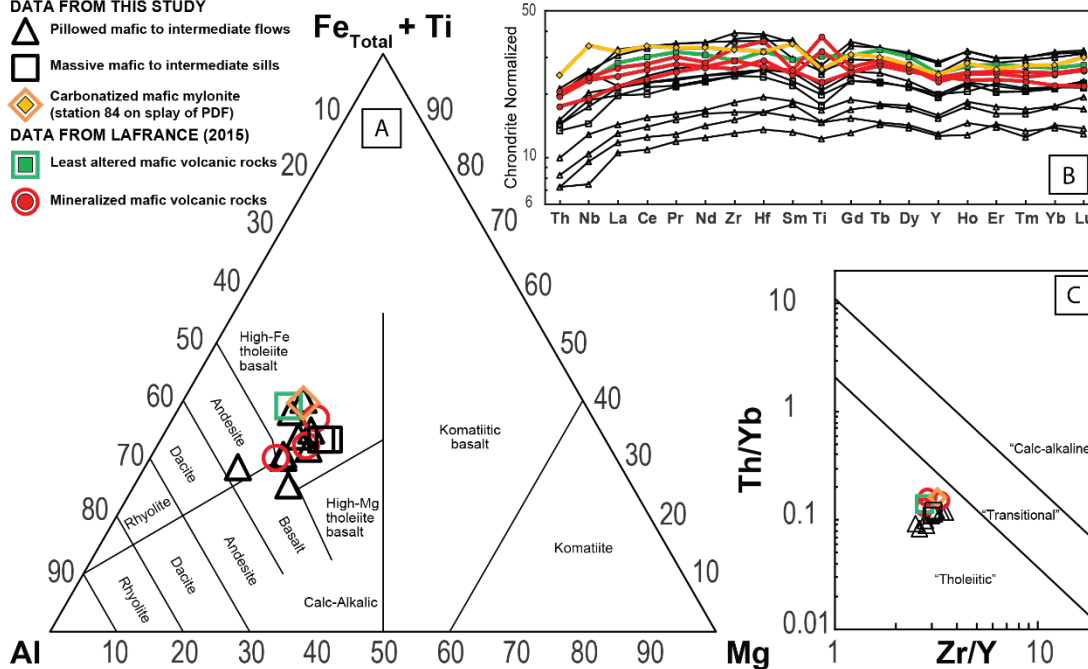
- Dominated by high-Fe Tholeiite basalts
- Reactive host rock (high Fe/Mg) similar to e.g., Cheminis



After Thurston et al. (2008)

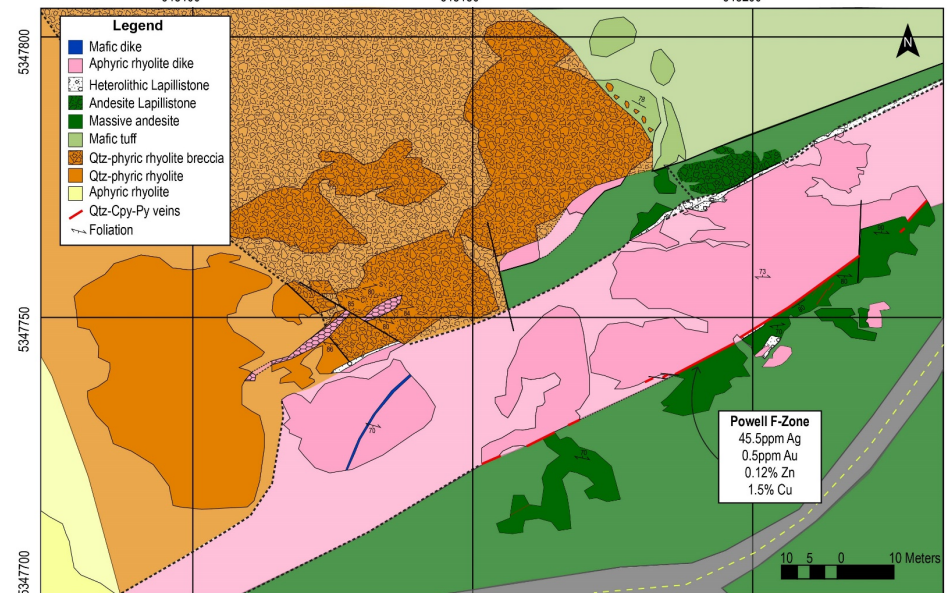
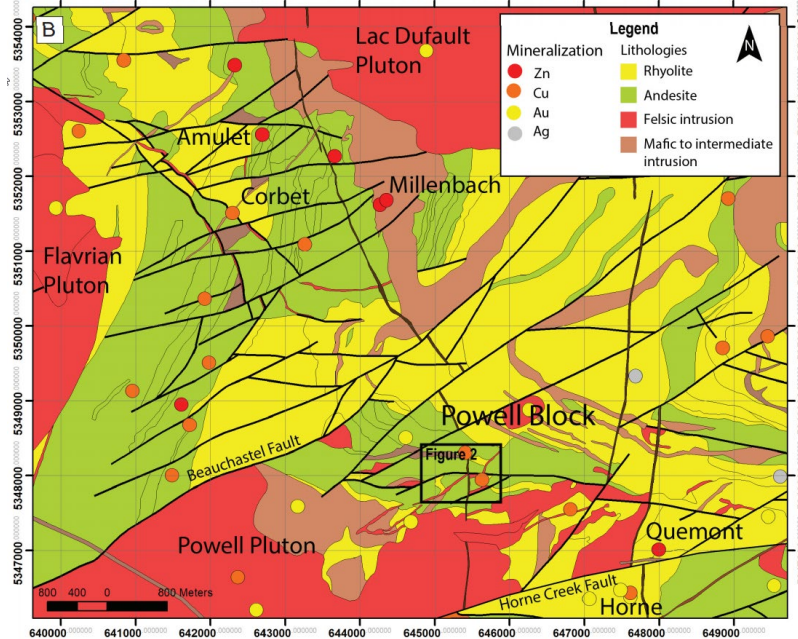
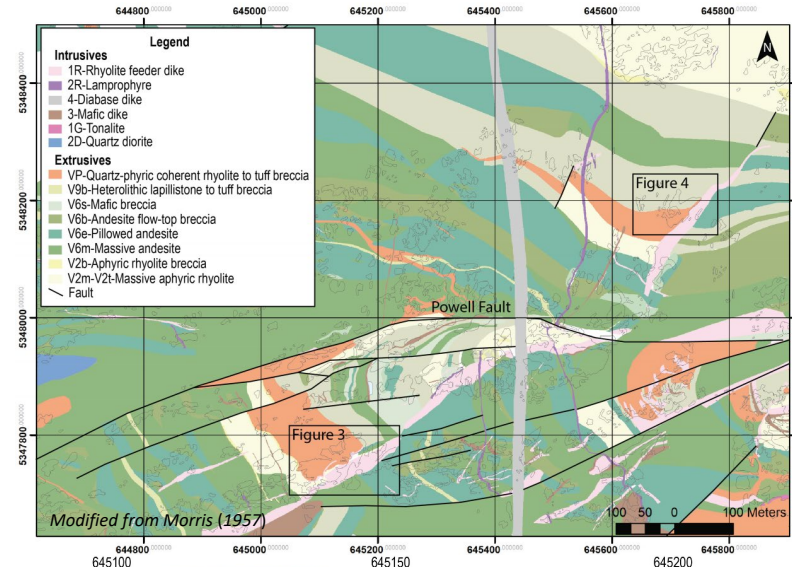
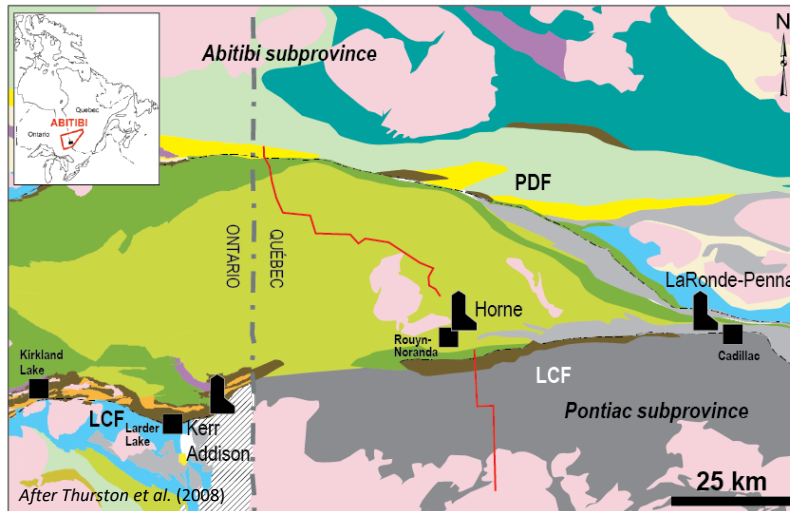
DATA FROM THIS STUDY

- △ Pillowed mafic to intermediate flows
- Massive mafic to intermediate sills
- ◇ Carbonatized mafic mylonite (station 84 on splay of PDF)
- DATA FROM LAFRANCE (2015)
- Least altered mafic volcanic rocks
- Mineralized mafic volcanic rocks



Modified after Système d'information géomineire of Québec (2017)

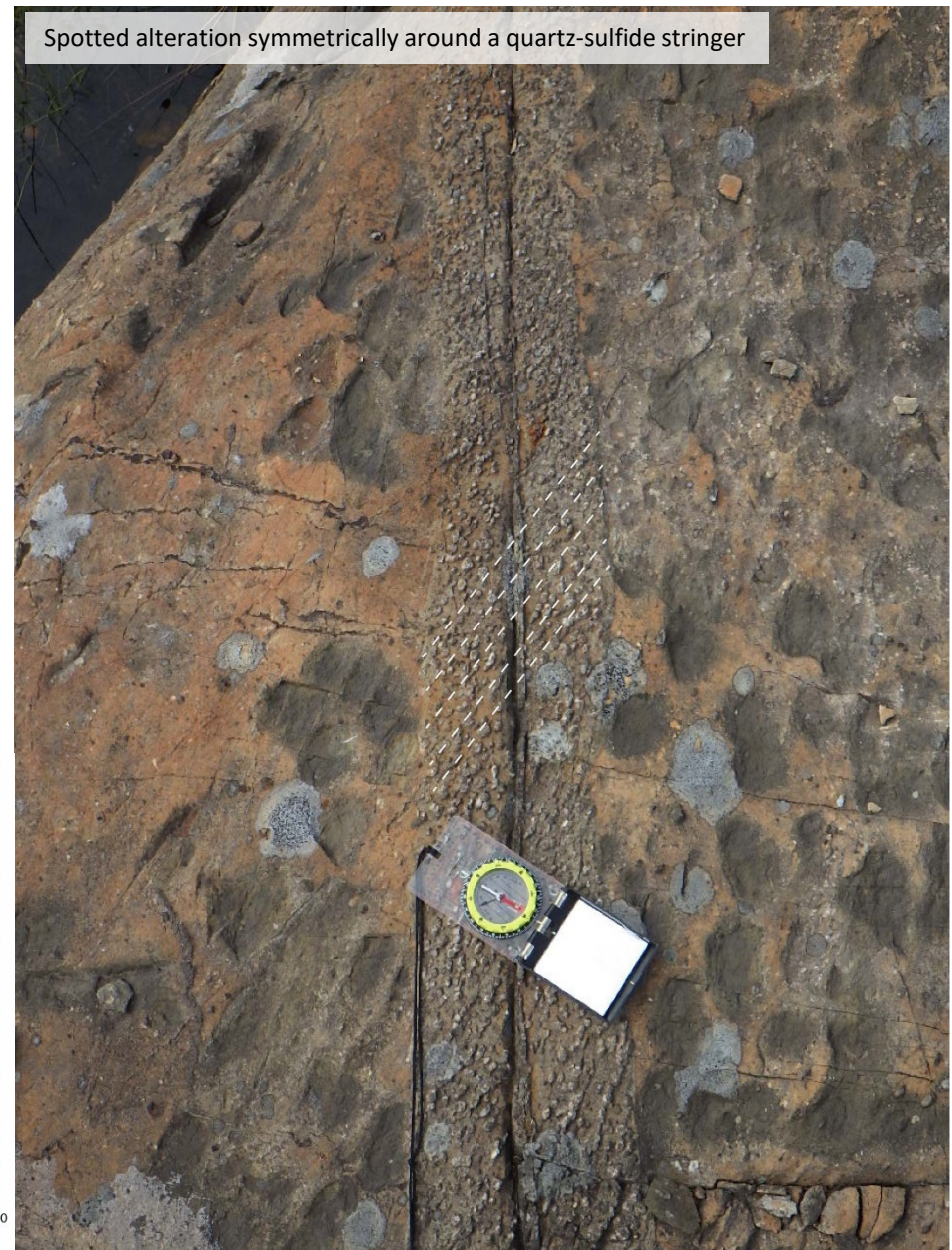
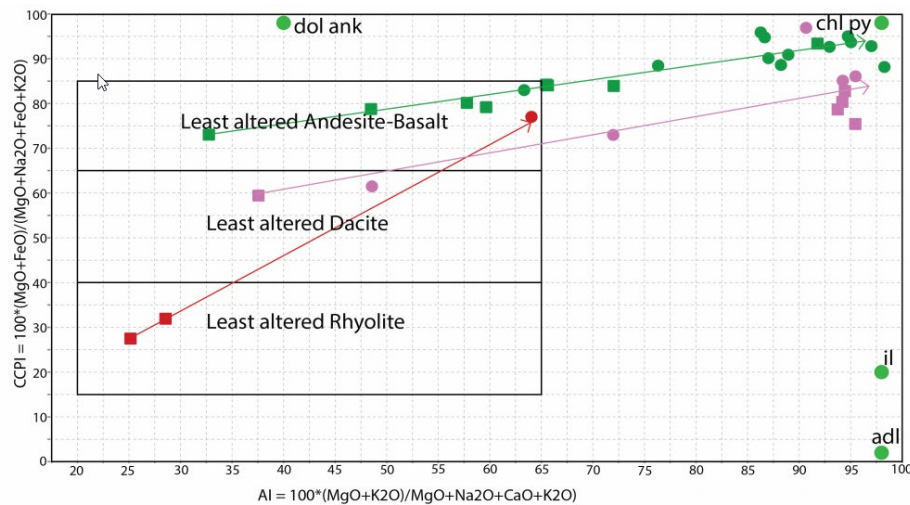
Preliminary results from detailed geological mapping within the Powell block, Rouyn-Noranda, Quebec



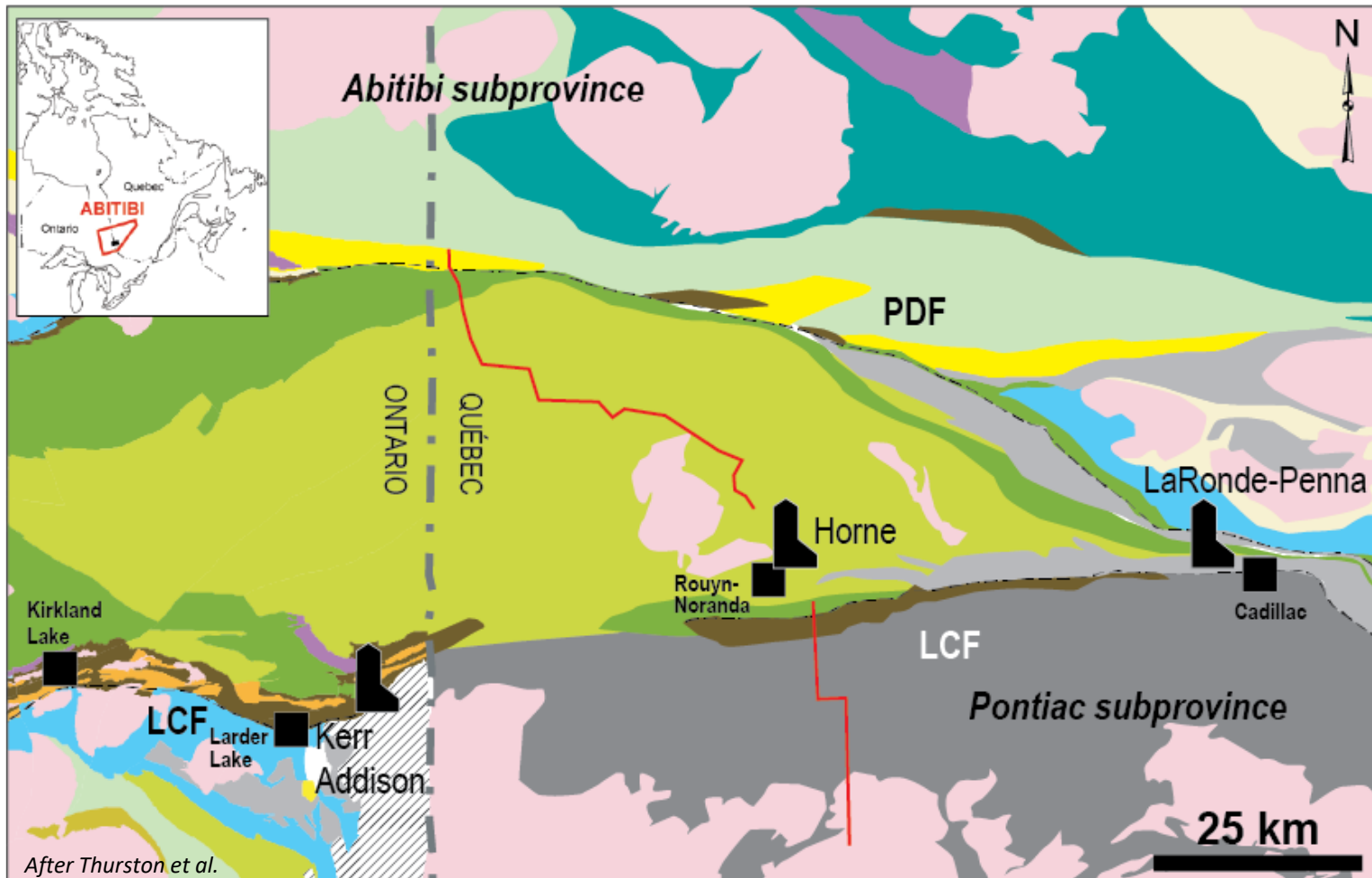
Preliminary results from detailed geological mapping within the Powell block, Rouyn-Noranda, Quebec

- Spotted alteration is structurally controlled
- Visual marks units that are metasomatized
- Occurs proximal to quartz-sulfide mineralization
- Correlate geochemically with increasing alteration indices

Alteration box plot (Large et al., 2001)



Emplacement mechanism for ultramafic and mafic volcanic rocks in the Pontiac Subprovince



After Thurston et al.
(2008)

- Towns
- Faults
- Metal Earth Transect
- PDF Porcupine-Destor Fault
- LCF Larder Lake-Cadillac Fault
- MRF Mattagami River Fault

PROTEROZOIC

▨ Sediments

ARCHEAN

- ▨ Granitic to tonalitic intrusions
- ▨ Mafic to ultramafic intrusions
- ▨ Paragneiss and wacke

ABITIBI EPISODE (ASSEMBLAGE) (Timiskaming)

- ▨ Conglomerate and wacke
- ▨ Volcanites (Porcupine)
- ▨ Turbidites
- ▨ Volcanites

2704 - 2695 Ma (Blake River)

- ▨ Upper Unit
- ▨ Lower Unit

2710 - 2704 Ma (Tisdale)

- ▨ Upper Unit
- ▨ Lower Unit

2719 - 2711 Ma (Kidd-Munro)

- ▨ Upper Unit
- ▨ Lower Unit

2723 - 2720 Ma (Stoughton-Roquemaure)

- ▨

2734 - 2724 Ma (Deloro)

- ▨

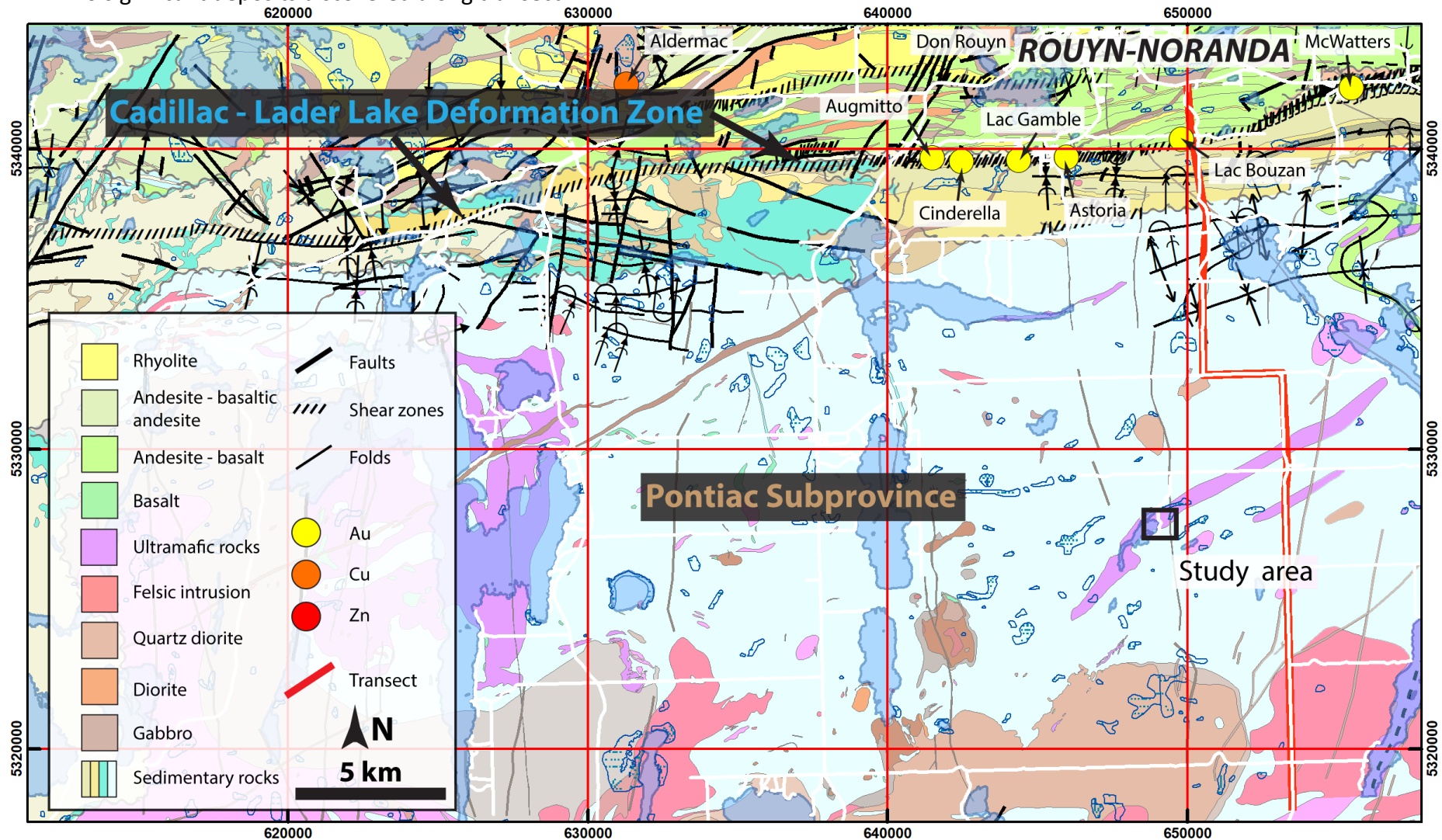
2750 - 2735 Ma (Pacaud)

- ▨

- ▨ >2750 Ma

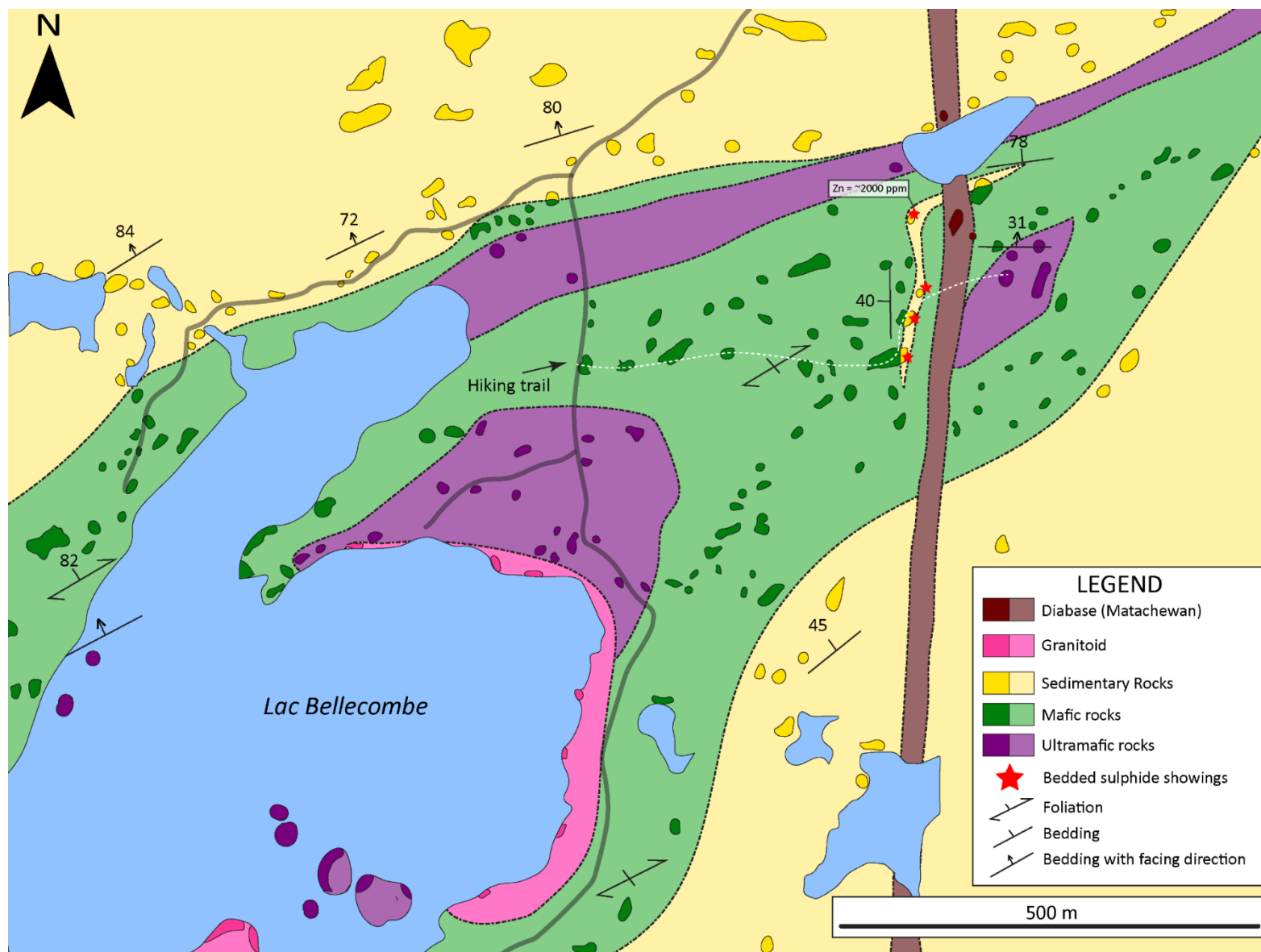
Emplacement mechanism for ultramafic and mafic volcanic rocks in the Pontiac Subprovince

- Note continuous ultramafic to mafic volcanic belt (~30 km strike length / ≤1000 m thick)
- Hosted in kilometers of monotonous metagraywacke
- New mapping suggest a primary contact and syn-sedimentary volcanism – deep seated crustal structure!
- No significant deposits discovered along transect



Emplacement mechanism for ultramafic and mafic volcanic rocks in the Pontiac Subprovince

- Map of ultramafic to mafic volcanic belt in the Pontiac Subprovince near Lac Bellecombe



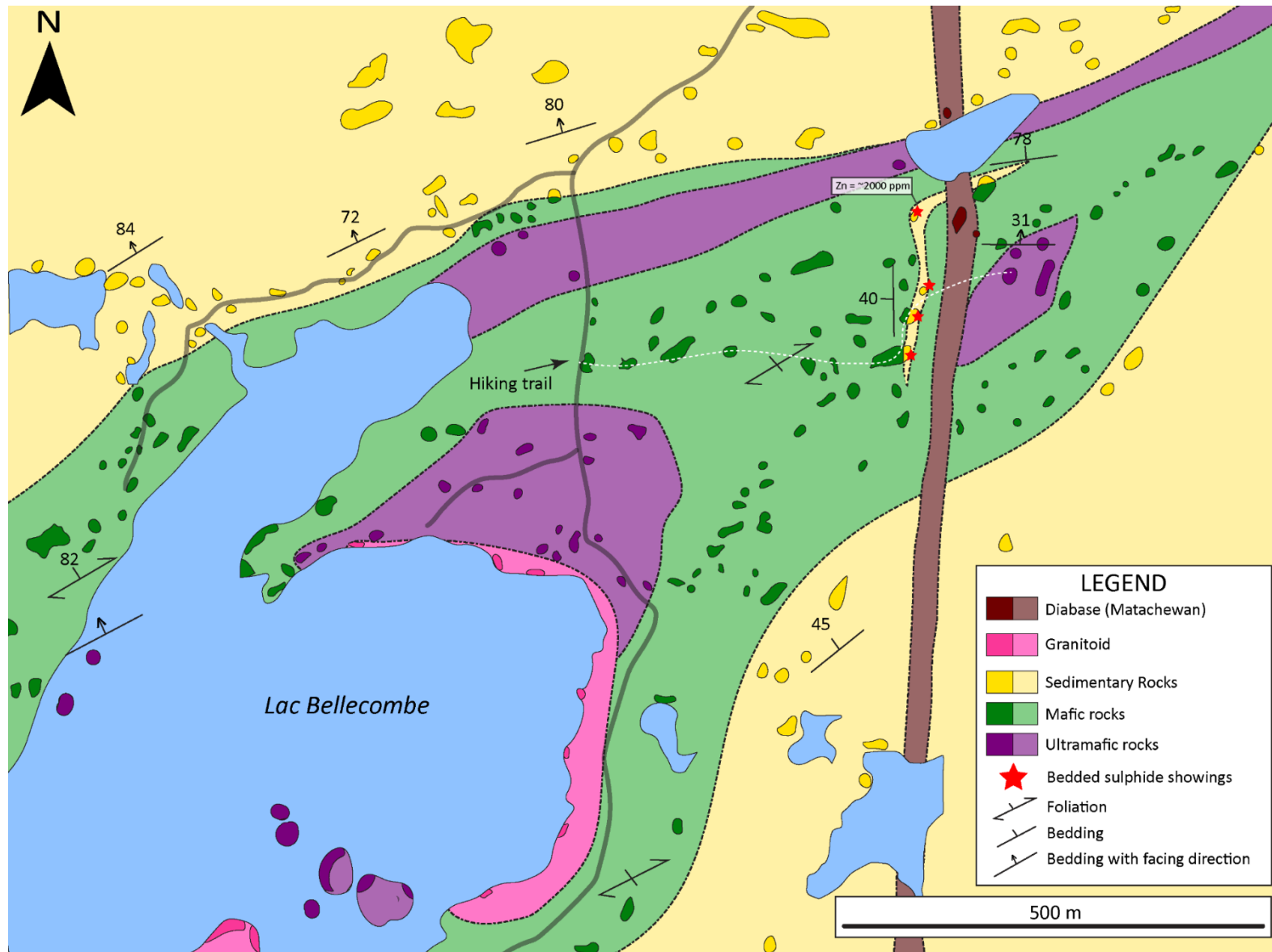


Fluidal peperite at the contact between sedimentary and mafic volcanic rocks



Ultramafic flow overlain by a bedded ultramafic volcaniclastic rock with inset highlighting the spinifex textures

New Zn occurrence in the Pontiac Subprovince the Pontiac Subprovince



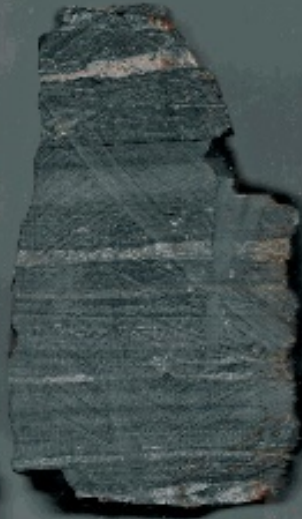
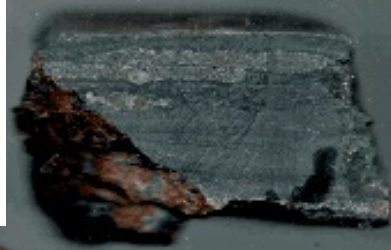
Transect projects

Metalliferous
sedimentary rock
hosted in the
volcanic belt. Inset
of outcrop
exposing 2m-thick
horizon



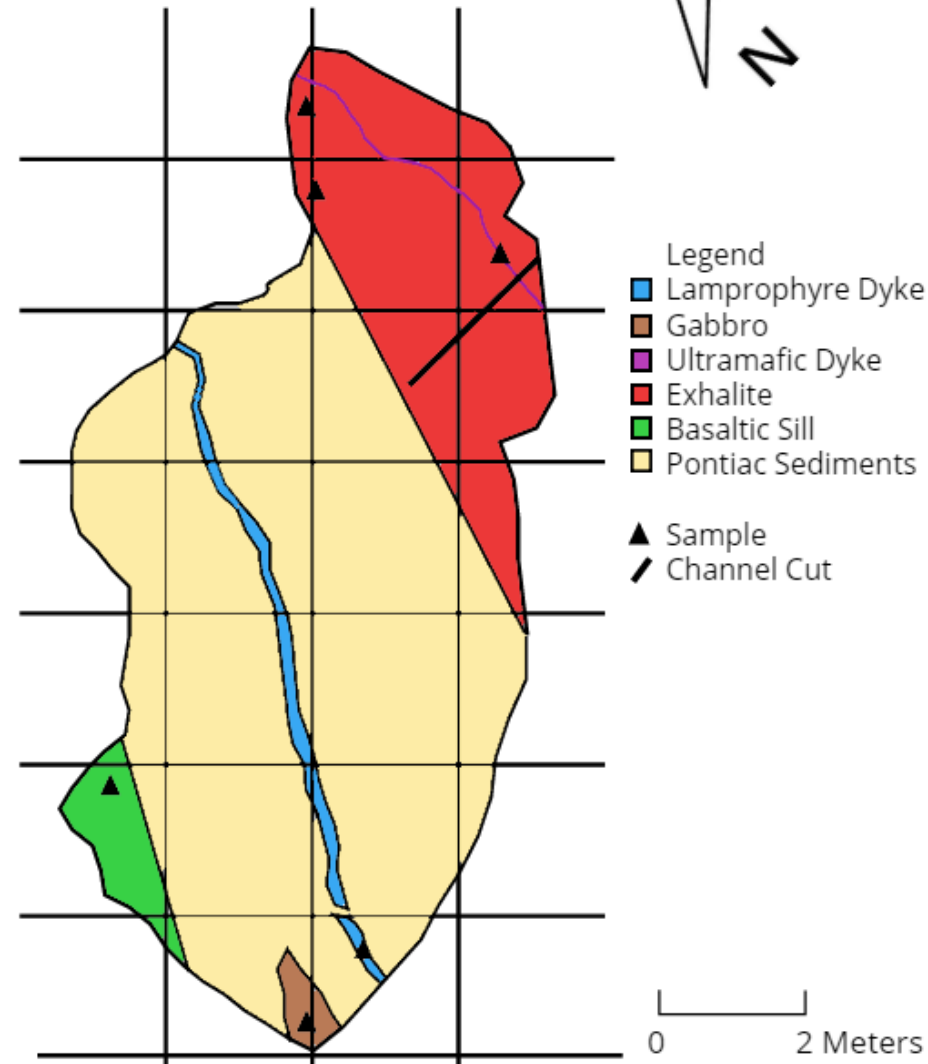
Transect projects

Samples of metalliferous
sedimentary rock and grid
map showing contact
relationships



Channel
samples of
metalliferous
sedimentary
rock. Note the
sulfide-rich
layers.

Outcrop Scale Map of Collected Samples



- The Rouyn-Noranda transect straddles the metal endowed Noranda District
- Transect mapping will help constrain geophysical data (seismic, MT, and gravity) in order to produce a crust-mantle cross-section
- Transect projects are addressing unresolved geological problems along the transect:
 - New whole-rock geochemical data and a **2722.1 ± 1.1 Ma U-Pb zircon age** were obtained for strata north of the Porcupine Destor fault in the **Kinojevis Group** with **implications for VMS- and orogenic Au-style mineralization**
 - Detailed geological mapping within the **Powell Block of the Blake River Group** has shown a **structural control on spotted alteration** that visually marks metasomatized volcanic rocks in proximity to discordant quartz-chalcopyrite vein mineralization. The altered rocks display VMS-like alteration indices, and may define **upflow zones for hydrothermal fluids in VMS prospective volcanic stratigraphy**
 - Field work in the **Pontiac Subprovince** has focused on determining the mechanism of **emplacement for an ultramafic- to mafic volcanic package** with implications for the overall evolution of the sedimentary rock-dominated subprovince. This work indicates that the volcanic rocks were emplaced during sedimentation, and they delineate a buried, **deep penetrating crustal structure**
 - A **previously undocumented Zn occurrence**, hosted by sedimentary rocks that are intercalated with the volcanic rocks, was discovered in this otherwise less-endowed and underexplored area

Marina D. Schofield

Adrian Rehm

Aidan Paleczny

David Snyder

Partners

