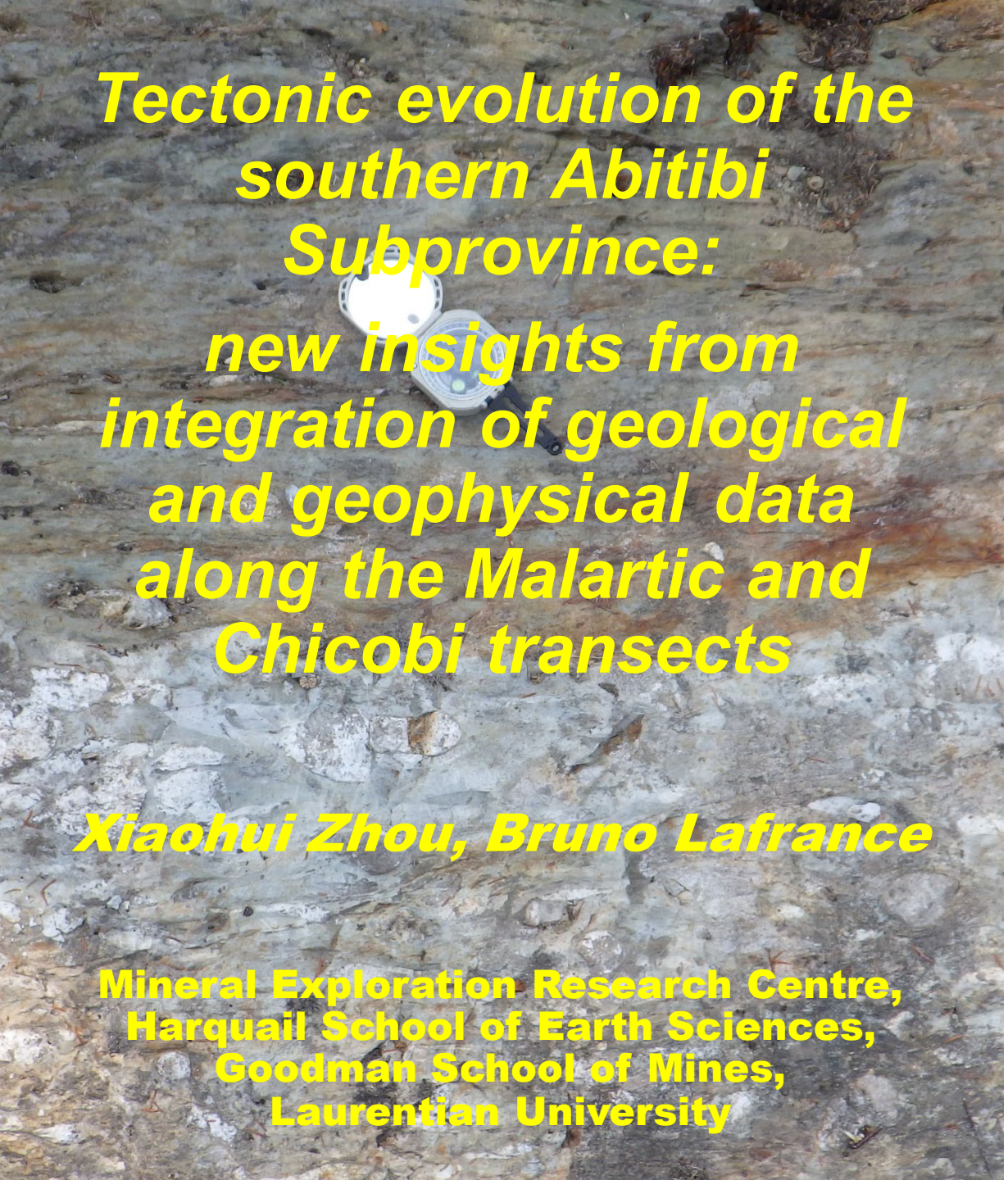

Tectonic evolution of the southern Abitibi Subprovince: new insights from integration of geological and geophysical data along the Malartic and Chicobi transects

Xiaohui Zhou, Bruno Lafrance

**Mineral Exploration Research Centre,
Harquail School of Earth Sciences,
Goodman School of Mines,
Laurentian University**

METAL EARTH

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

CANADA FIRST RESEARCH EXCELLENCE FUND

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MERC
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Outline

- **Malartic Transect**

  Stratigraphy and Structural Geology, Mineral Occurrences, Major Research/Thesis Topics, Geological-Geophysical Cross Section

- **Chicobi Transect**

  Stratigraphy, Structural Geology, Gold Showing, Geological-Geophysical Cross Section

- **Structural Evolution and Gold Mineralization of the Cadillac Basin**
- **Summary**

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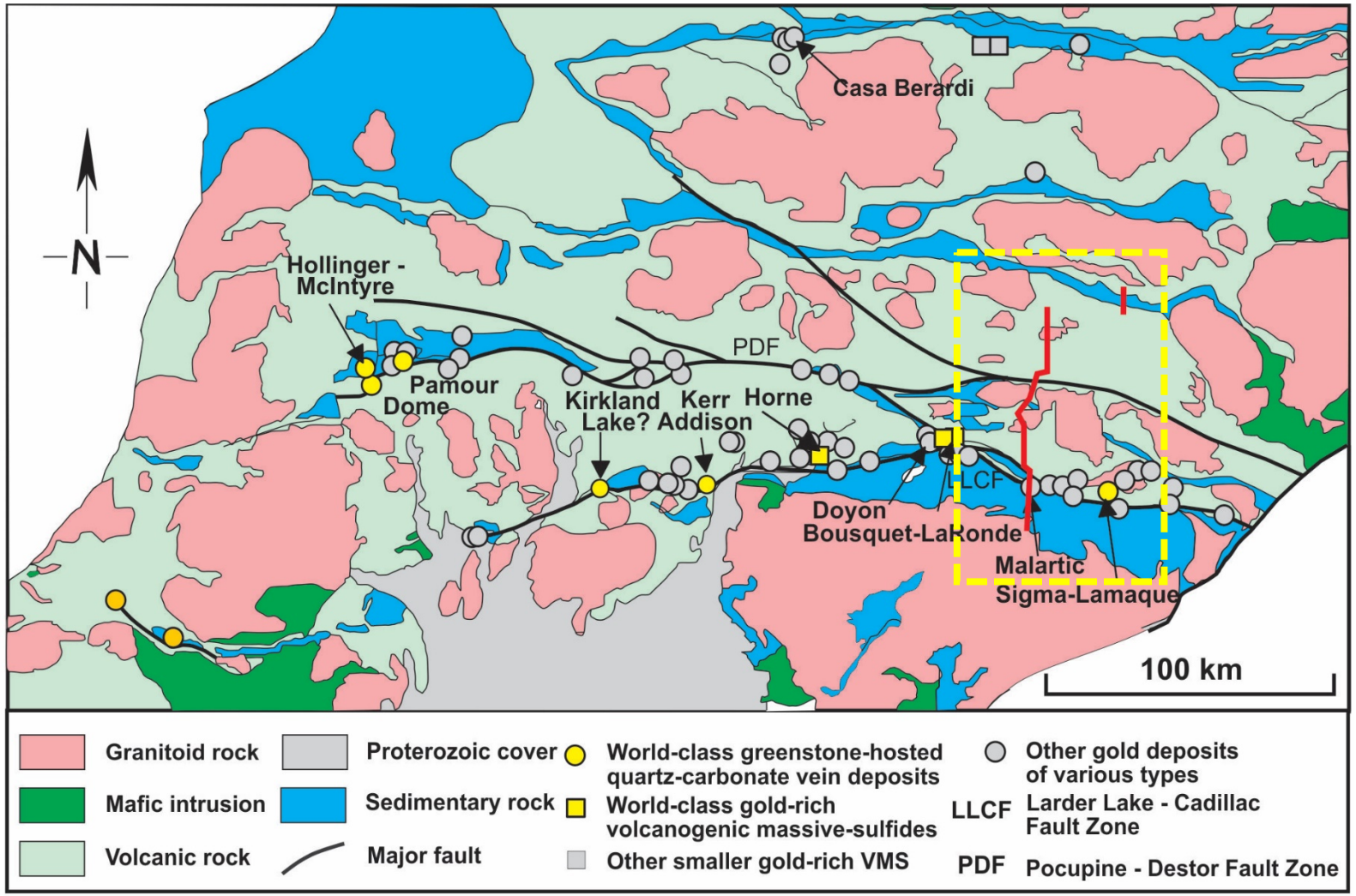
Superior Province

1. Lithostratigraphic associations and volcano-sedimentary terrane boundaries;
2. Crustal scale deformation zones: PDF and LLCF;
3. World-class gold deposits: vein-type, gold-rich VMS, other various types



Dubé and Gosselin, 2007

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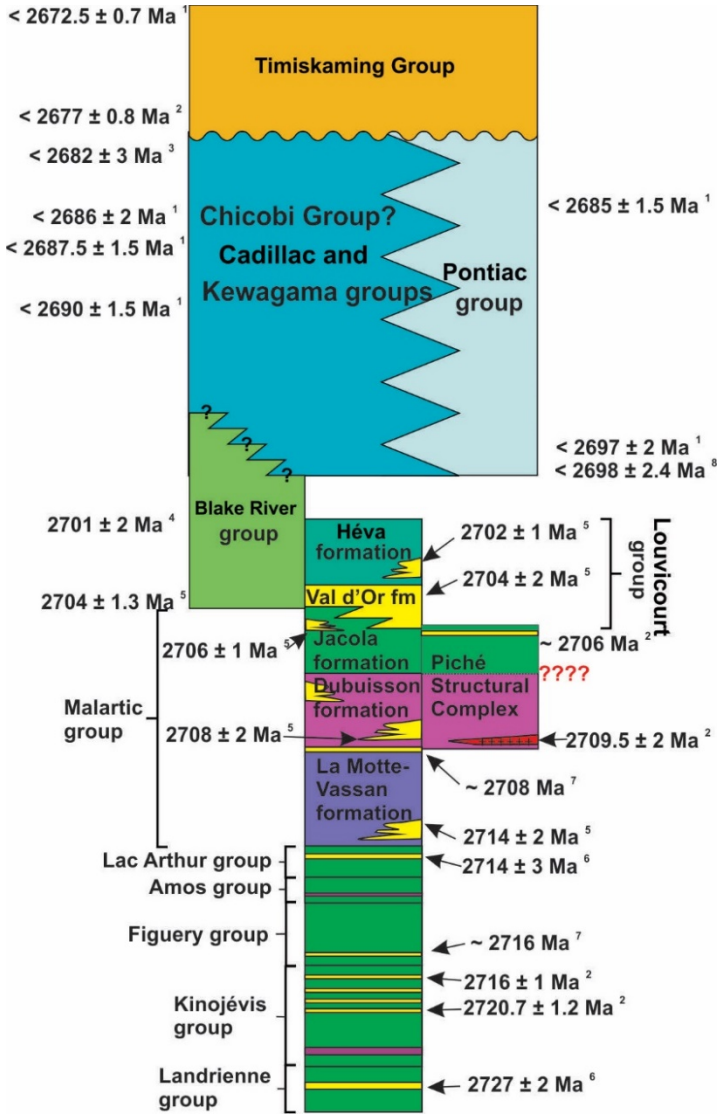
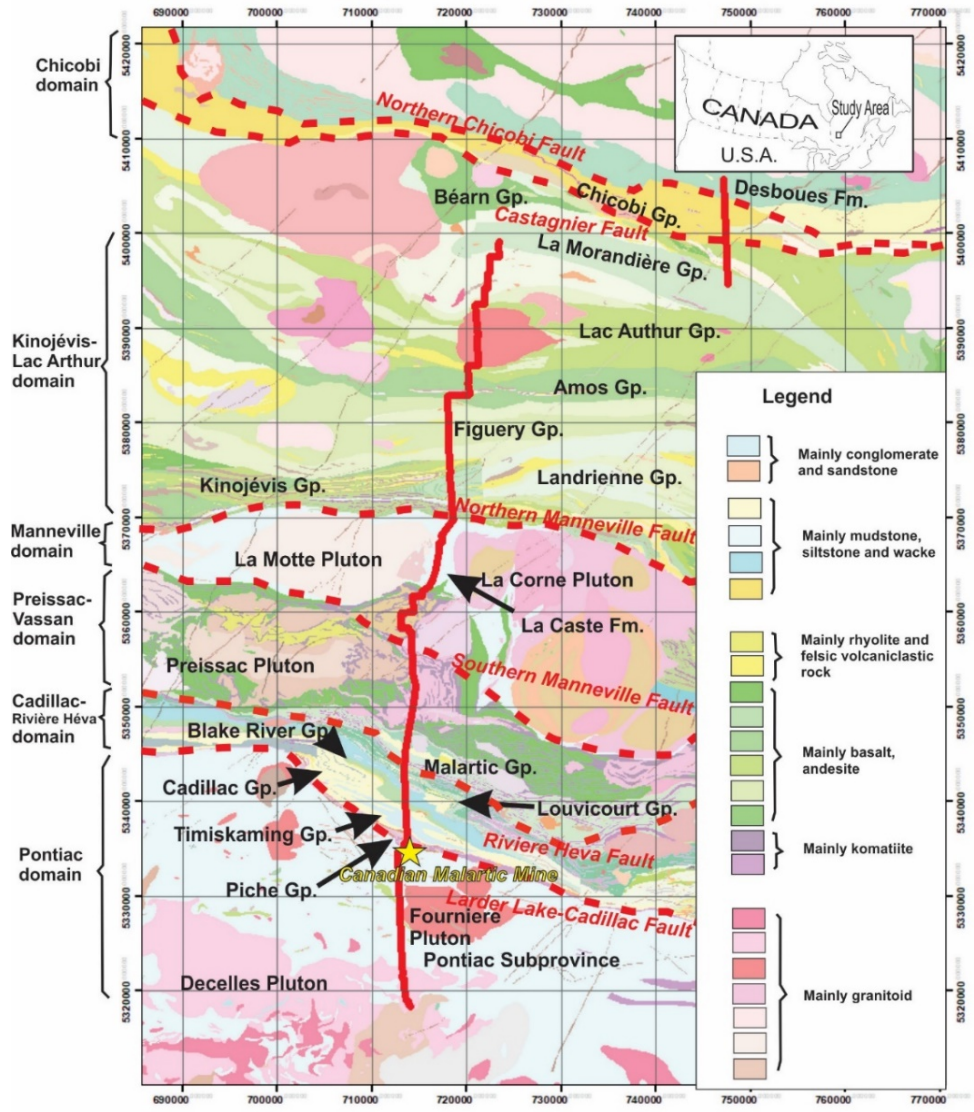
Malartic Transect: Stratigraphy



Modified from Pilote et al. 2015 and Bedeaux et al., 2017



Modified from SIGEOM, 2017

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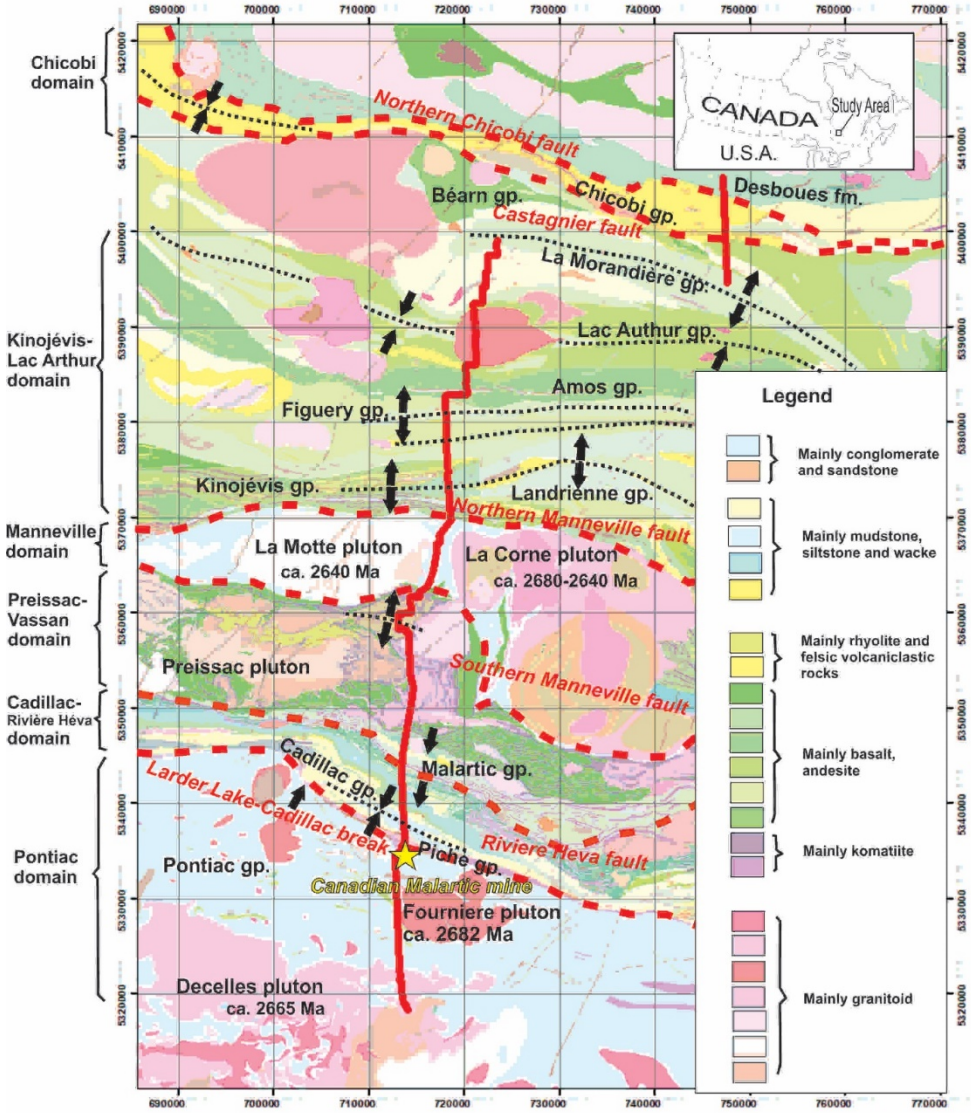
Deformation and Metamorphism

- **Early shortening, pre-Timiskaming (> 2678 Ma):** isolated fabrics in the clasts of Chicobi conglomerate, early isoclinal folding in Pontiac
- **Extension (2677-2672 Ma):** deposition of Timiskaming and syn-Timiskaming magmatism (e.g. Dimroth et al., 1982; Bleeker, 2012); formation of pull-apart basins (Daigneault, 2002)
- **N-S Shortening (2672-2665 Ma):** NW-W cleavage, moderate to steep lineation, regional upright folds
- **Sinistral shearing (2672-2665 Ma):** En echelon vein arrays in Cadillac basin; Northern Chicobi fault
- **Exhumation of S-type Decelles, La Corne and La Motte batholith (2665-2640 Ma)**: shallow foliation (Daigneault et al., 2002)
- **Dextral transpression:** Z drag folds and shear band cleavage, cleavage anticlockwise to bedding, moderate or shallow lineation

- **M: late- or post-D3** Greenschist to Amphibolite facies, Peak at ca. 2657±7 Ma (Piette-Lauziere, 2017)



Modified from SIGEOM, 2017

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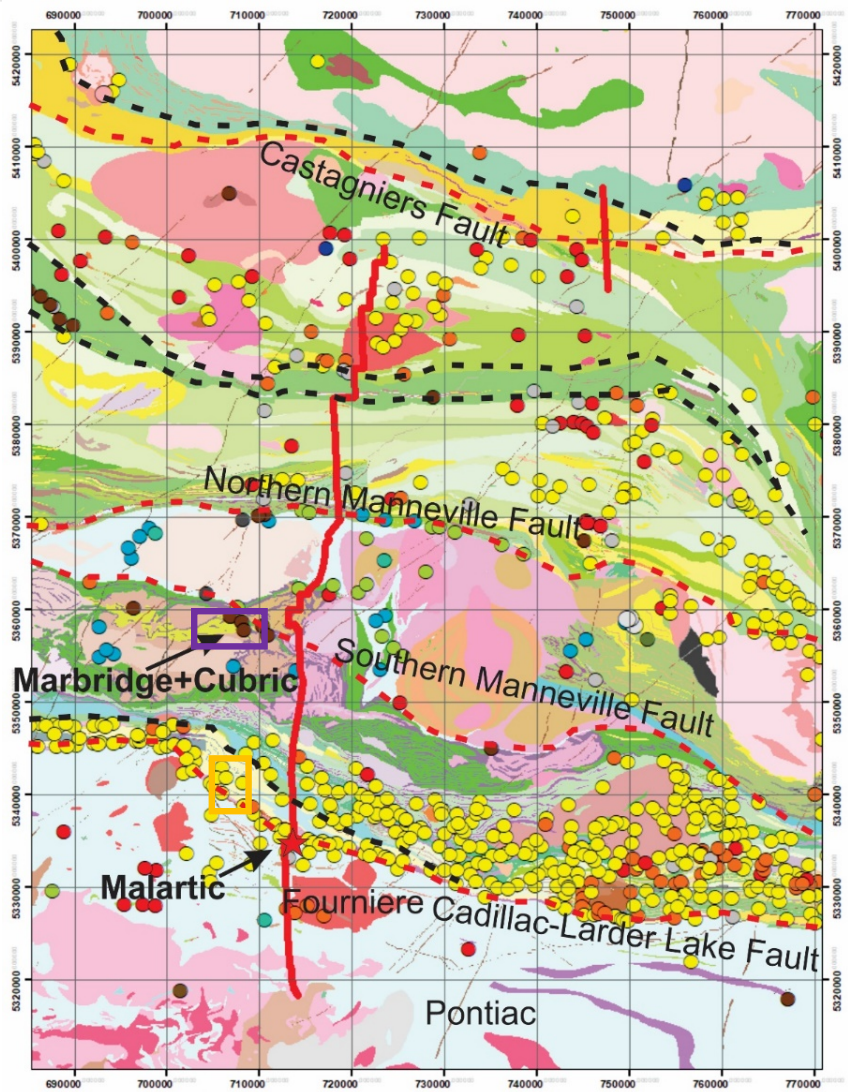
Major Research/Thesis Projects

- ✓ **Xiaohui Zhou, R.A.**
  1. Contact relationships and fault kinematics in major crustal-scale deformation zones
  2. Structural control and modification of mineral deposits
- ✓ **Brendon Samson, M.Sc. Student**
  Structural evolution of the Cadillac basin and its implications for gold mineralization

- ✓ **Danielle Shirriff, M.Sc. Student**
  Ore genesis and structural modification of Nickel Mineralization at Cubric showing along the Southern Manneville Fault.



(SIGEOM,2017)

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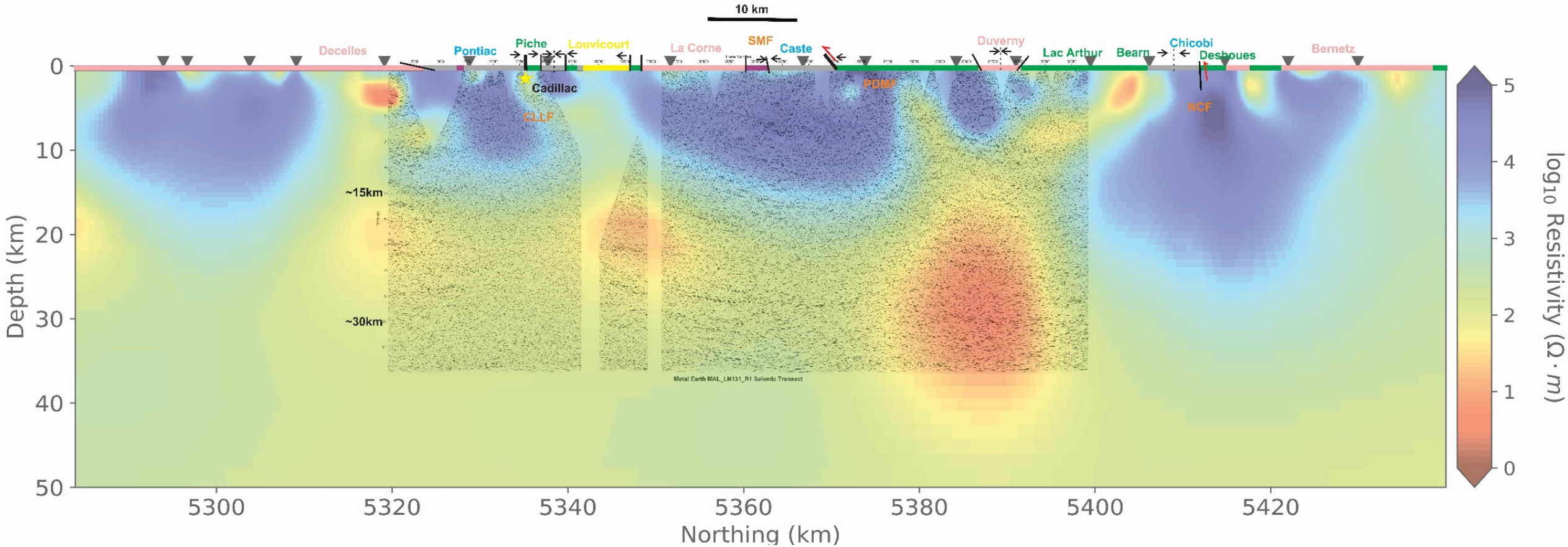
Malartic Seismic and MT Section



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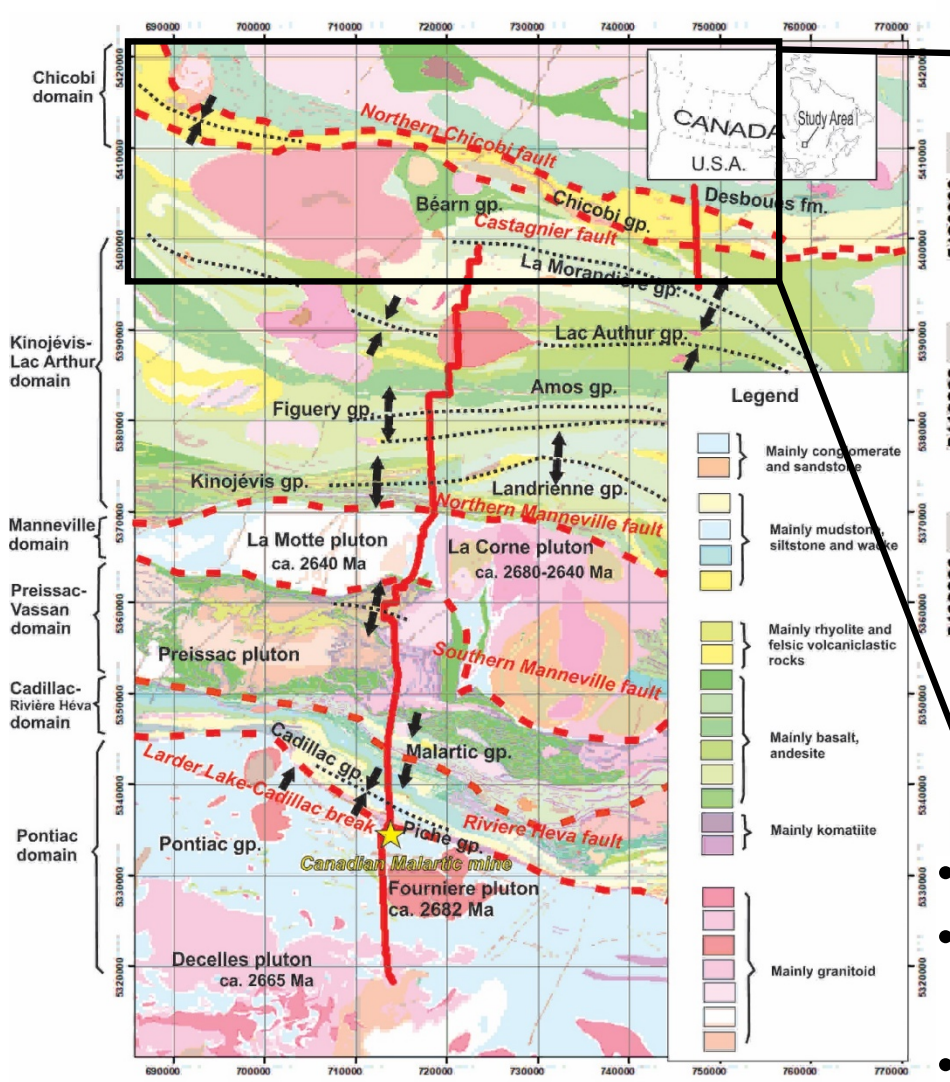
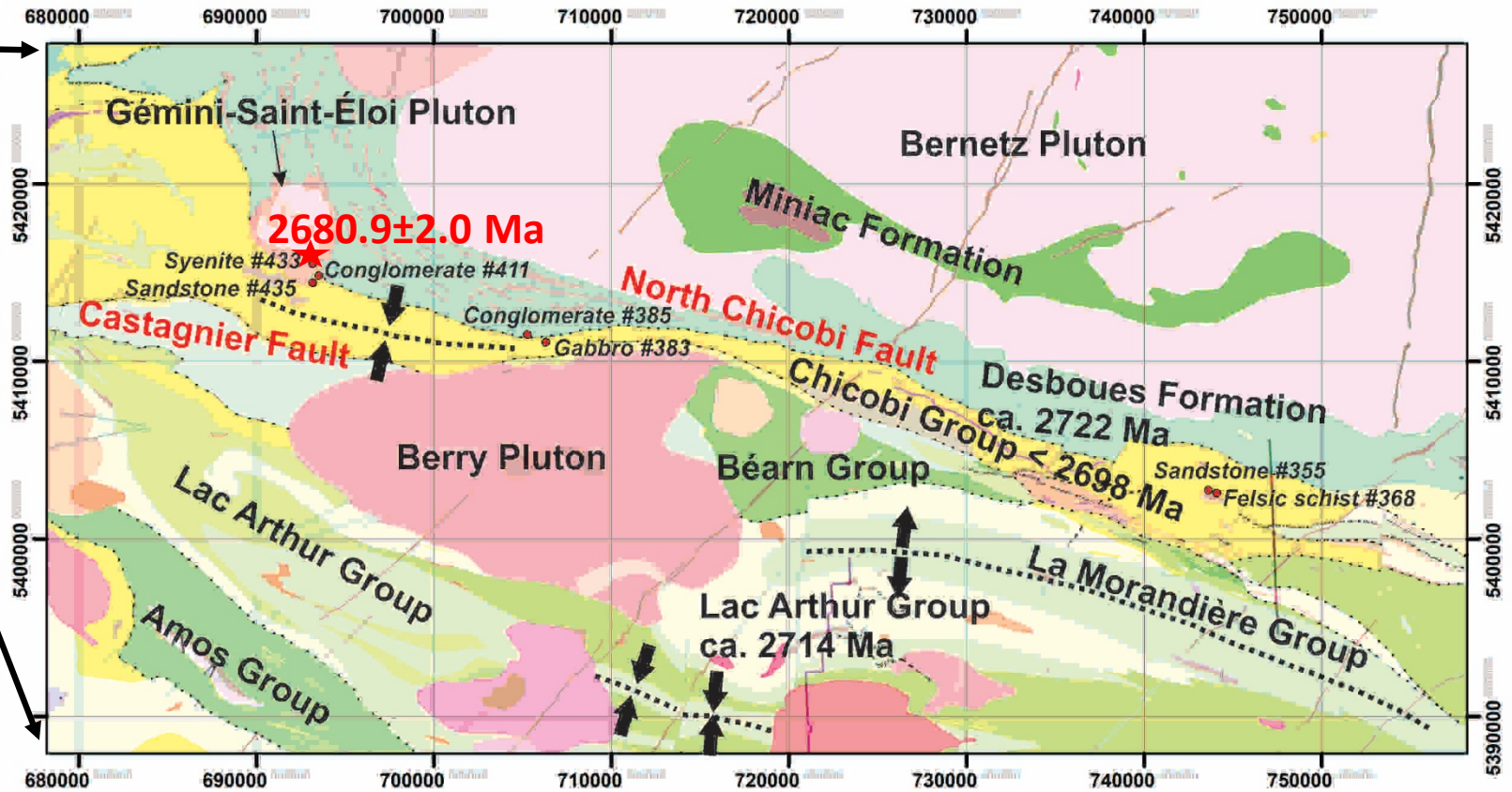
Chicobi Deformation Zone



(SIGEOM,2017)



- Chicobi basin unconformably overlies older volcanic terranes
- Gemini-Saint-Eloi pluton intrudes both Chicobi sedimentary rocks and older mafic volcanic rocks of the Desboues Formation
- Fault-bounded, multi-phase deformation
- Amphibolite facies metamorphism

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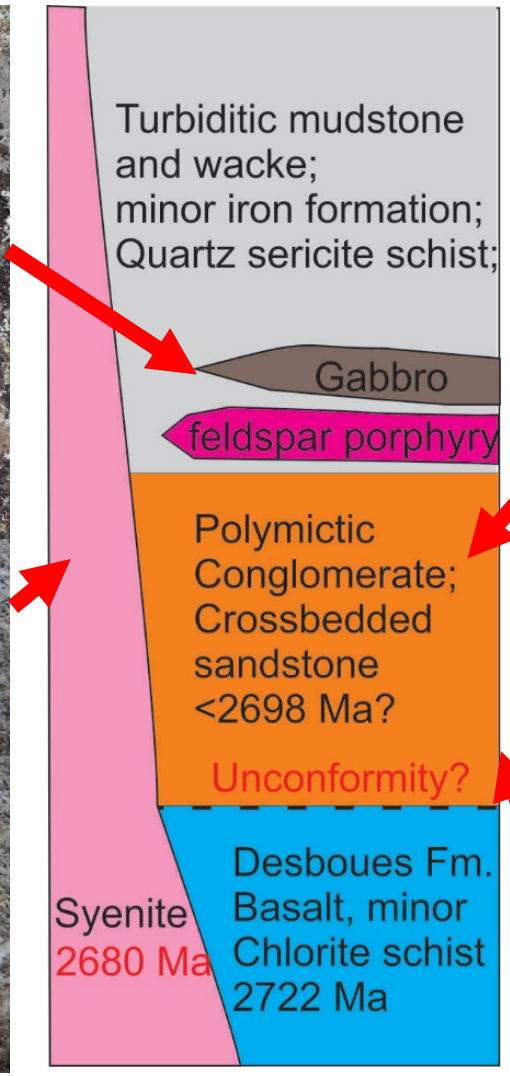
Chicobi Basin lithostratigraphic units



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Chicobi Deformation Zone

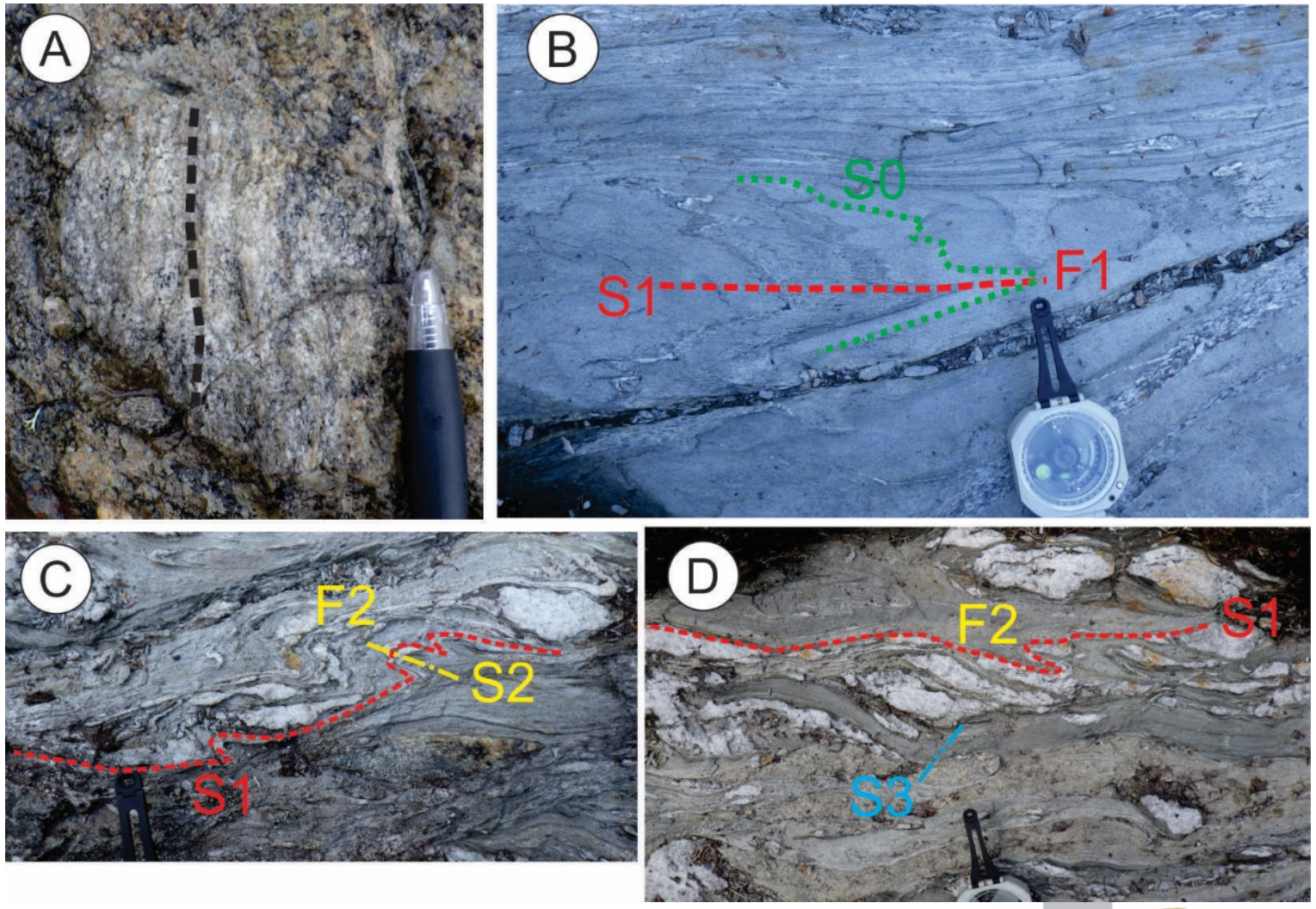
A: Foliated granitoid clasts: pre-deposition of Chicobi conglomerate

B: **N-S shortening** isoclinal F1 and W subvertical axial S1

C: Sinistral shearing S-folded F2 and NW subvertical S2

D: Dextral shearing

Z drag folds and S3 NE subvertical crenulation cleavage



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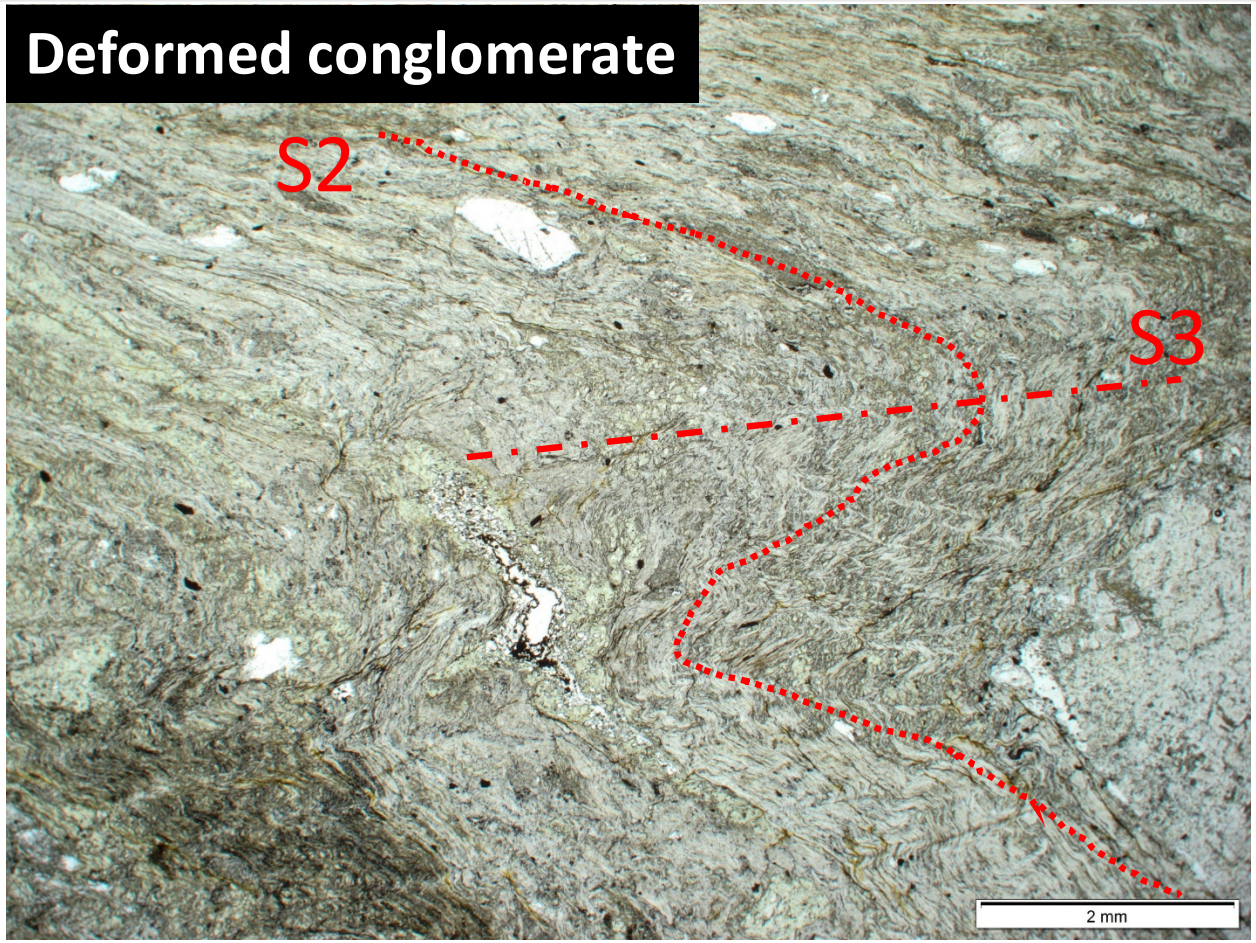
Petrology and Microstructure



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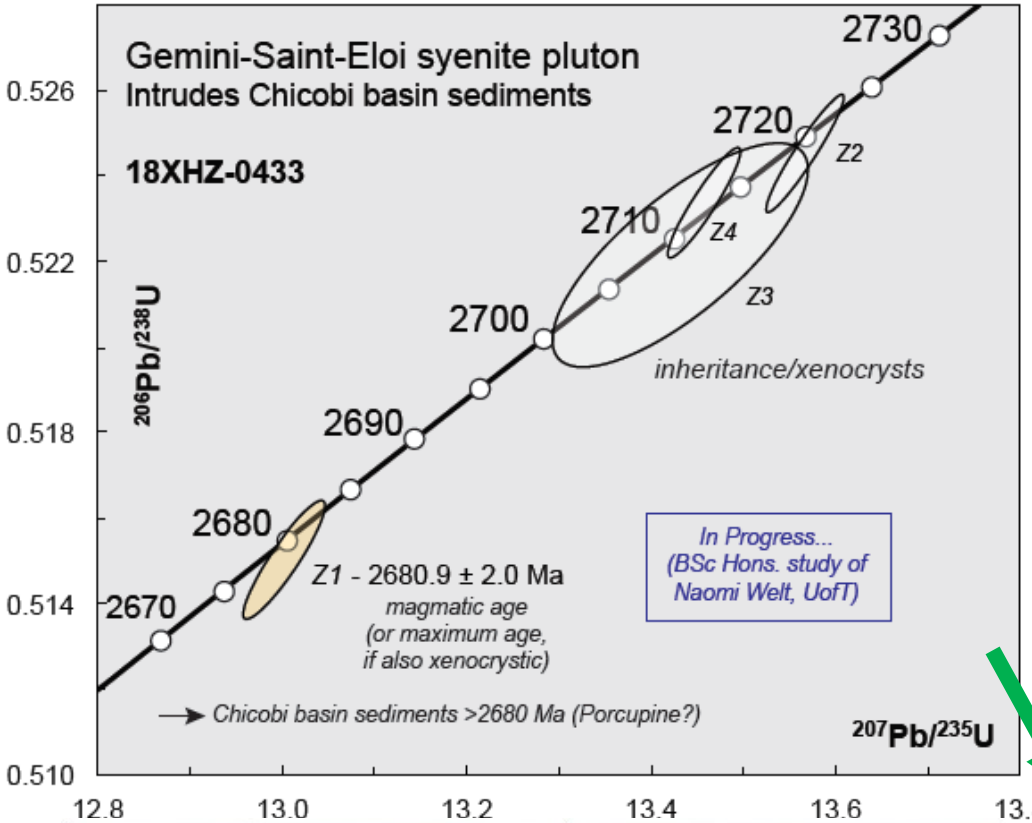
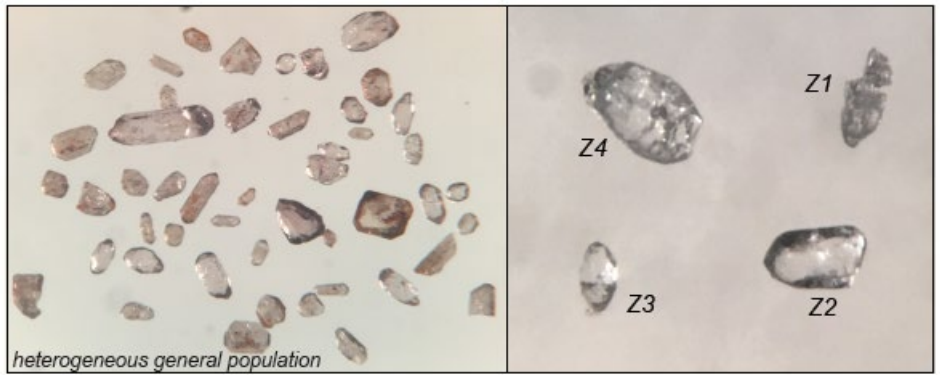
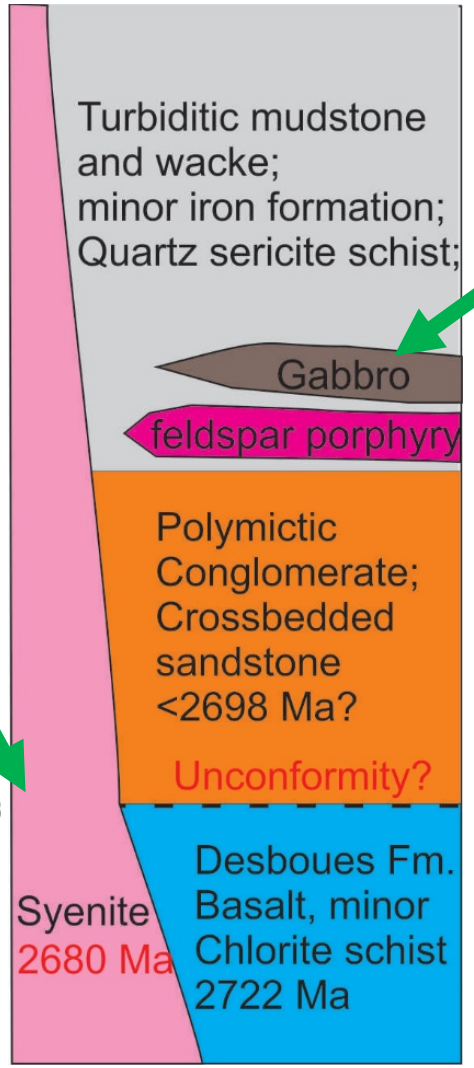
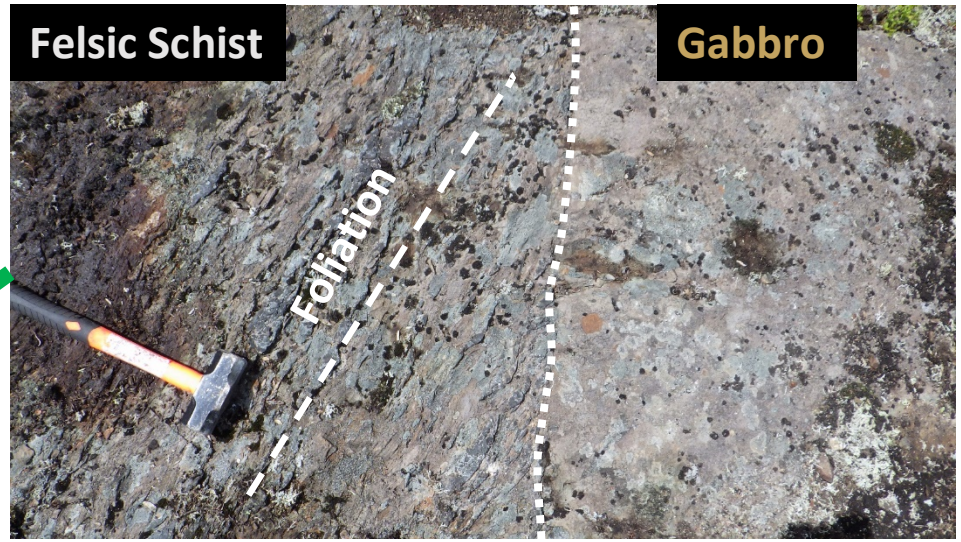
Geochronology Results

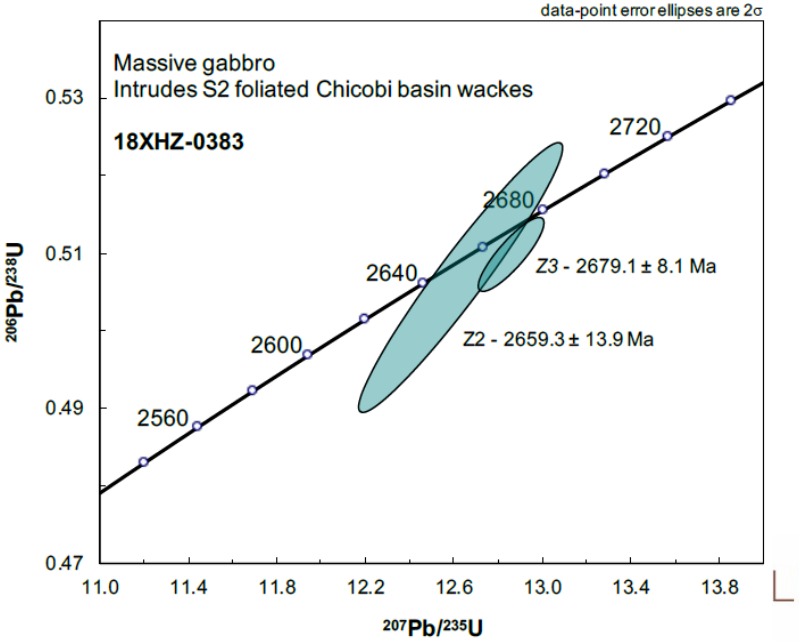








data-point error ellipses are 2σ



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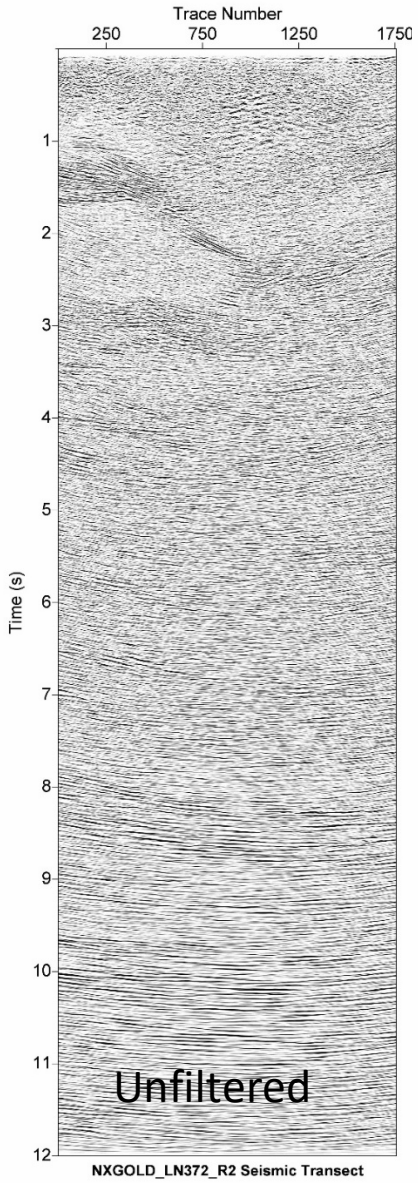
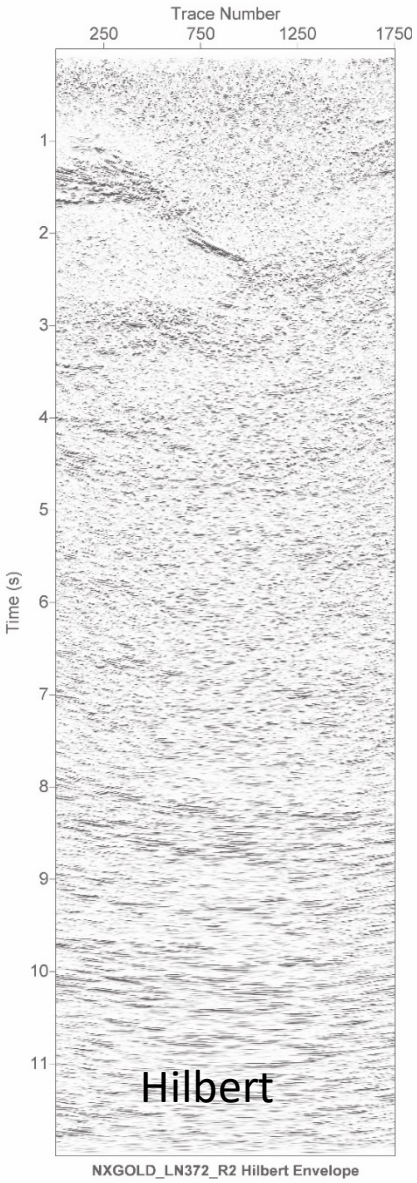
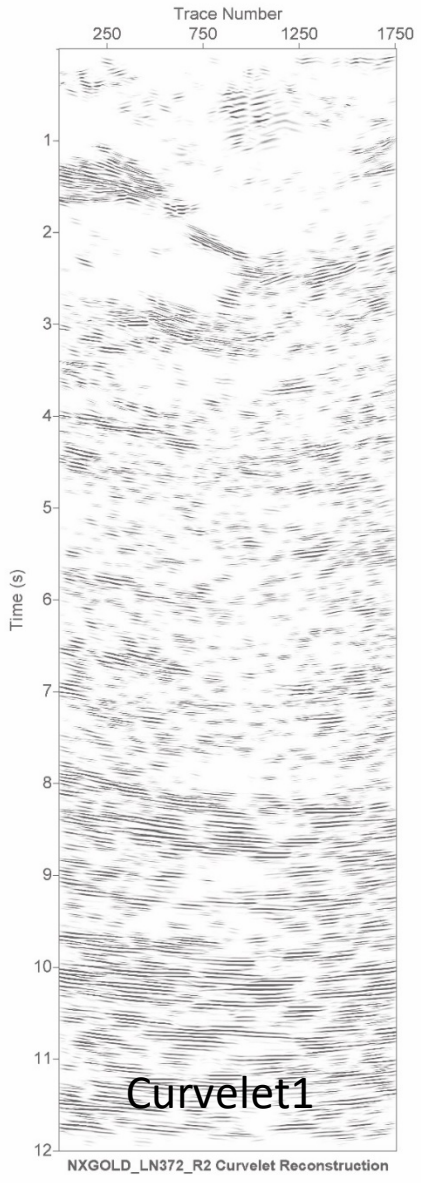
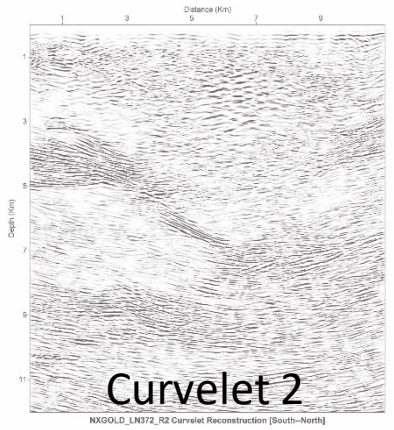
Chicobi Seismic Profile









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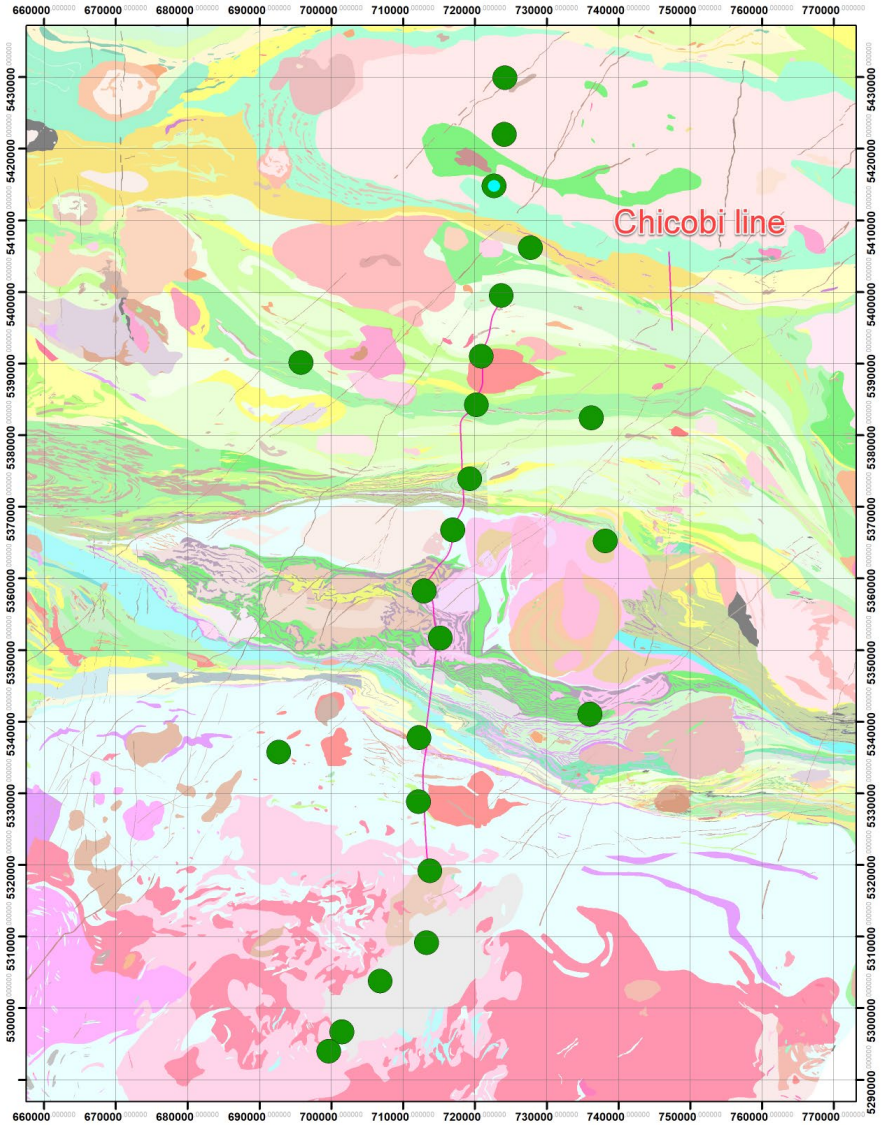
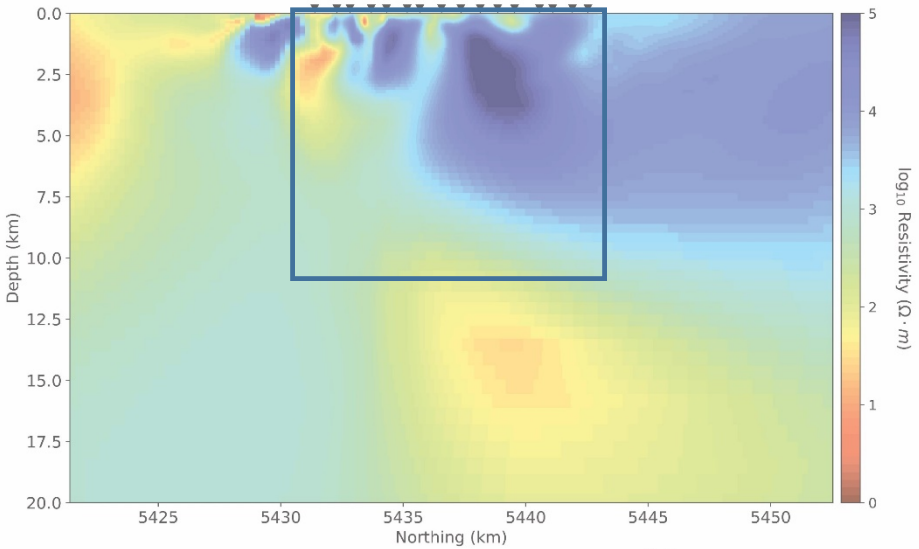
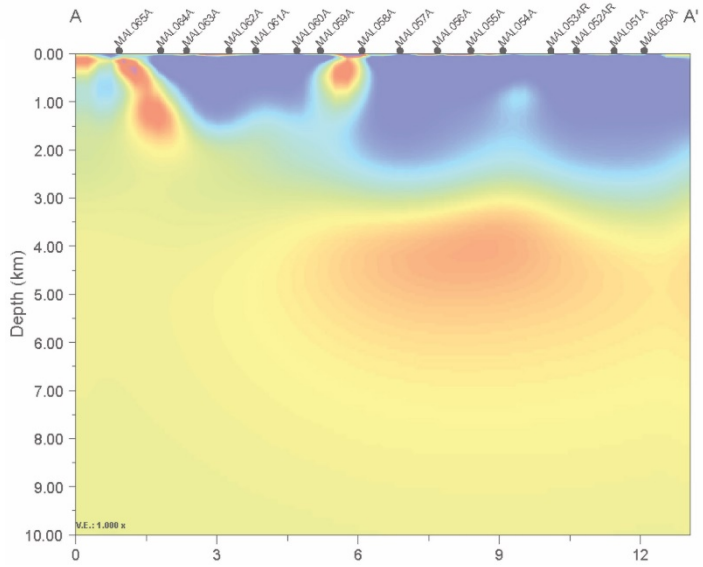
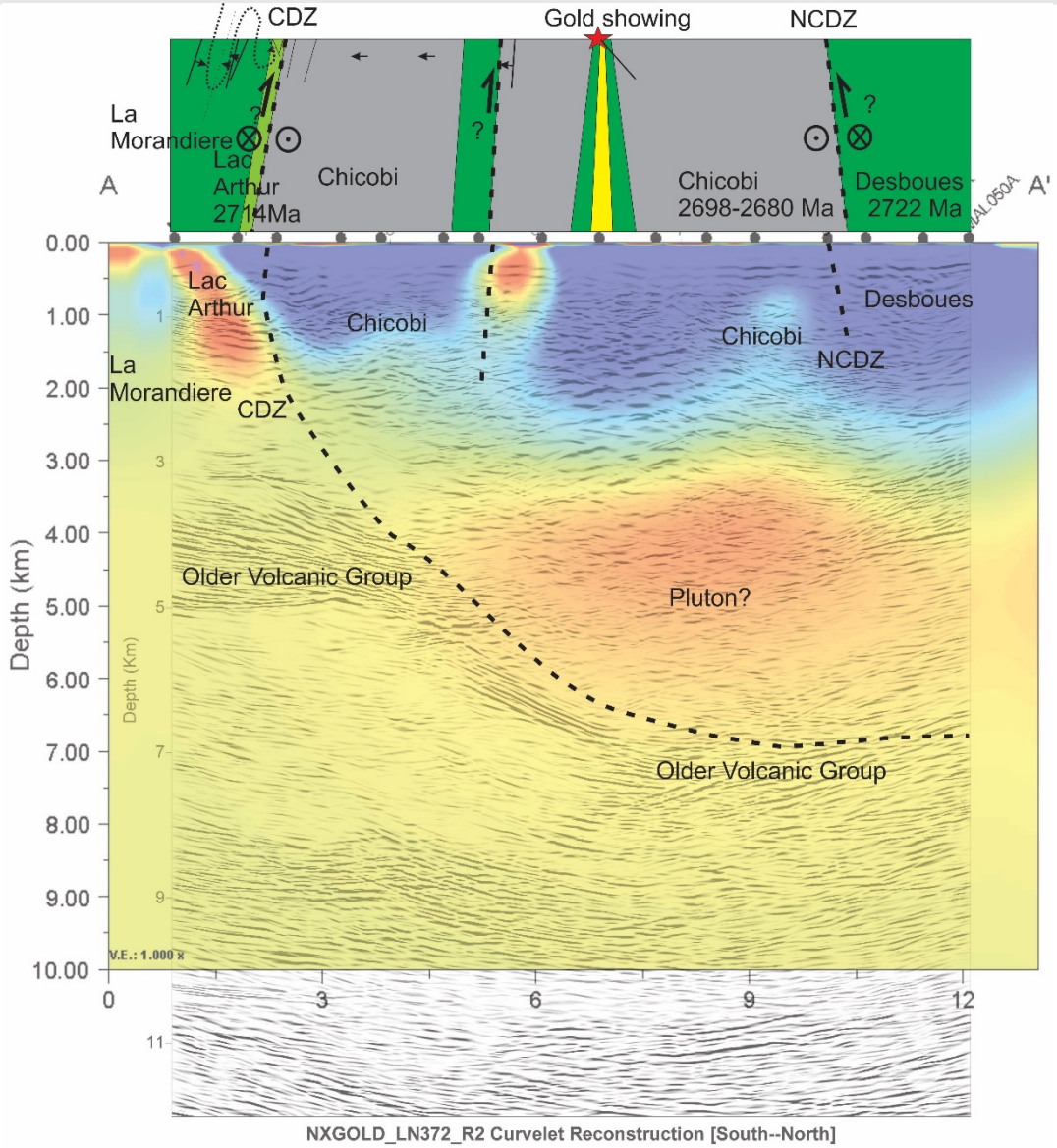
Chicobi MT Profile

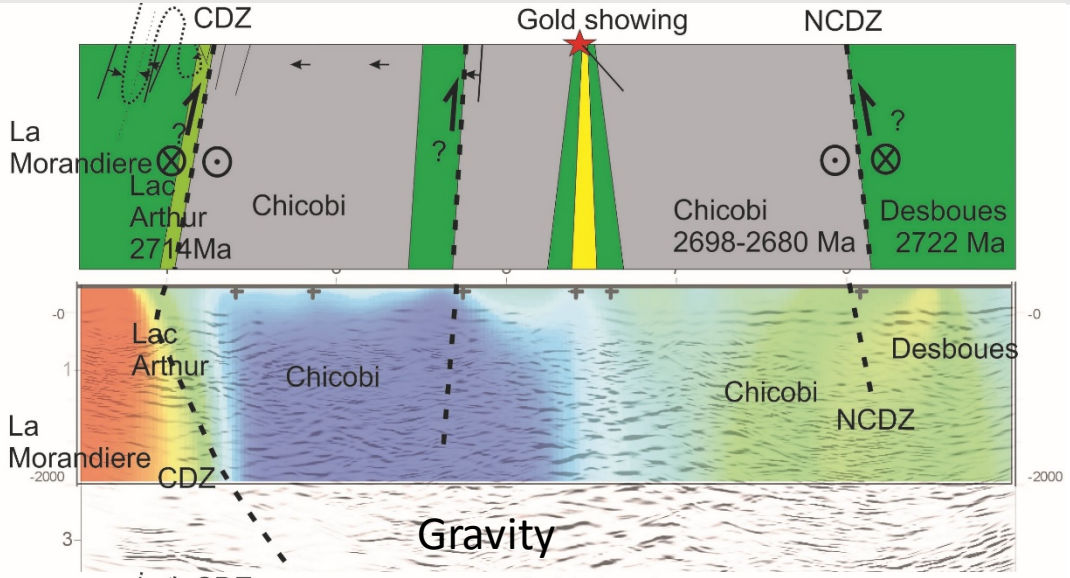


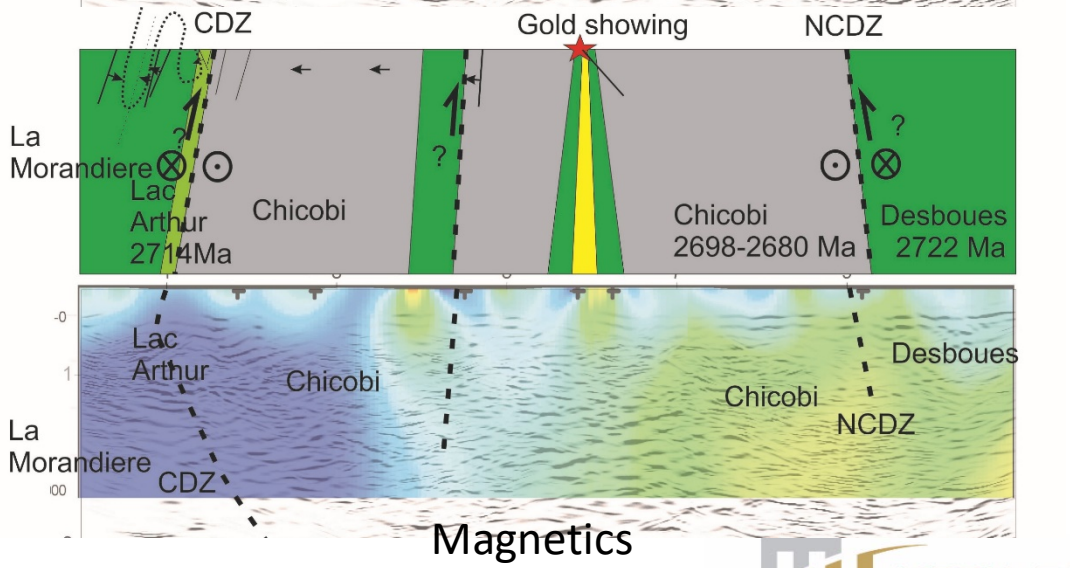




Chicobi Section

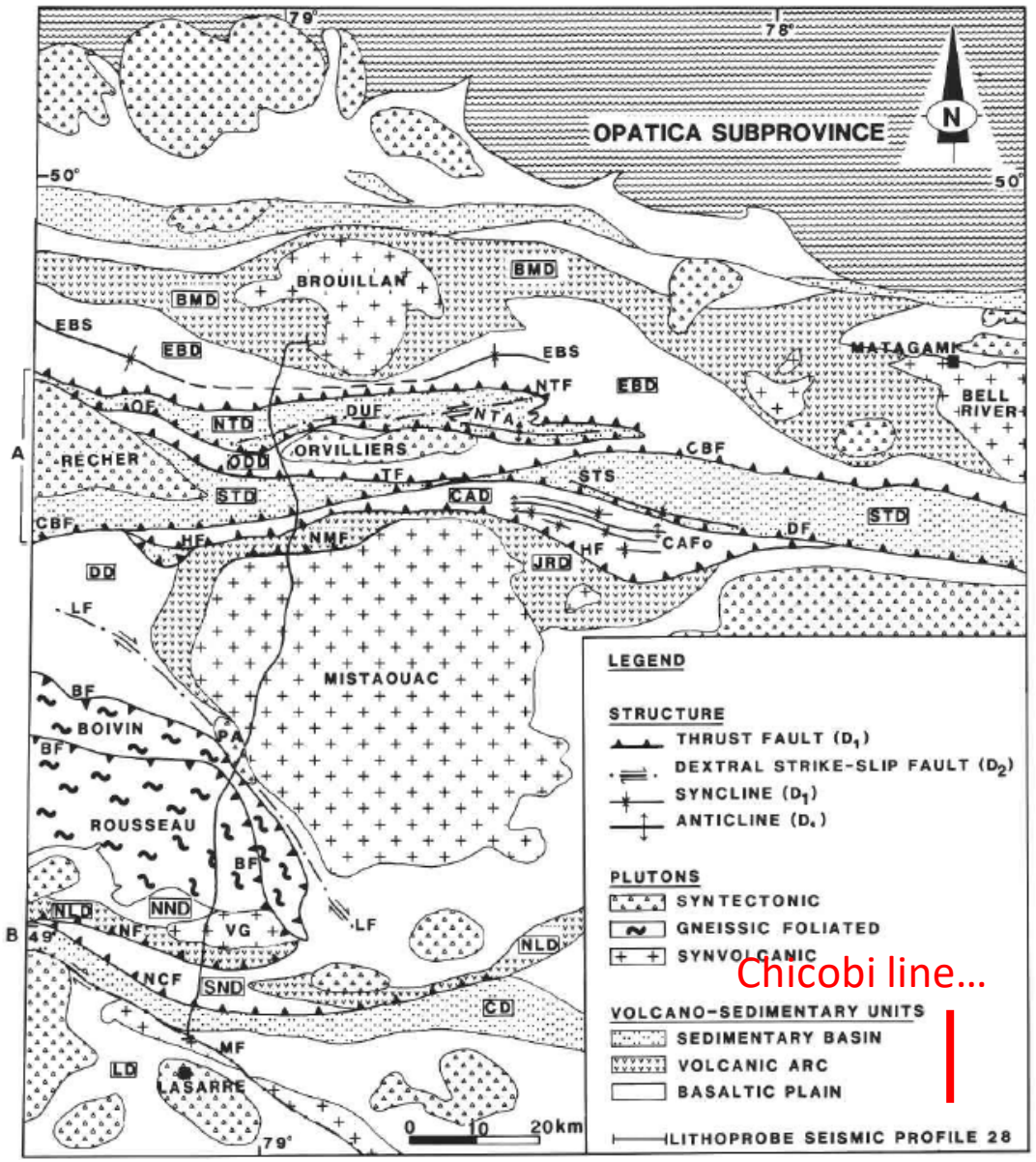


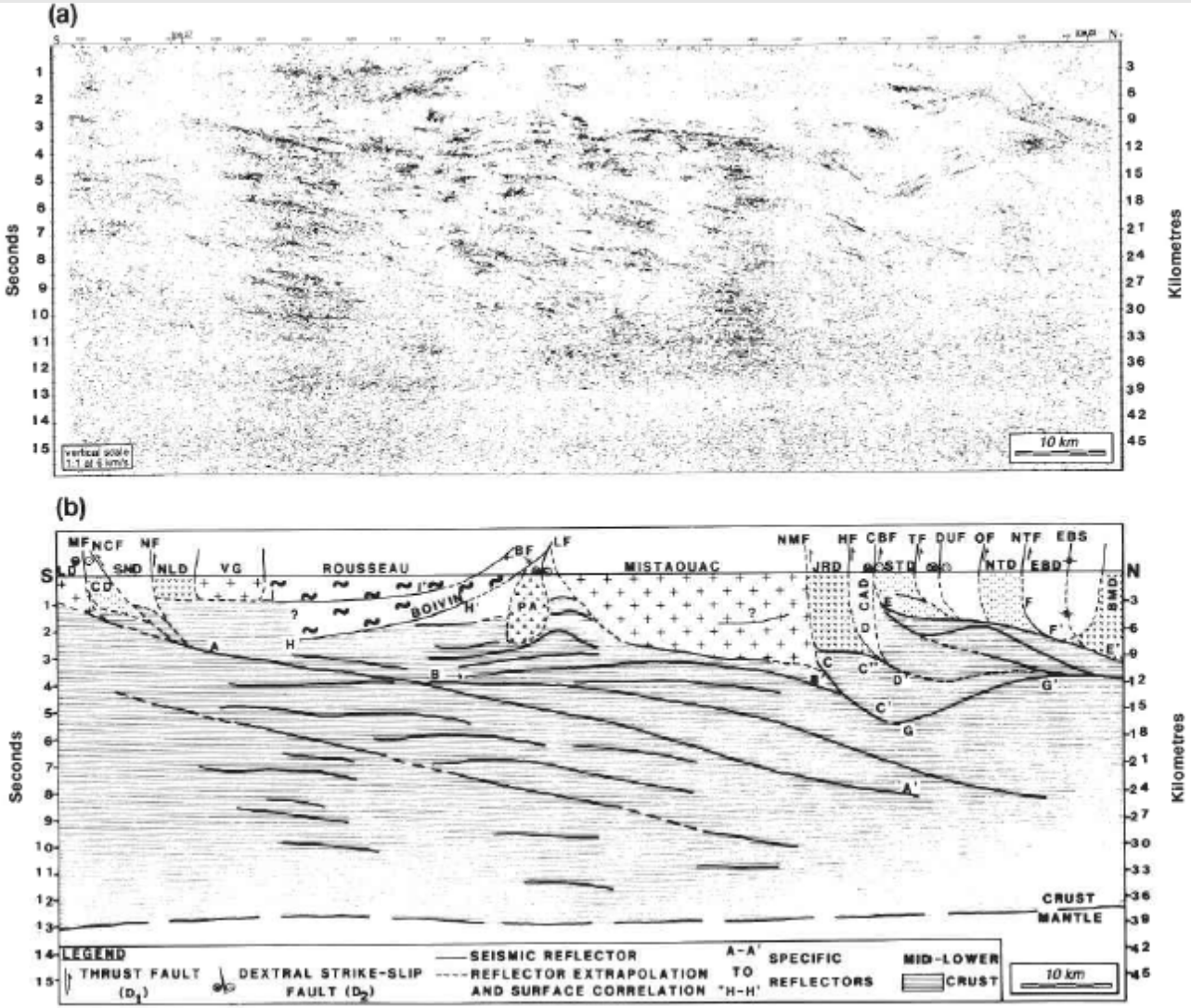




METAL EARTH

Lithoprobe Seismic Section





Lacroix and Swayer, 1995

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Chicobi Basin Summary

- Contacts between the <2698-2680 Ma Chicobi sedimentary basin and the older Desboues formation volcanic rocks were intruded by syenite of the Gemini-Saint-Eloi pluton dated at 2680 ± 2.0 Ma.
- All rocks were effected by W-striking upright F1 regional folds, followed by NW-striking F2 sinistral S-folds and NE-striking F3 dextral Z-folds. Veins were emplaced before D1 regional folding.
- The massive gabbro, dated between 2679 ± 8.1 Ma and 2659.3 ± 13.9 Ma, crosscuts S2 penetrative cleavage in the Chicobi sediments, which gives the minimum age of the regional folding deformation episode.
- Geophysical (seismic, MT, gravity) data consistently show the Castagniers deformation zone as a listric detachment dipping northward.

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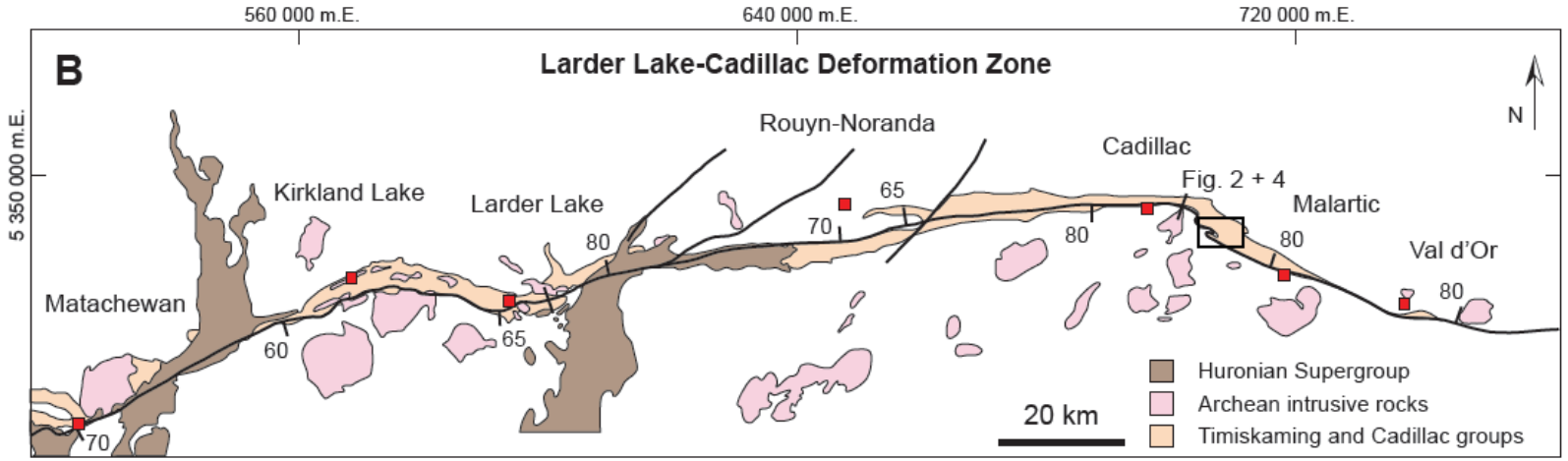
Larder Lake-Cadillac Break



Modified from Poulsen, 2017

Six persistent and unifying characteristics through out the break (Poulsen, 2017; Ridler, 1970):

1) A spatial association with ultramafic volcanic rocks;
2) A spatial association with conglomeratic sedimentary rocks;
3) A locus for carbonate alteration;
4) A spatial association with alkalic-shoshonitic igneous rocks;
5) A locus for high-strain phyllonitic rocks, shear zones and minor folds;
6) A depositional site for numerous gold deposits and occurrences.

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Larder Lake-Cadillac Break

Cadillac-Malartic segment

Lithologies

Timiskaming Group (2677-2672 Ma)
- Sandstone
- Polymictic conglomerate
- Granodiorite **(ca. 2675 ± 2.0 Ma)**

Cadillac Group (<2686 Ma)
- Turbiditic wacke
- Sandstone
- Polymictic conglomerate
- Iron formation

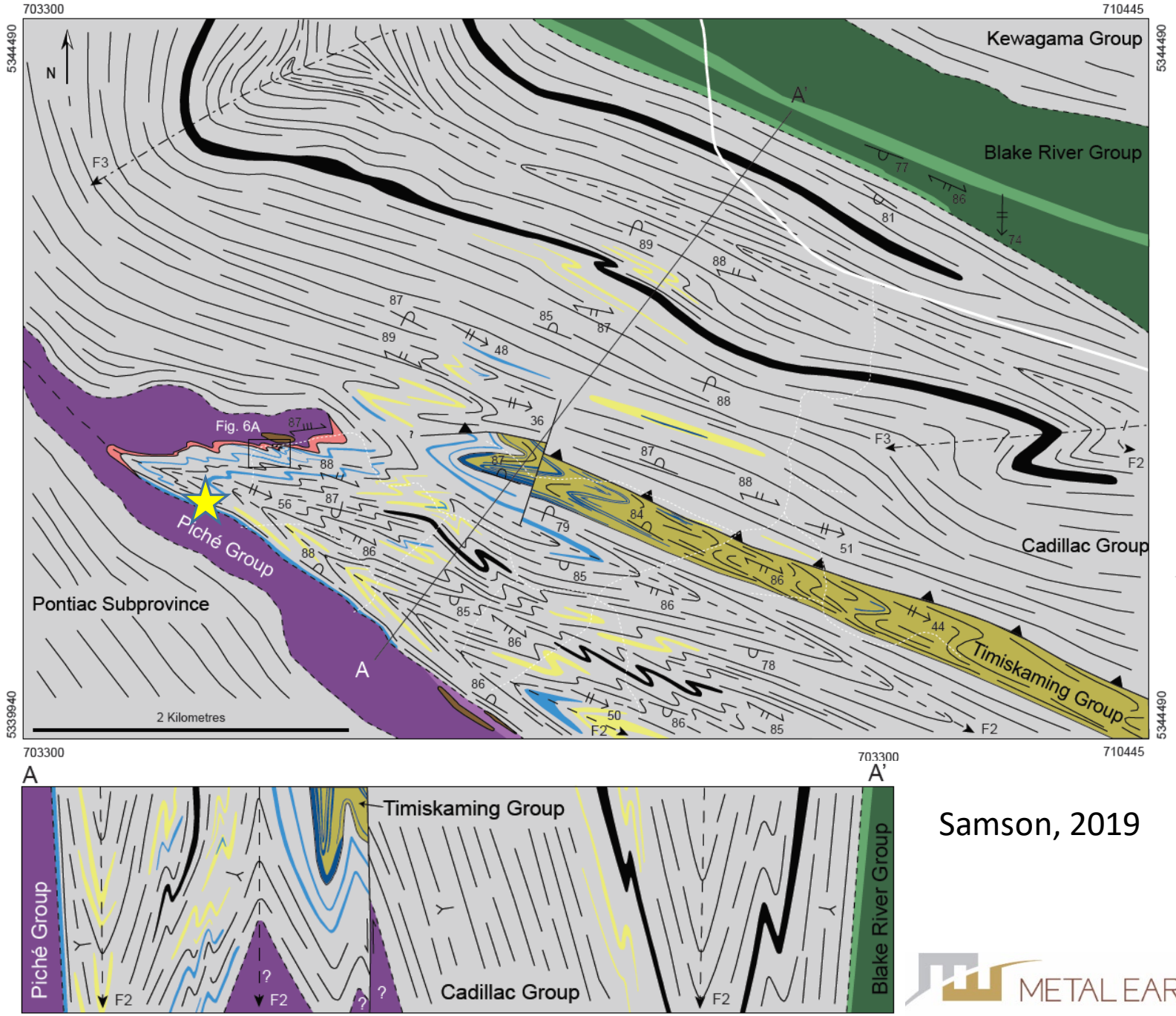
Kewagama Group (<2686 Ma)
- Turbiditic wacke

Blake River Group (2704 - 2695 Ma)
- Mafic flow
- Felsic flow

Piché Group (2709 - 2706 Ma)
- Mafic and ultramafic flow
- Felsic flow
- Gabbro

Pontiac Subprovince (<2686 Ma)
- Turbiditic wacke

Structural Symbols
- Bedding unknown; inclined; overturned
- L2 lineation
- S2; S3 cleavage
- Bedding trace
- F2; F3 axial plane trace
- Fault unknown; thrust



Samson, 2019

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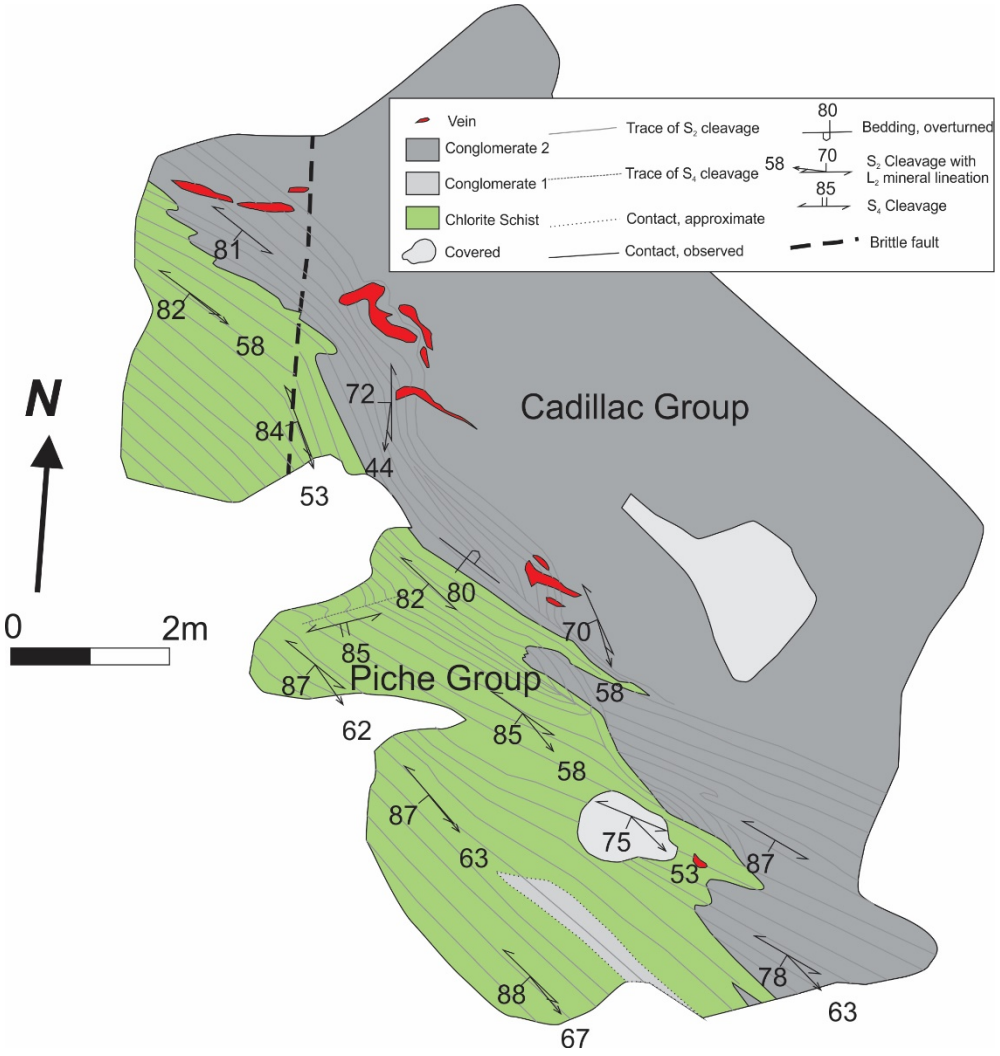
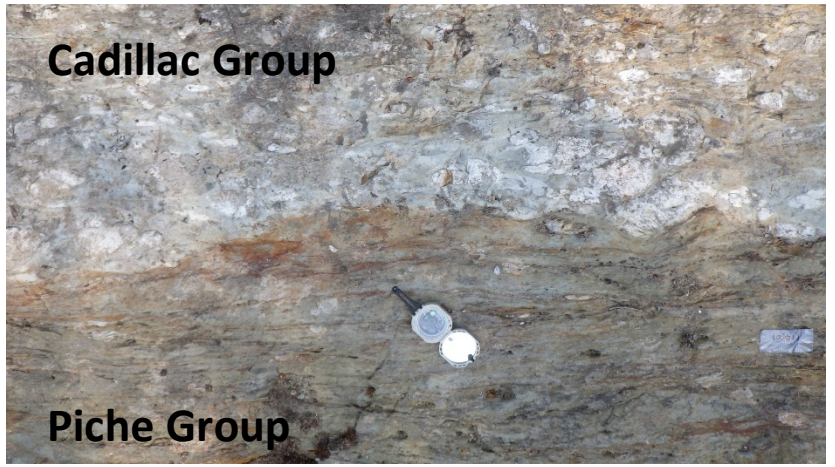
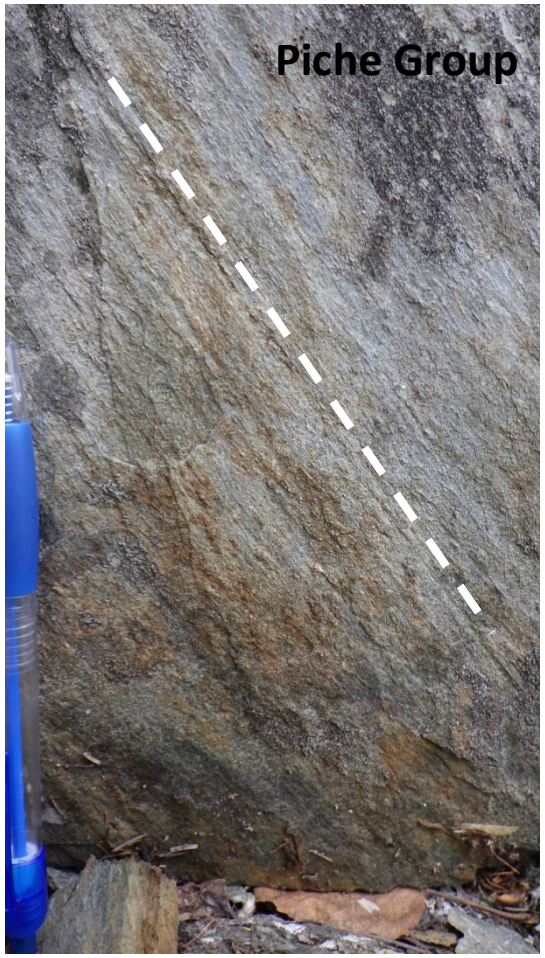
Larder Lake-Cadillac Break







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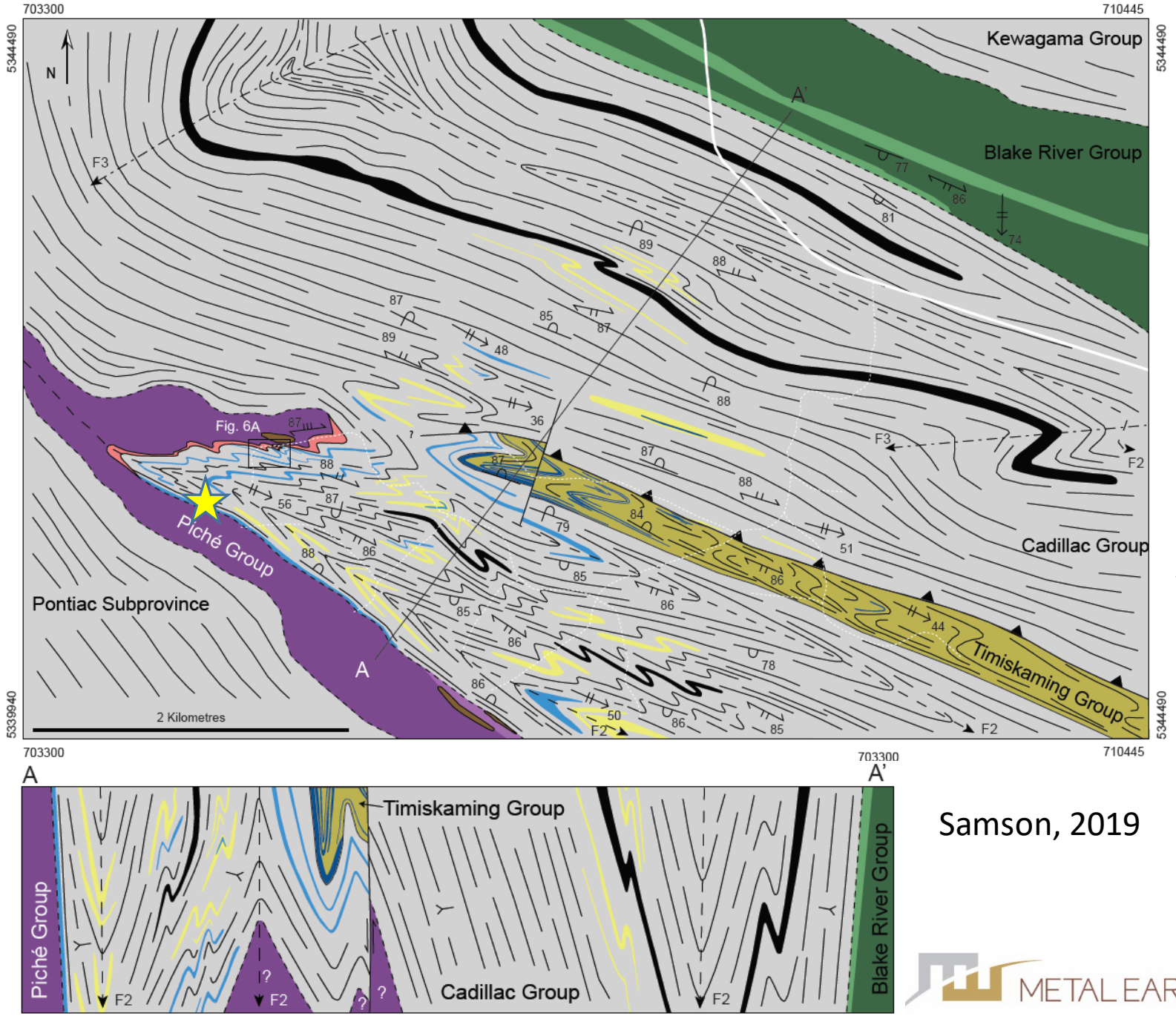

Samson, 2019

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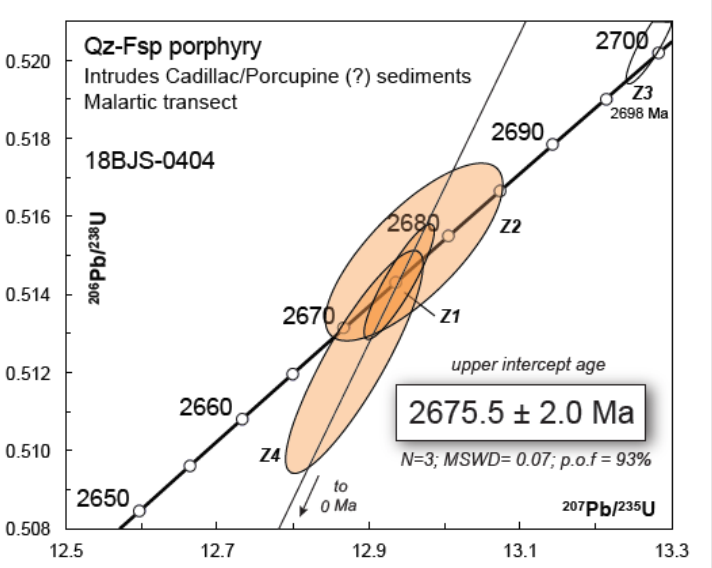
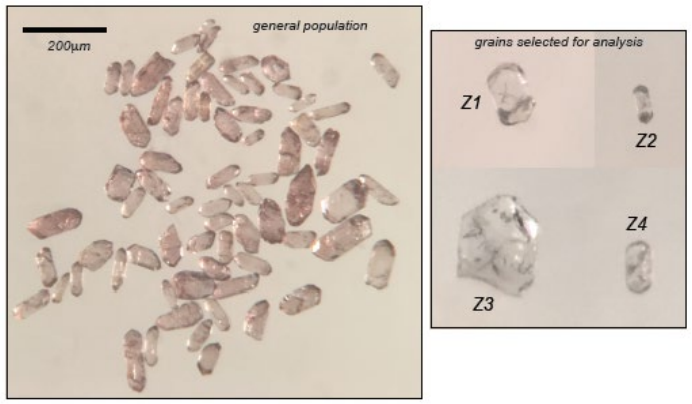
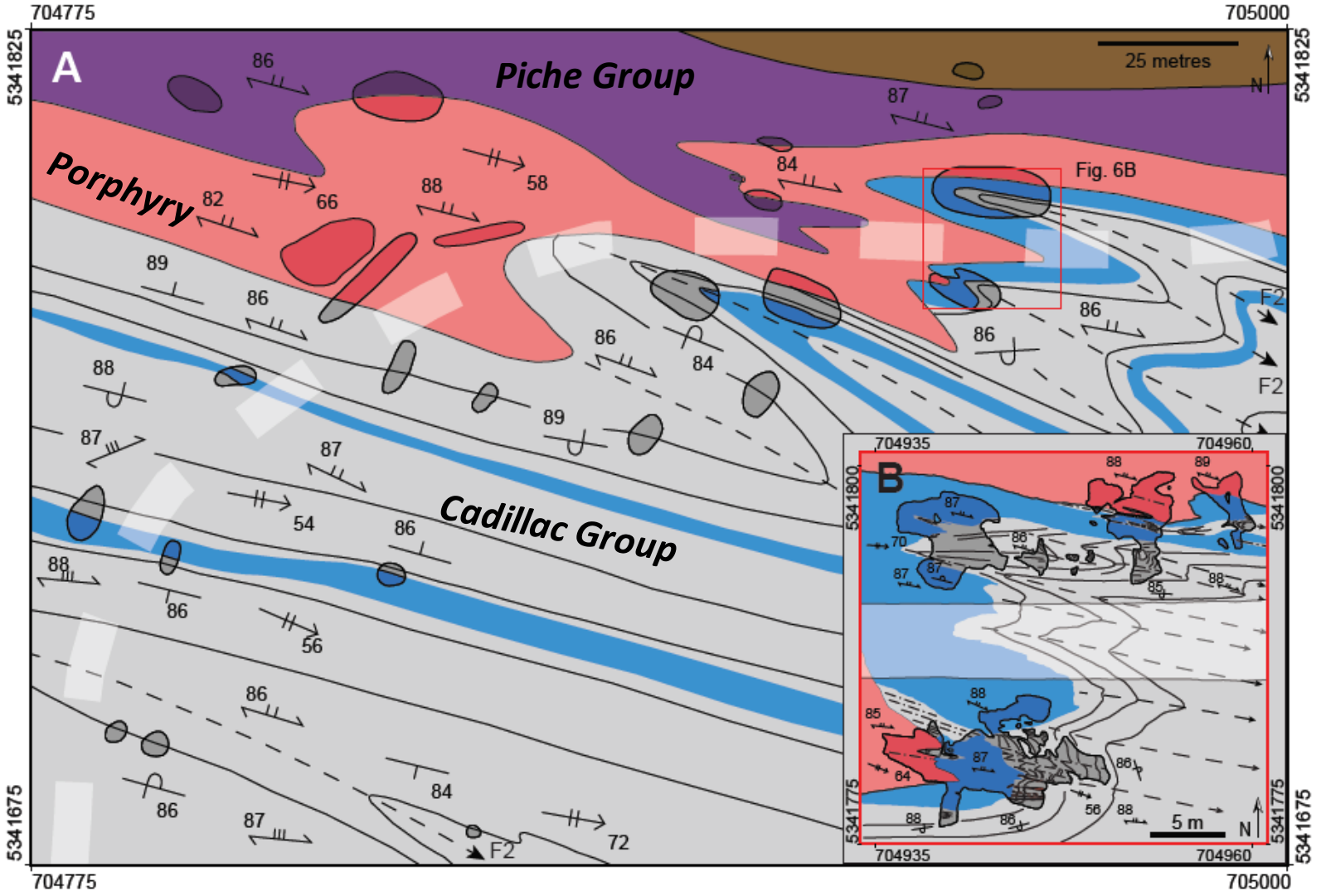




Mike Hamilton, pers. comm.



Samson, 2019

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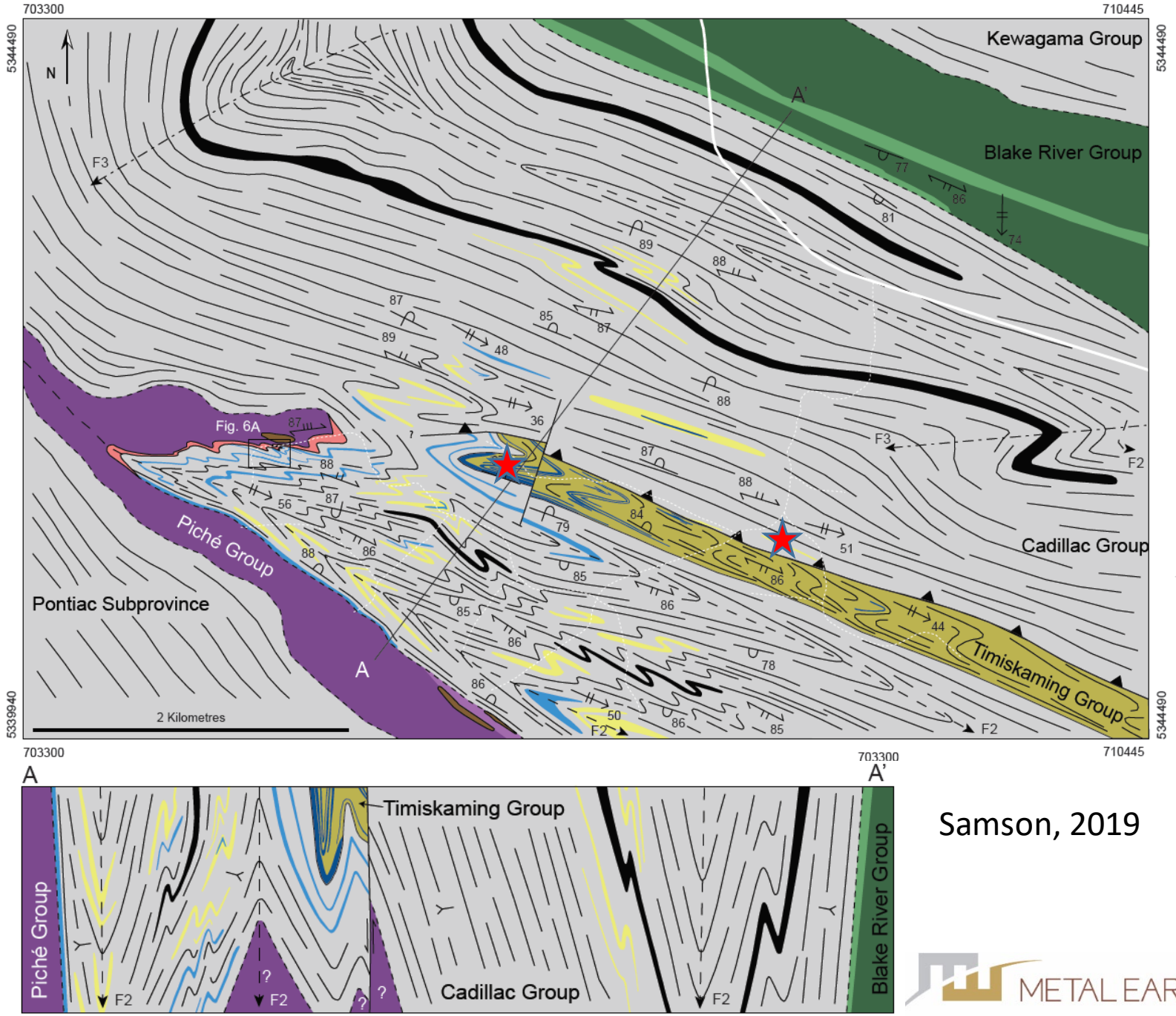

Samson, 2019

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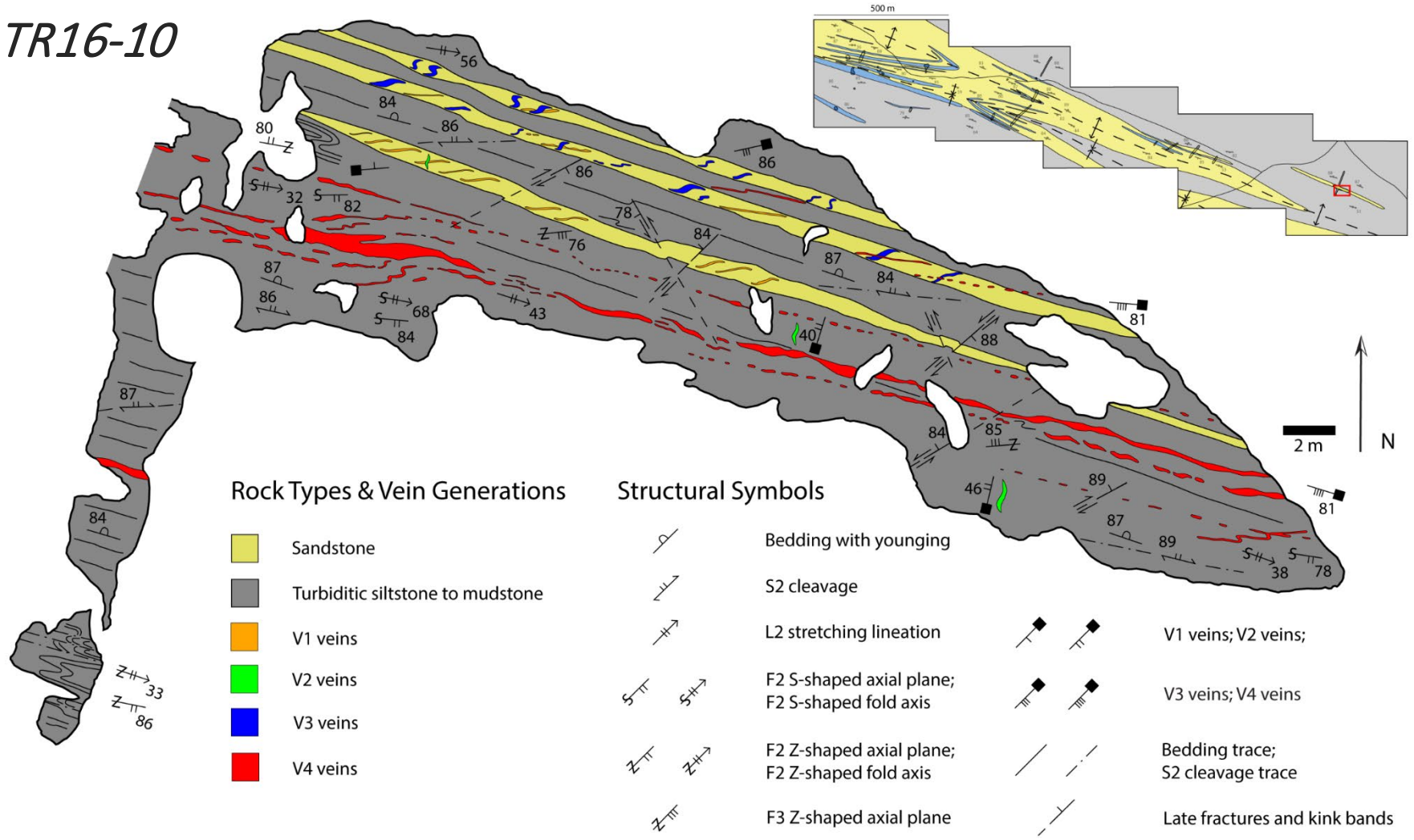
Gold mineralization in the Cadillac Basin



Samson et al., 2018

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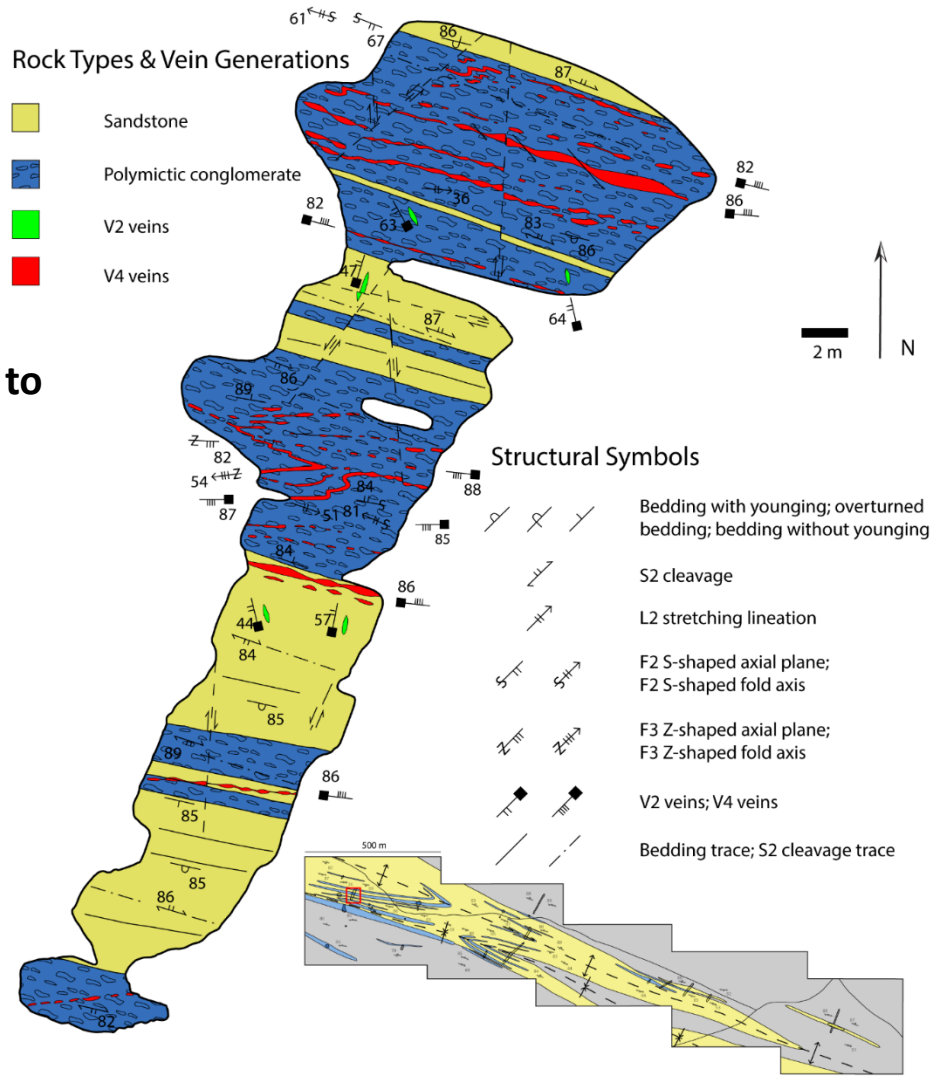
Gold mineralization in the Cadillac Basin

TR16-02

- **Located on southern limb of regional anticline**
- **Timiskaming-style conglomerate interlayered with massive and normal graded sandstone**
- **Cleavage is oriented clockwise to S-younging beds**
- **Gold-bearing veins are oriented anticlockwise to S-younging beds**



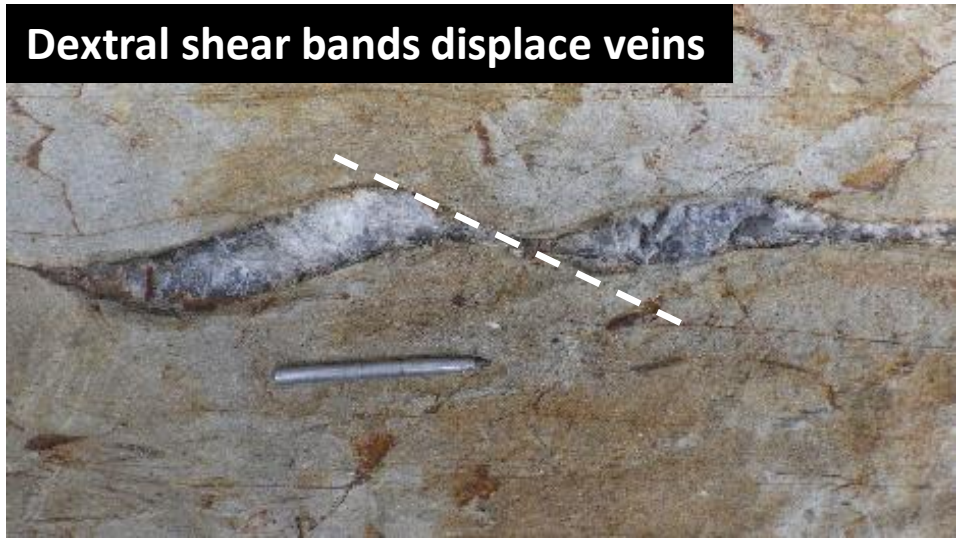
Samson et al., 2018

METAL EARTH

Deformation Structures and Veins in the Cadillac Basin

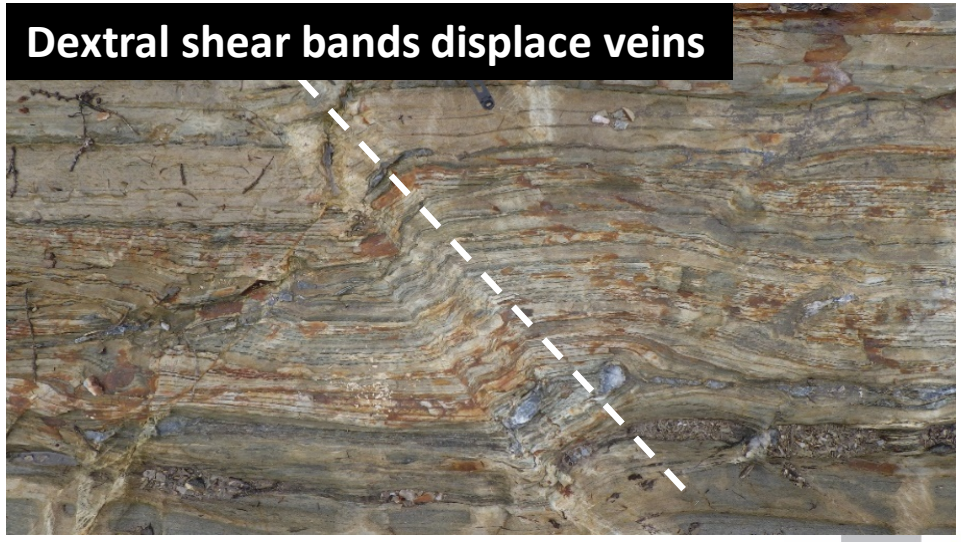
Tension gashes formed during sinistral shear

Dextral shear bands displace veins



Vein boudins Z-folded during dextral shear

Dextral shear bands displace veins



METAL EARTH

Canadian Malartic Gold Deposit

Host Rocks:

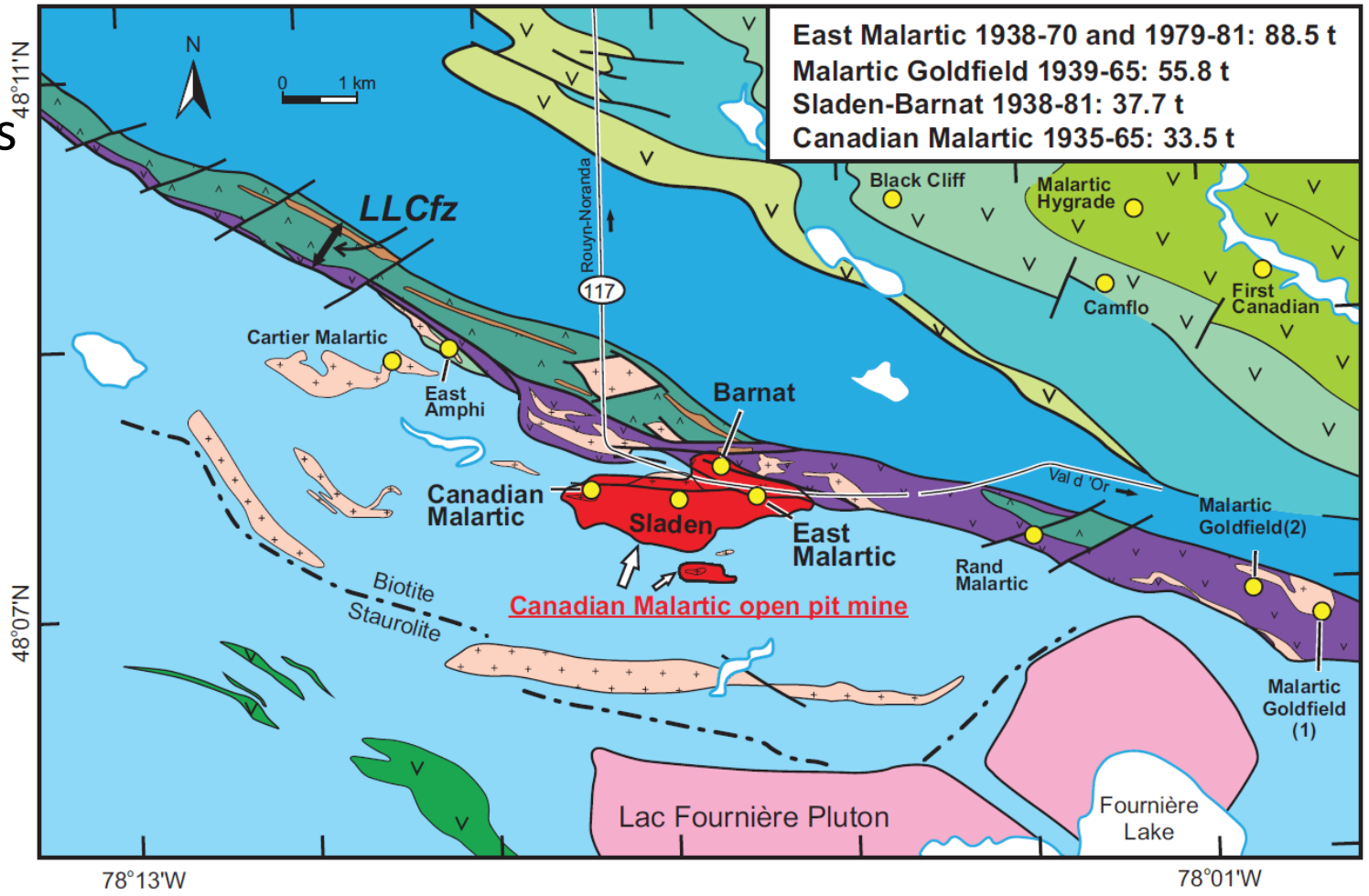
1. Pontiac metasedimentary rocks (2685-2682 Ma)
2. Sladen pluton: ~2677 Ma

Structures:

An early isolated, local, isoclinal folding overprinted by penetrative northwest-striking principal cleavage and regional folds.

Mineralization:

An early magmatic-hydrothermal event followed by syn-regional folding mineralization, ca. 2664 Ma

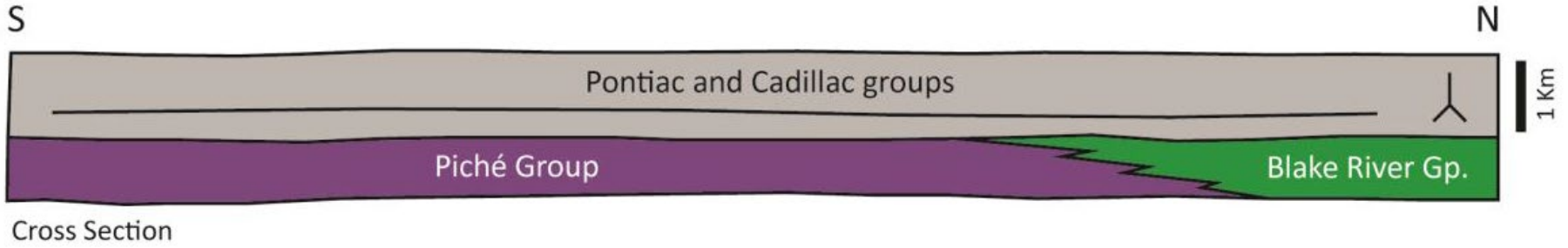


De Souza et al., 2016

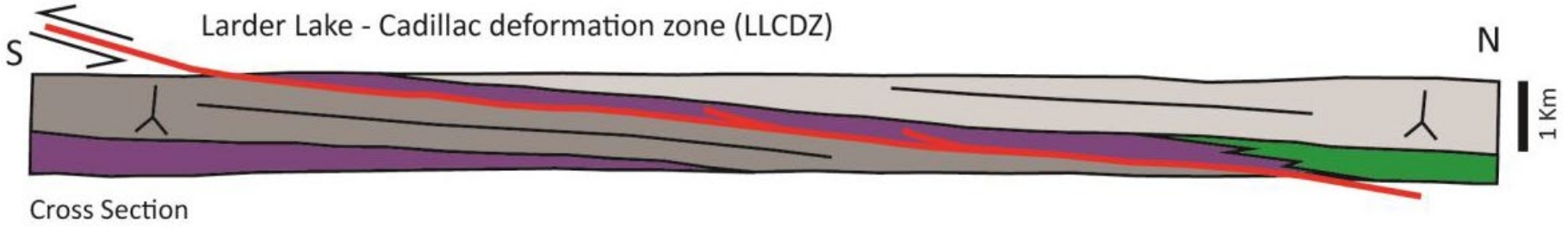
METAL EARTH

Tectonic Model of the Cadillac Basin

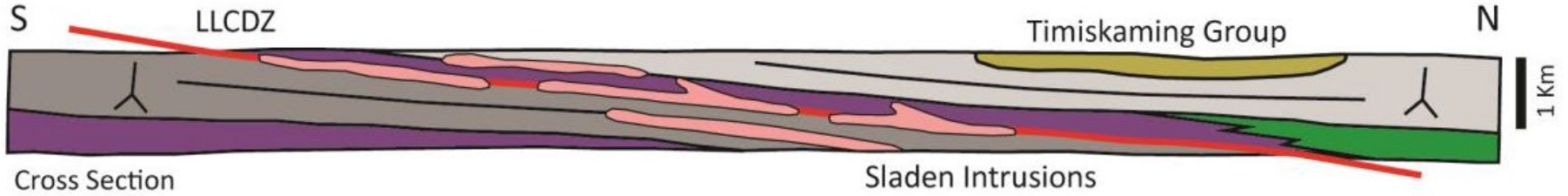
Stage 1: (< 2686 Ma) Deposition of the Cadillac and Pontiac groups above volcanic substrate



Stage 2: (> 2678 - 2677 Ma) Early thrusting of Piché Group above the Pontiac Group



Stage 3: (ca. 2675 Ma) Emplacement of intrusions and deposition of the Timiskaming Group



Samson, 2019, Metal Earth MSc thesis

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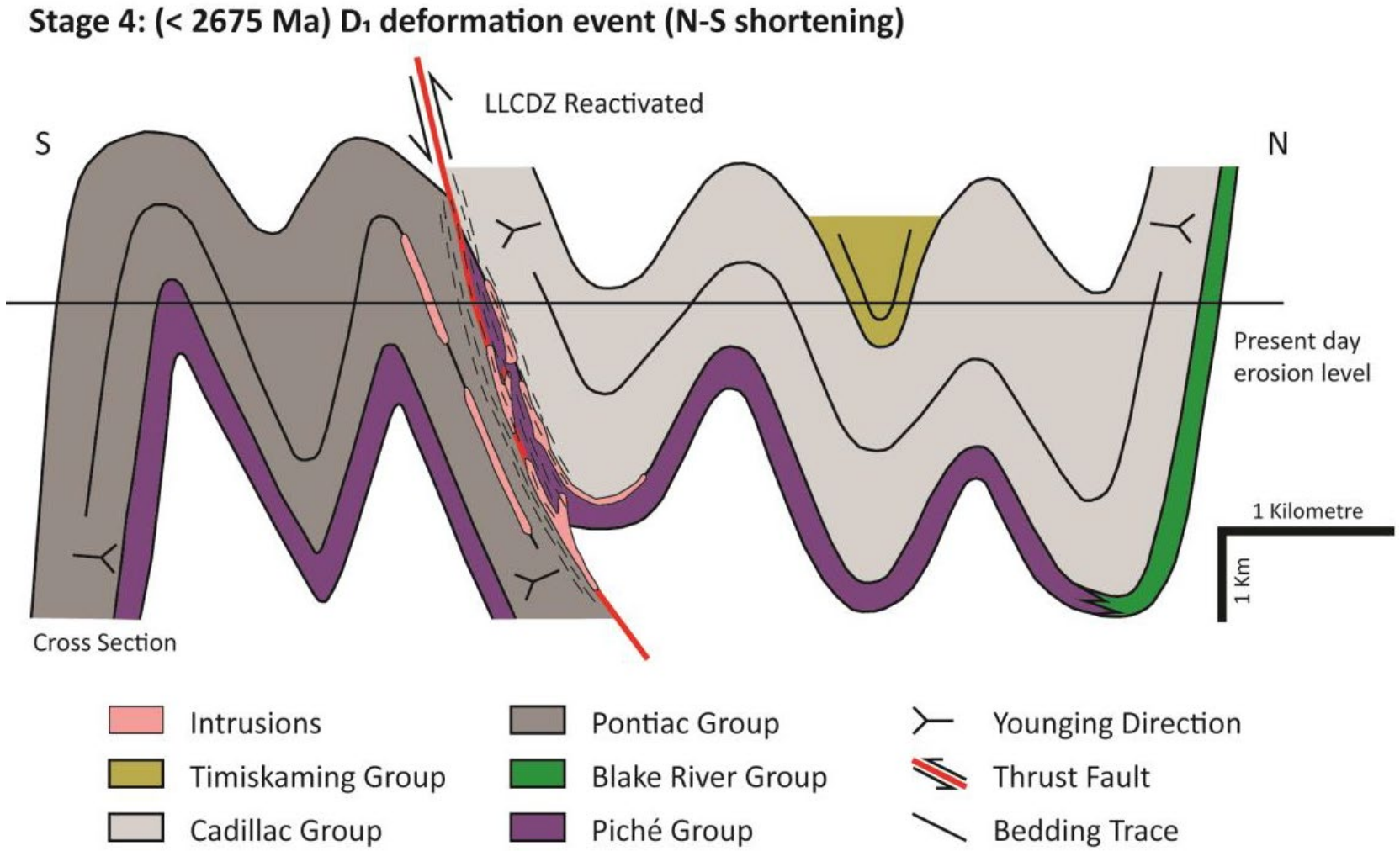
Tectonic Model of the Cadillac Basin



Samson, 2019, Metal Earth MSc thesis

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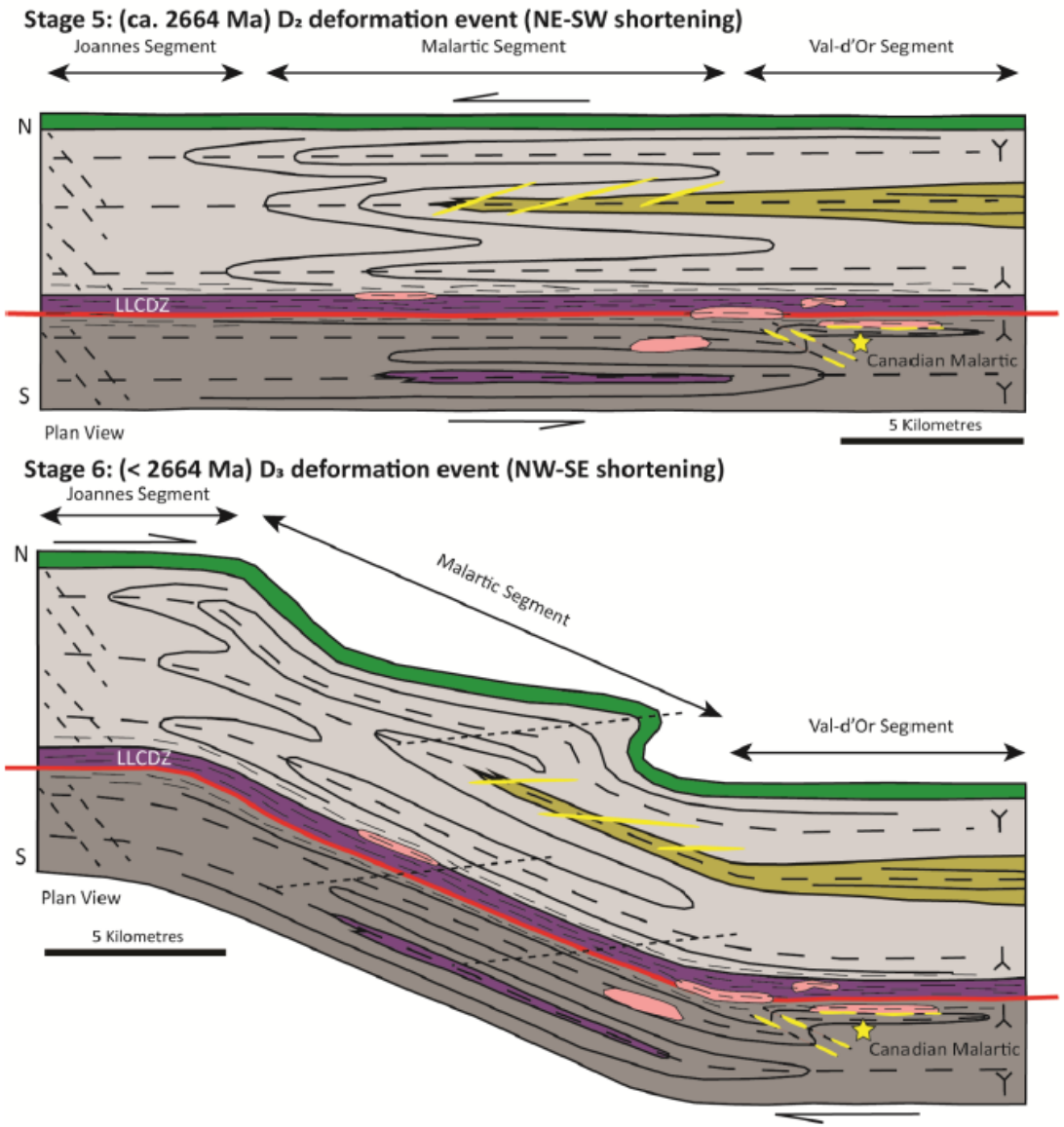
Tectonic Model of the Cadillac Basin



Samson, 2019, Metal Earth MSc thesis

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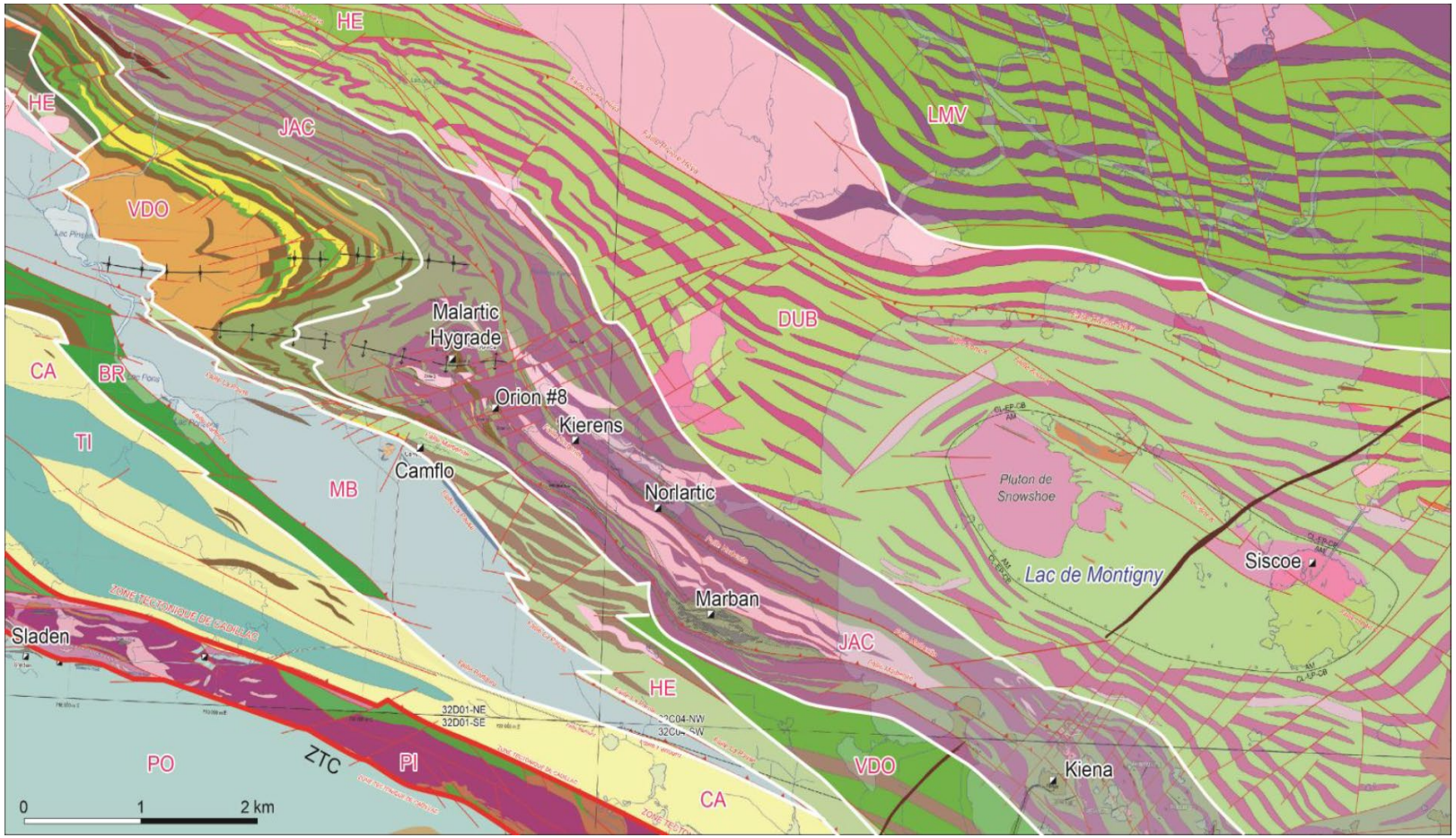
Early Gold…

Auriferous veins were cut by granitoid dikes. The age of these granitoid dikes gives the minimum age of gold mineralization.

Examples:

1. Kiena, 2686 Ma (Morasse et al. 1995)
2. Norlantic, 2692 Ma (Couture et al 1994)
3. Lakeshore Malaritc, 2694 Ma (Guay et al. 2018)



Pilote et al. 2015

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Summary

- Contacts between older volcanic terranes and younger sedimentary basins (e.g. Larder Lake-Cadillac break, Northern Chicobi contact) were originally unconformities, then intruded by granitoid plutons ranging from 2680-2675 Ma. All rocks were overprinted by regional folds and penetrative cleavage.
- Regional folding is constrained between 2680-2659 Ma, based on new ages from foliated syenite and massive gabbro in the Chicobi basin area.
- Seismic, MT and gravity data of the Chicobi transect show a listric detachment that dips northward, which is consistent with Lithoprobe line.
- Malartic bend of the Larder Lake-Cadillac break is caused by late dextral Z-folding.
- Archean lode gold deposits in the Malartic transect area are structurally controlled and modified. Gold mineralization spans from 2694 Ma to 2664 Ma, and shows different timing with respect to regional folding.

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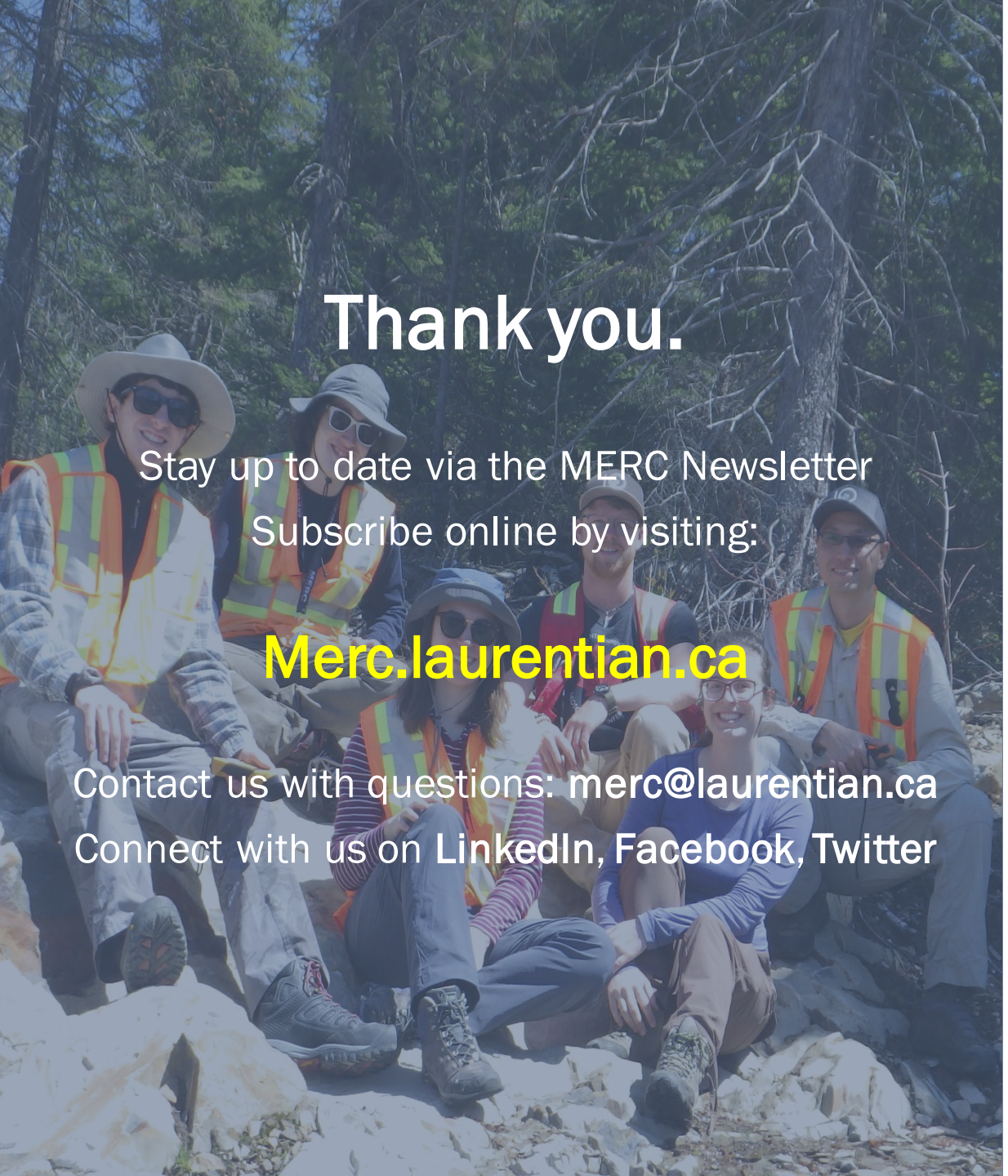

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