

Wabigoonies



Lauren



Unraveling the lithotectonic evolution of the western Wabigoon subprovince: Insight into the influence of inherited lithospheric architecture on metallogenesis

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SEG 100 Conference

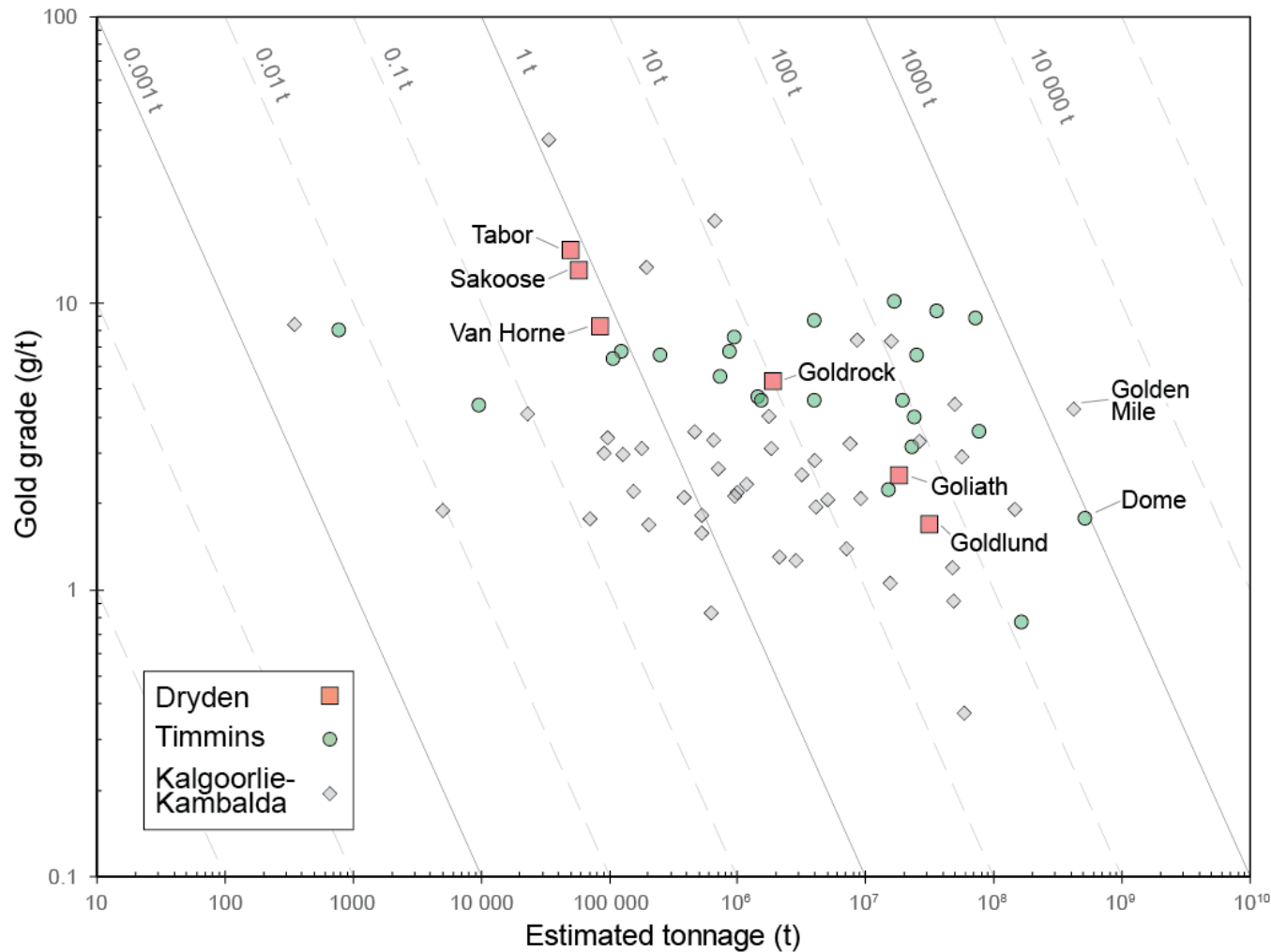
Celebrating a Century of Discovery

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SEG100 Conference
WS07; 9/23/2021



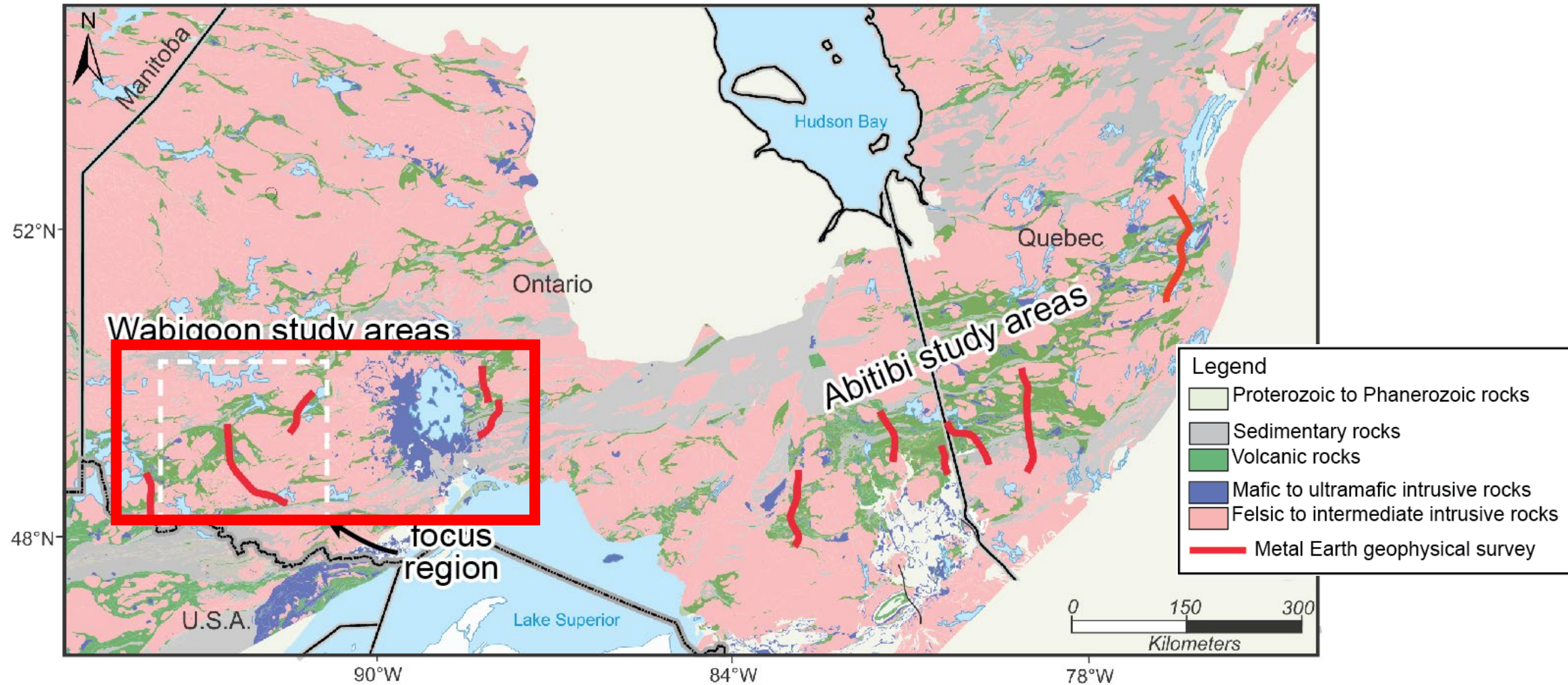
Comparing districts – A gold grade-tonnage perspective



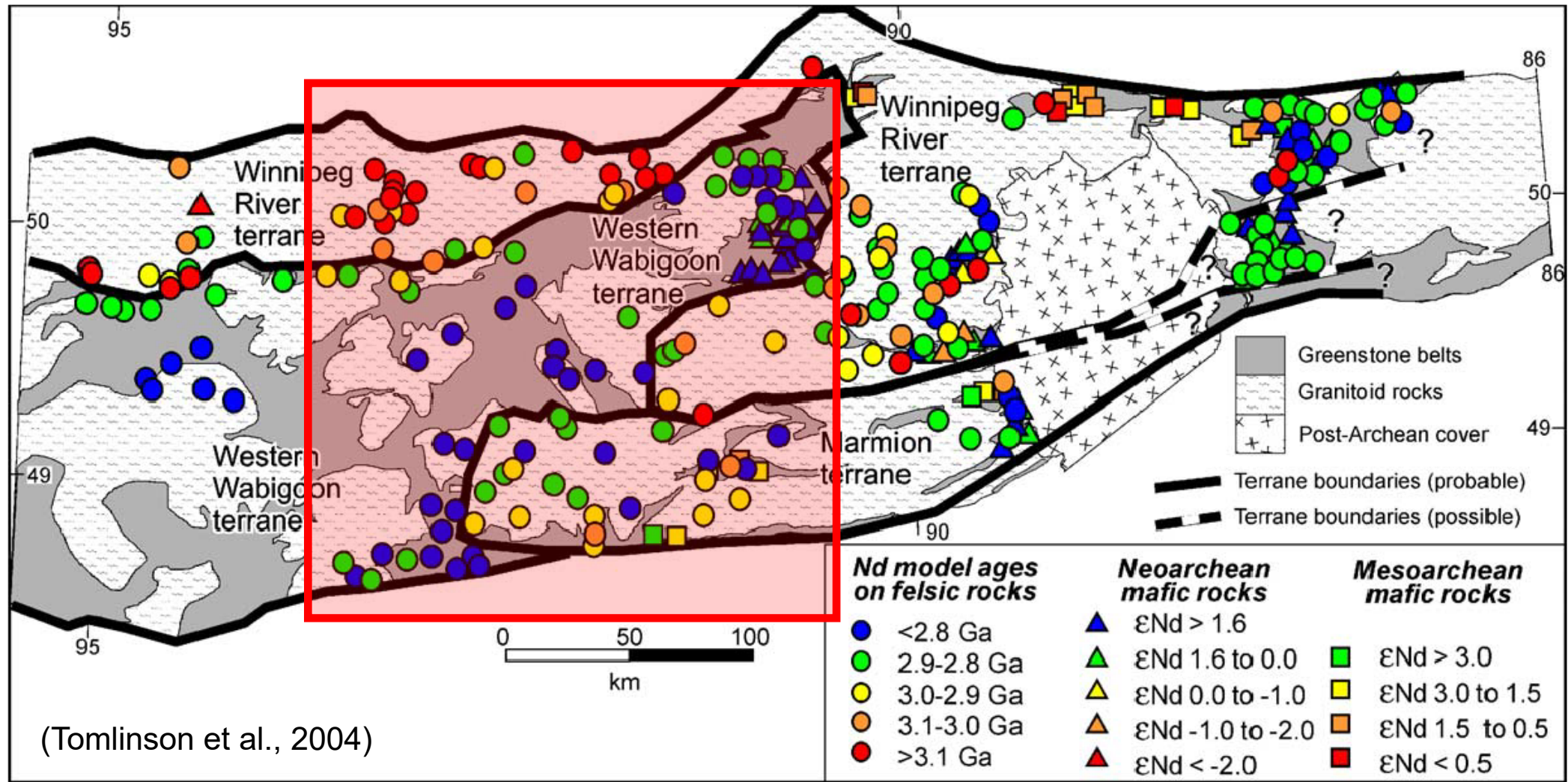
WHY DO SOME GREENSTONE BELTS CONTAIN LESS GOLD?

- **LACK OF EXPLORATION?**
- **DEFORMATION HISTORY?**
- **LITHOSPHERIC EVOLUTION AND ARCHITECTURE?**
- **GEODYNAMIC SETTING?**

Regional framework – Metal Earth transects

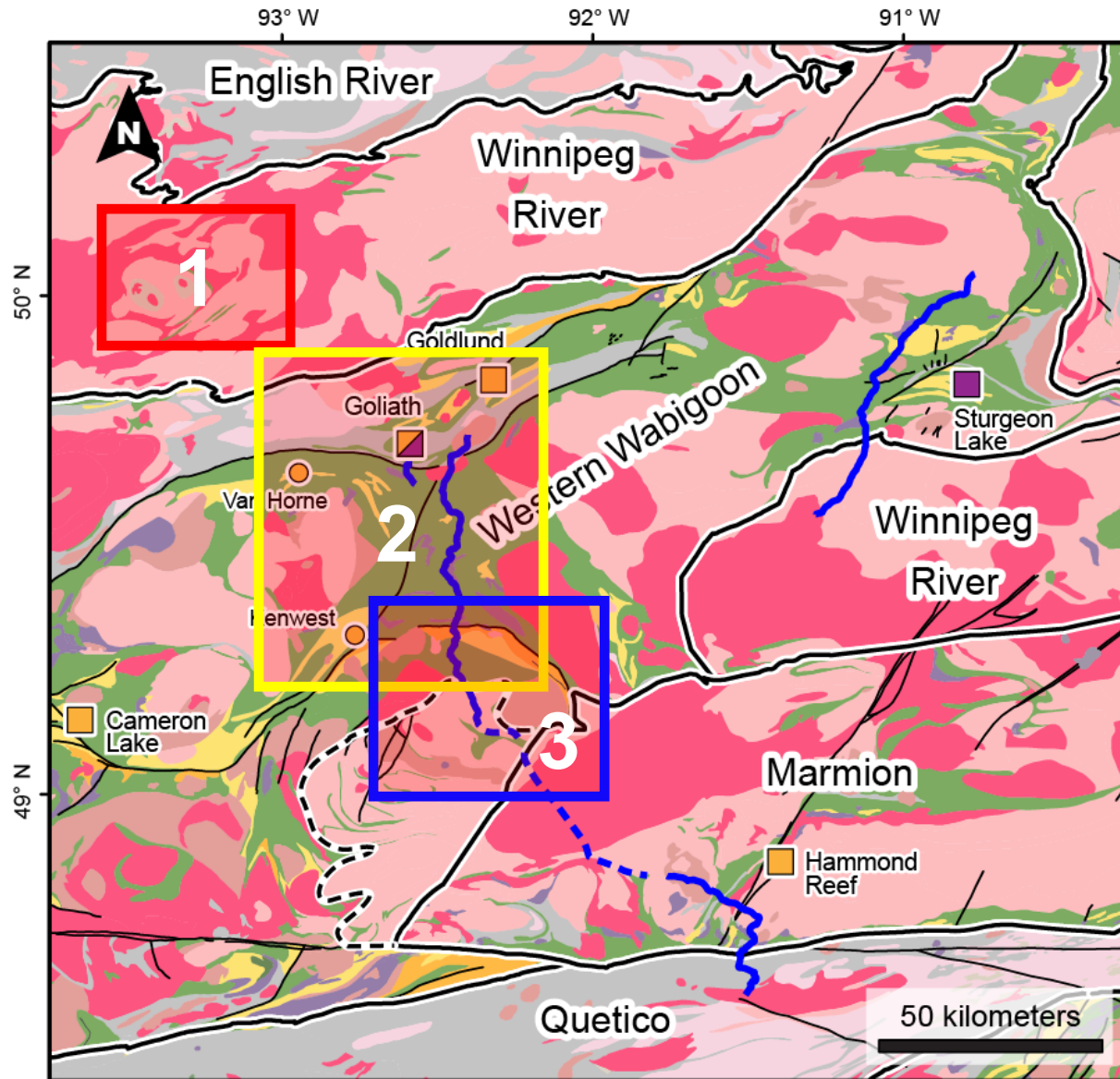


Terrane architecture – A Nd perspective



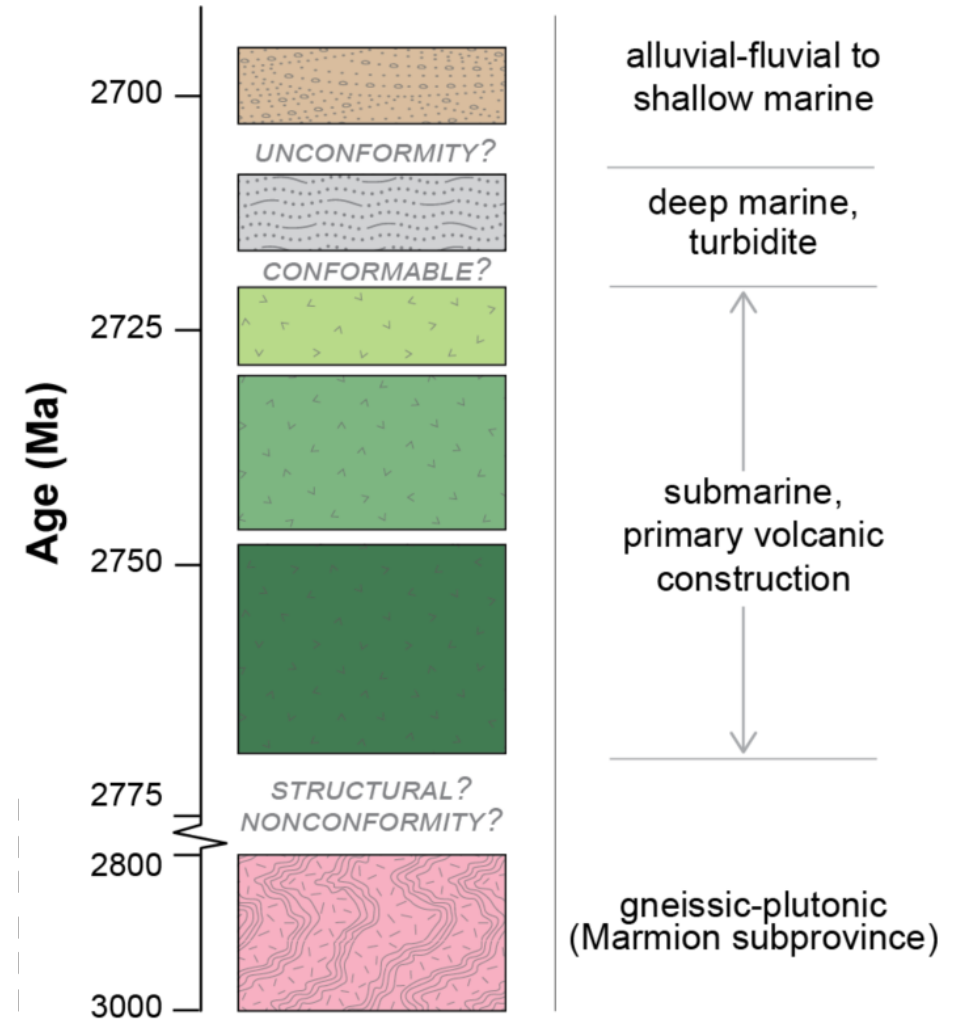
(Tomlinson et al., 2004)

Geological setting – Domains and study locations



Schematic stratigraphic section

Emplacement or depositional environment



Outline – Studies in the western Wabigoon

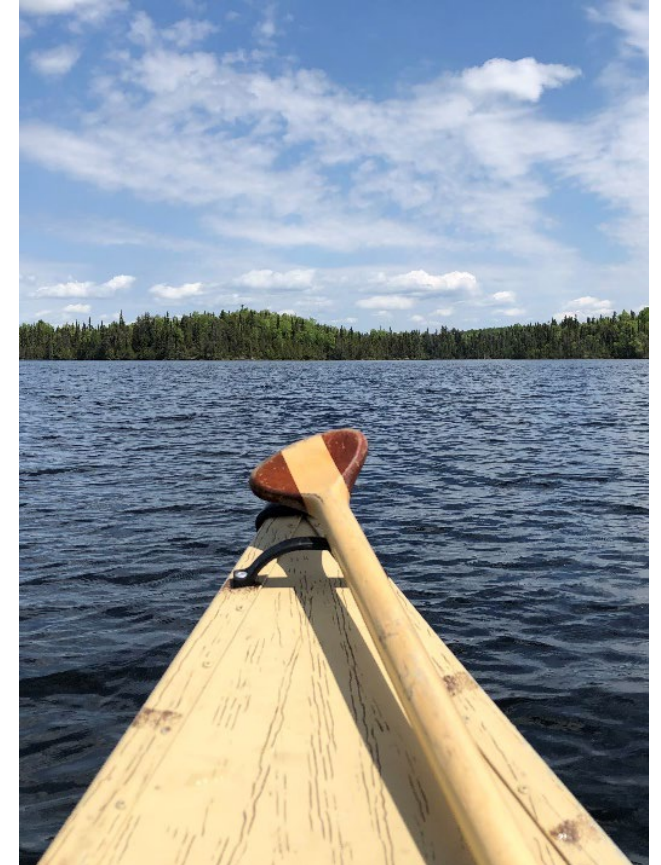


Topics discussed today:

- 1) Structural setting, timing, and geochemical signature of orogenic gold in the WWS
- 2) Investigations on the broader lithotectonic evolution and influence of crustal-scale architecture on metallogenesis

New datasets:

- Regional- to outcrop-scale mapping
- Petrographic / paragenetic constraints
- LA-ICP-MS isotopic / trace element and whole-rock geochemical data
- Geophysical surveys
- Integrated prospectivity analysis



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Associated researchers – Student-driven projects



The research group (i.e., the Wabigoonies):

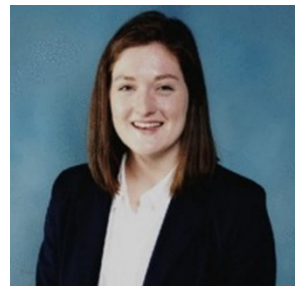
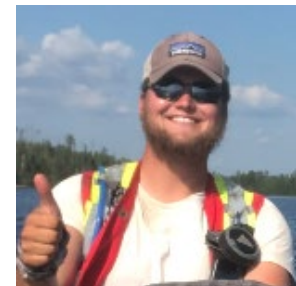
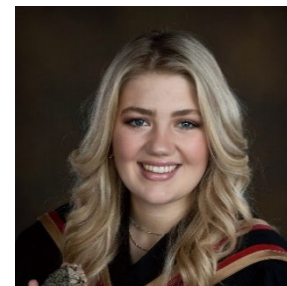
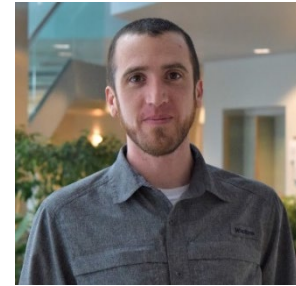
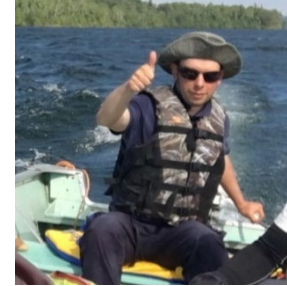
- Faculty: Dr. Stéphane Perrouty (LU)
- PDF/RA: Dr. Ben Frieman (LU)
- PhD: Rebecca Montsion (LU)

expected
completion
late 2021)

- *MSc 1: David Downie (LU)*
- *MSc 2: Amokelani Mavundza (LU)*

completed
(2018-20)

- MSc 3: Kendra Zammit (LU)
- BSc 1: Katharina Holt (QueensU)
- BSc 2: Brandon Smith (LU)
- BSc 3: Lauren Norenberg (QueensU)
- BSc 4: Jordan Peterzon (QueensU)
- +4 FAs from 2018-19 (LU, UManitoba)



(Brandon not pictured)



The Study Region – A new 1:50,000 scale map



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Contents lists available at [ScienceDirect](https://www.sciencedirect.com)

Data in Brief

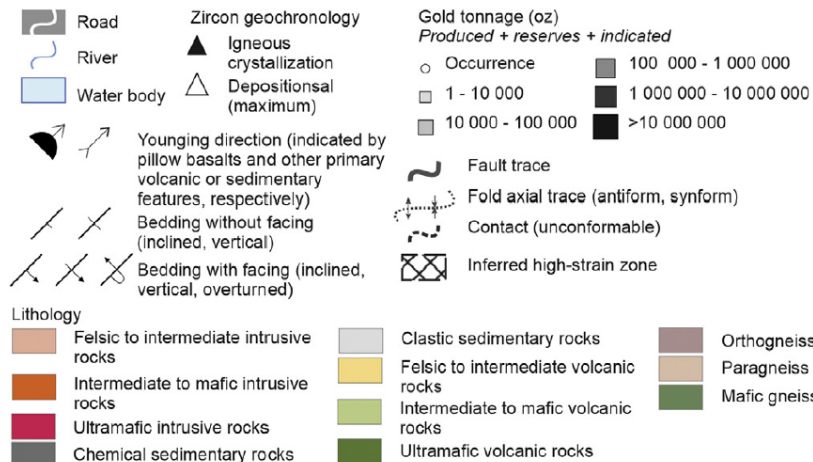
journal homepage: www.elsevier.com/locate/dib



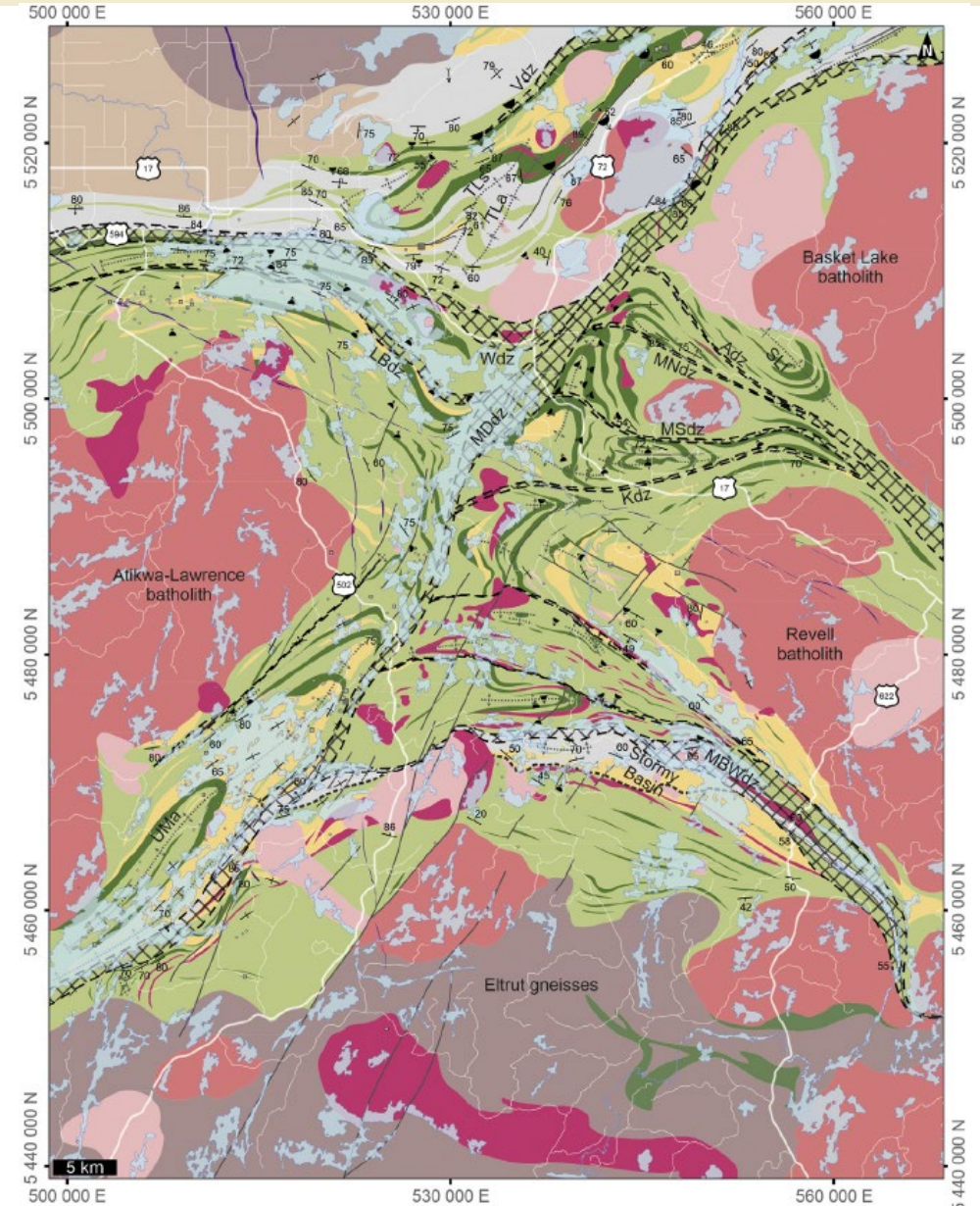
Data Article

Geological and geophysical data compilation for the western Wabigoon and southern Abitibi subprovinces of the Superior Province, Ontario, Canada

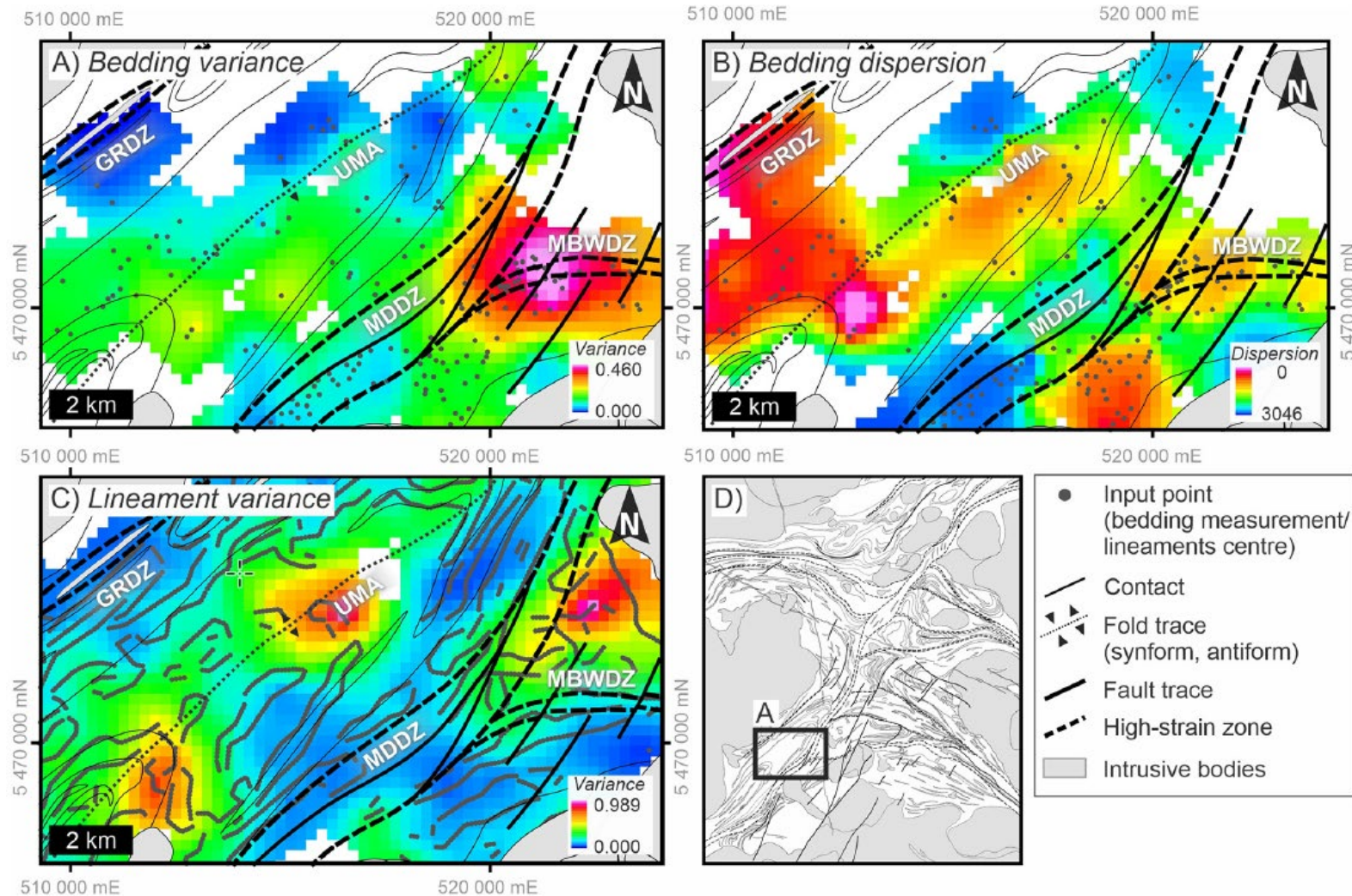
Rebecca M. Montsion^{a,b,*}, Stéphane Perrouty^a, Ben M. Frieman^a



(Montsion et al., 2021; DiB)



Prospectivity analysis – Variance calculations

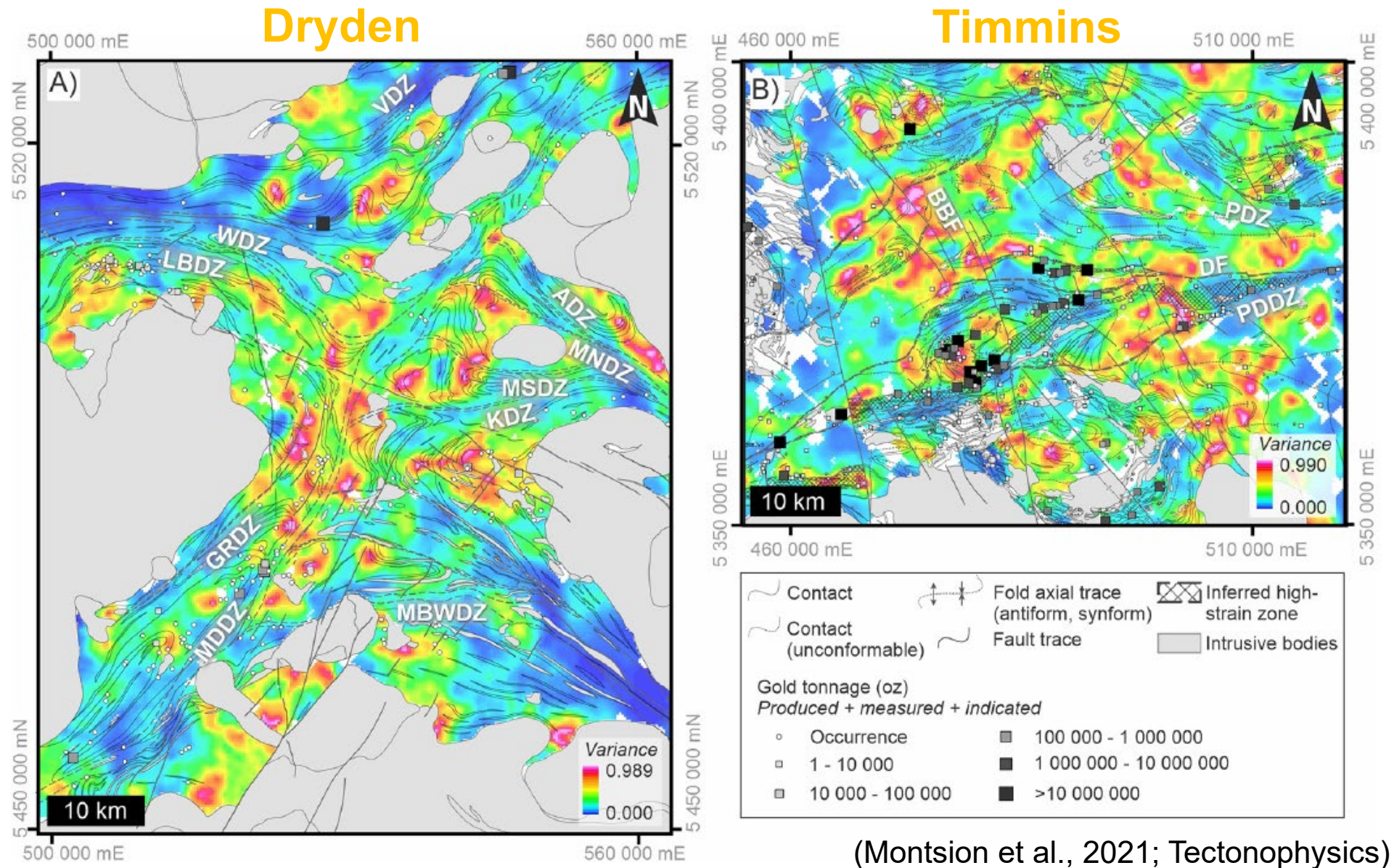


- Integrated legacy mapping with new observations and magnetic constraints used to produce a new detailed map
- Used as an input for prospectivity analysis and comparisons to the well-studied Timmins camp

(Montsion et al., 2021; Tectonophysics)

Variance maps – Quantification of complexity

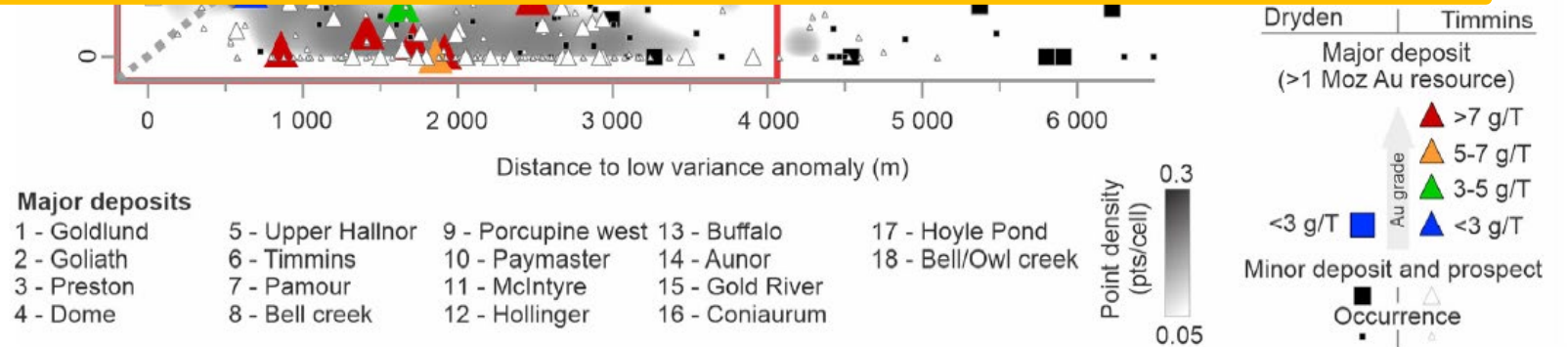
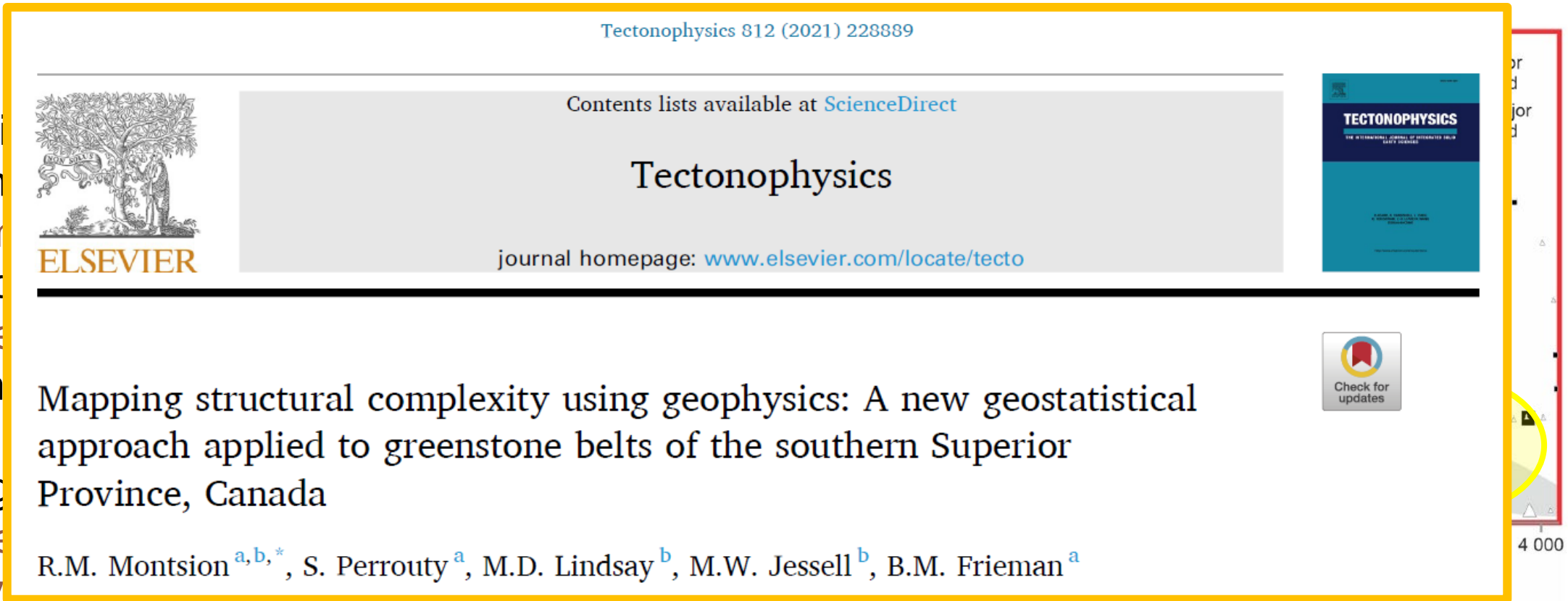
- Structural variance maps
- Compared to gold deposits and occurrences



(Montsion et al., 2021; Tectonophysics)

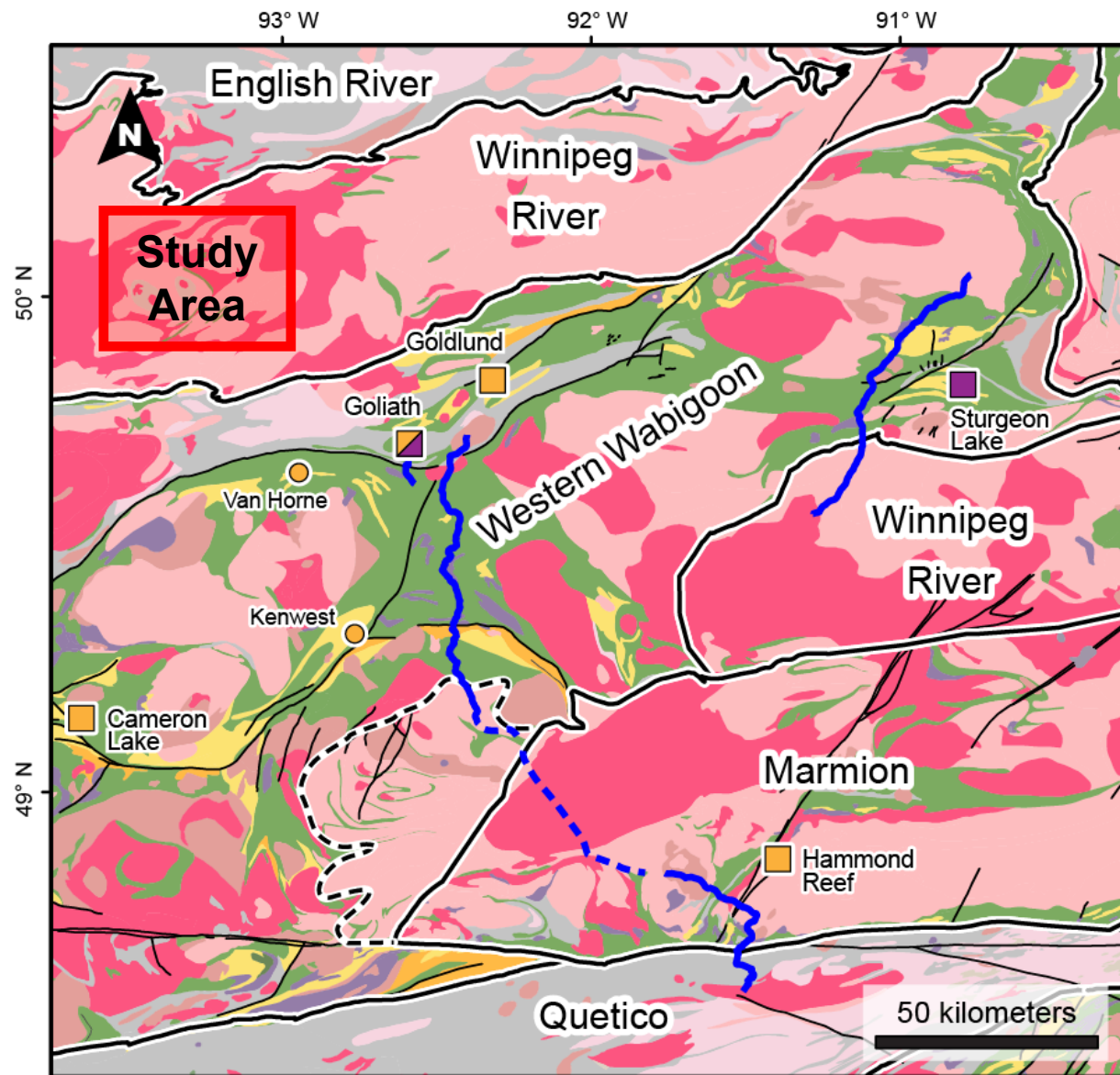
Variance Results – Relationships to Au

- Variance from com calc diffe Tim
- Sug diffe dev hydrothermal fluid pathways

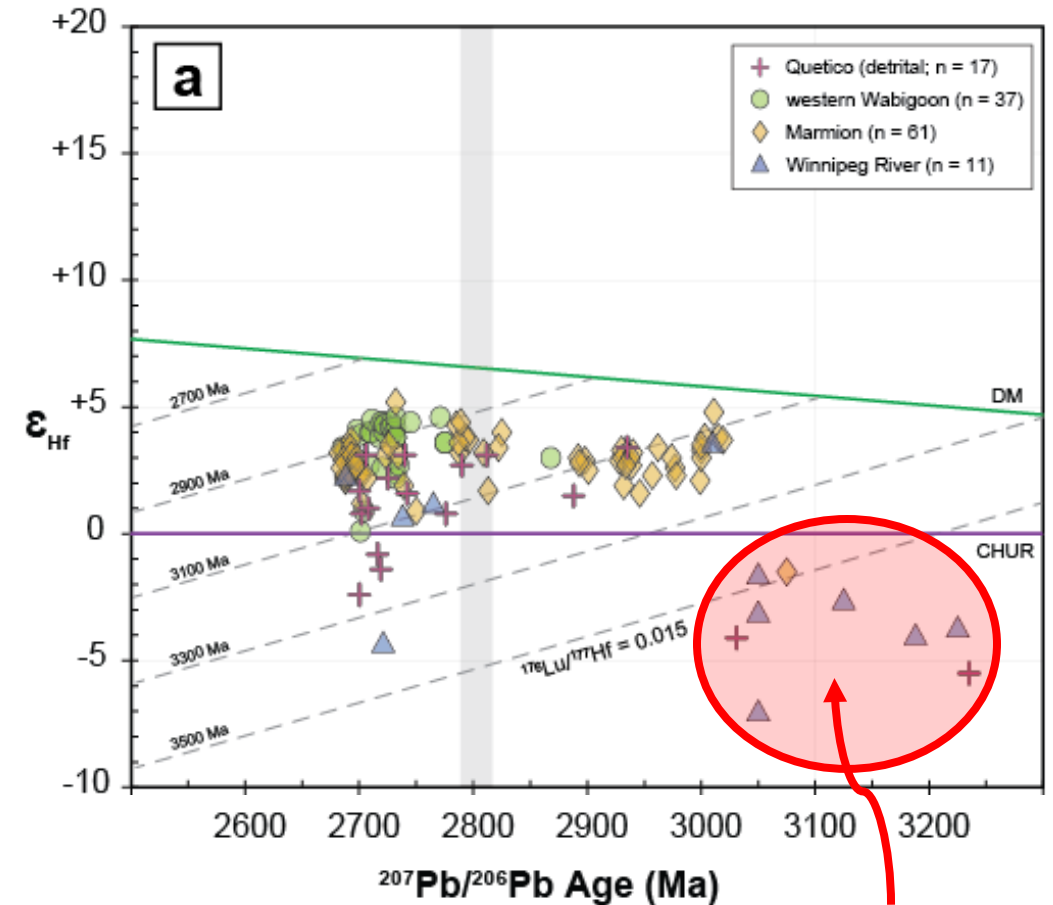


(Montsion et al., 2021; Tectonophysics)

Geologic setting – Winnipeg River study



Insight from Hf and Nd isotopes

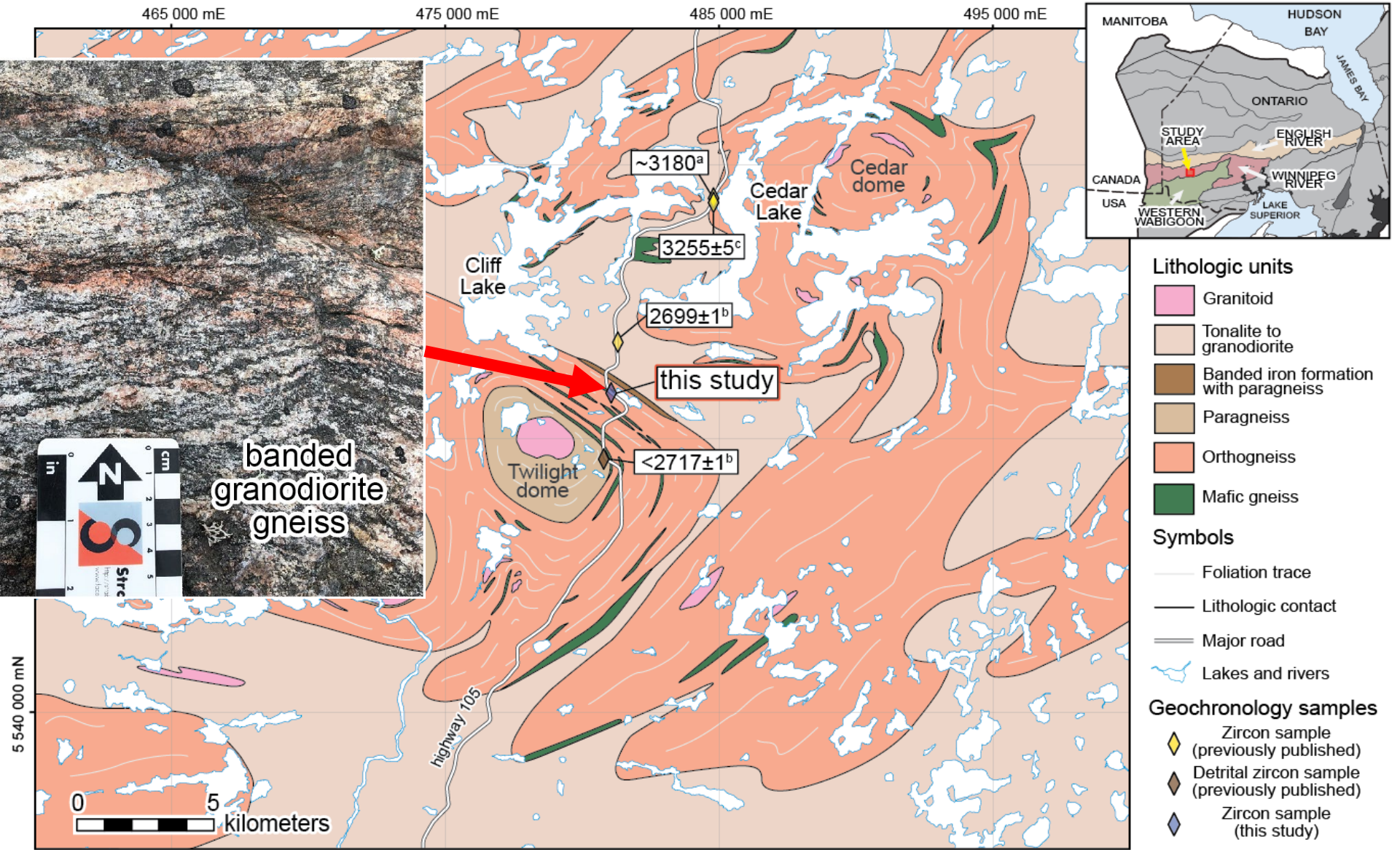
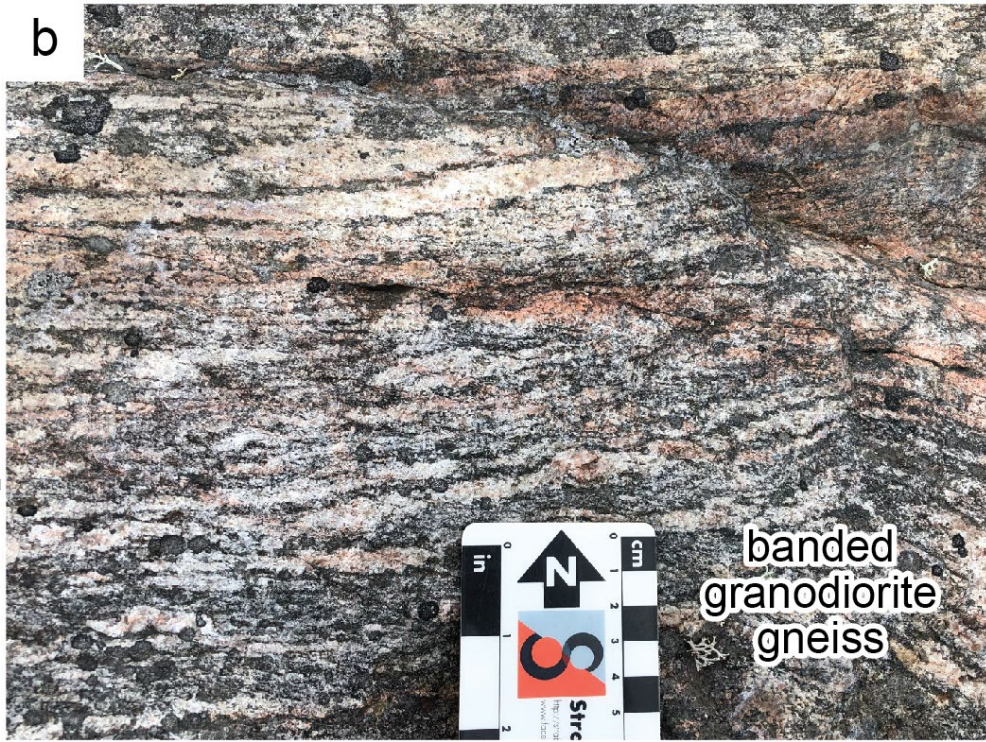


presence of older crust?

Winnipeg River – Cedar Lake gneiss complex

Canada

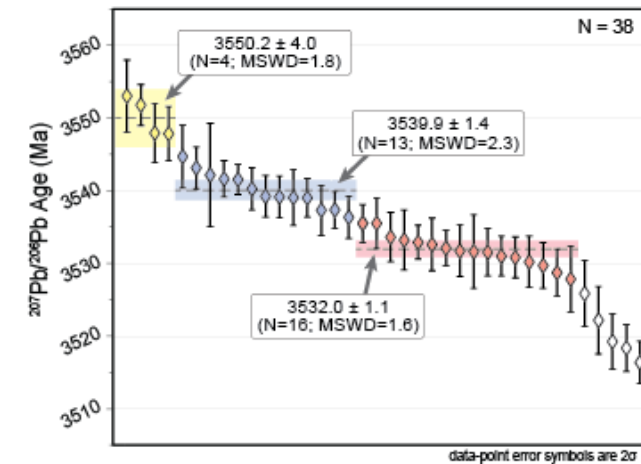
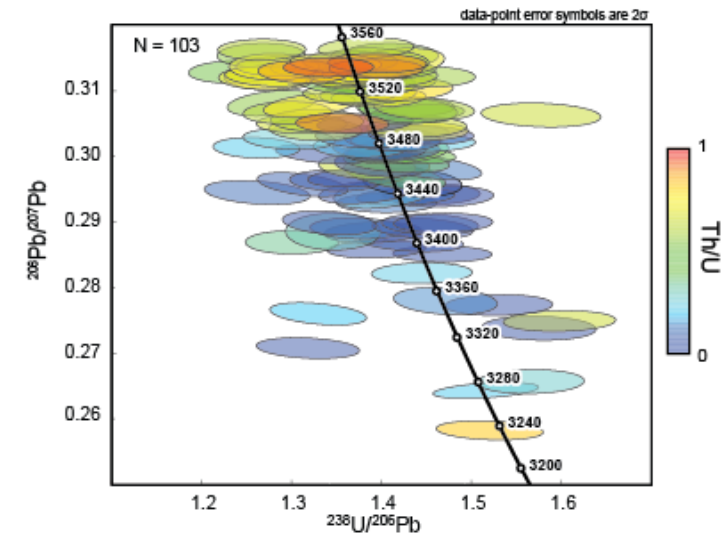
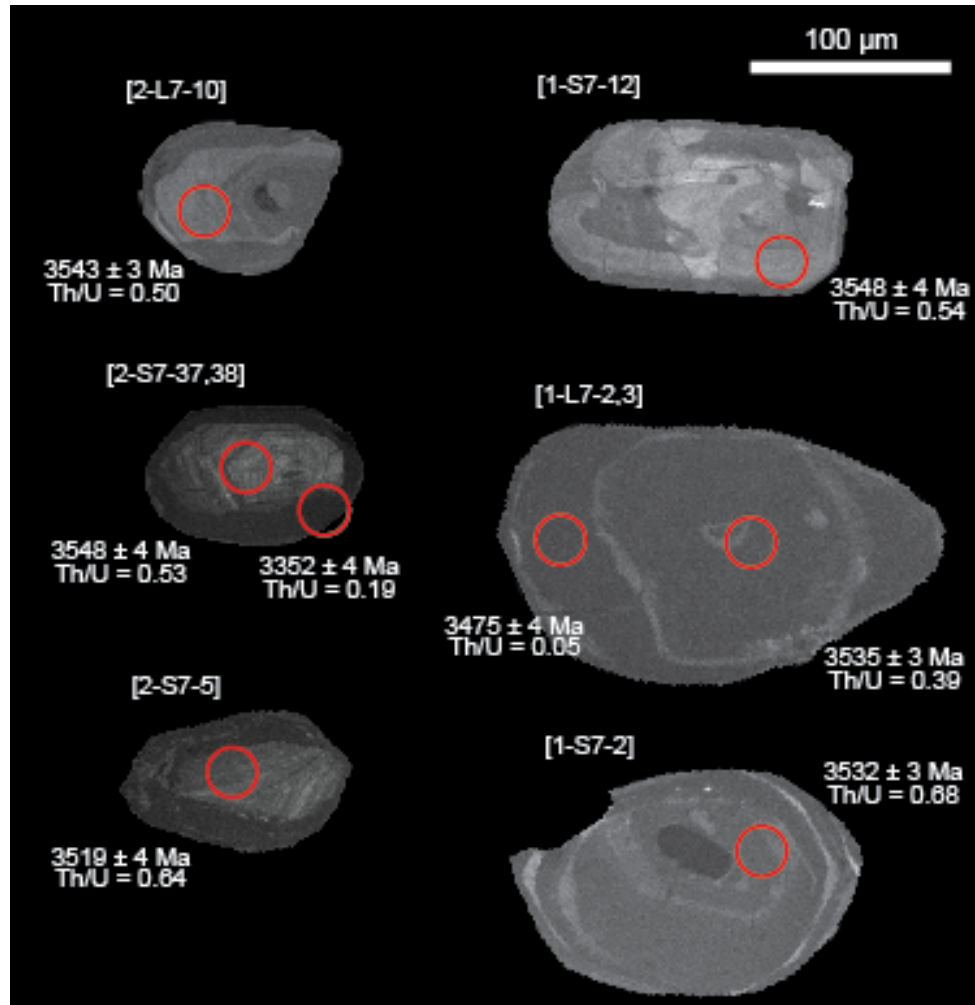
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MERC
Mineral Exploration Research Centre
at the HARQUAIL School of Earth Sciences

Cedar Lake gneiss – U-Pb zircon results

Canada

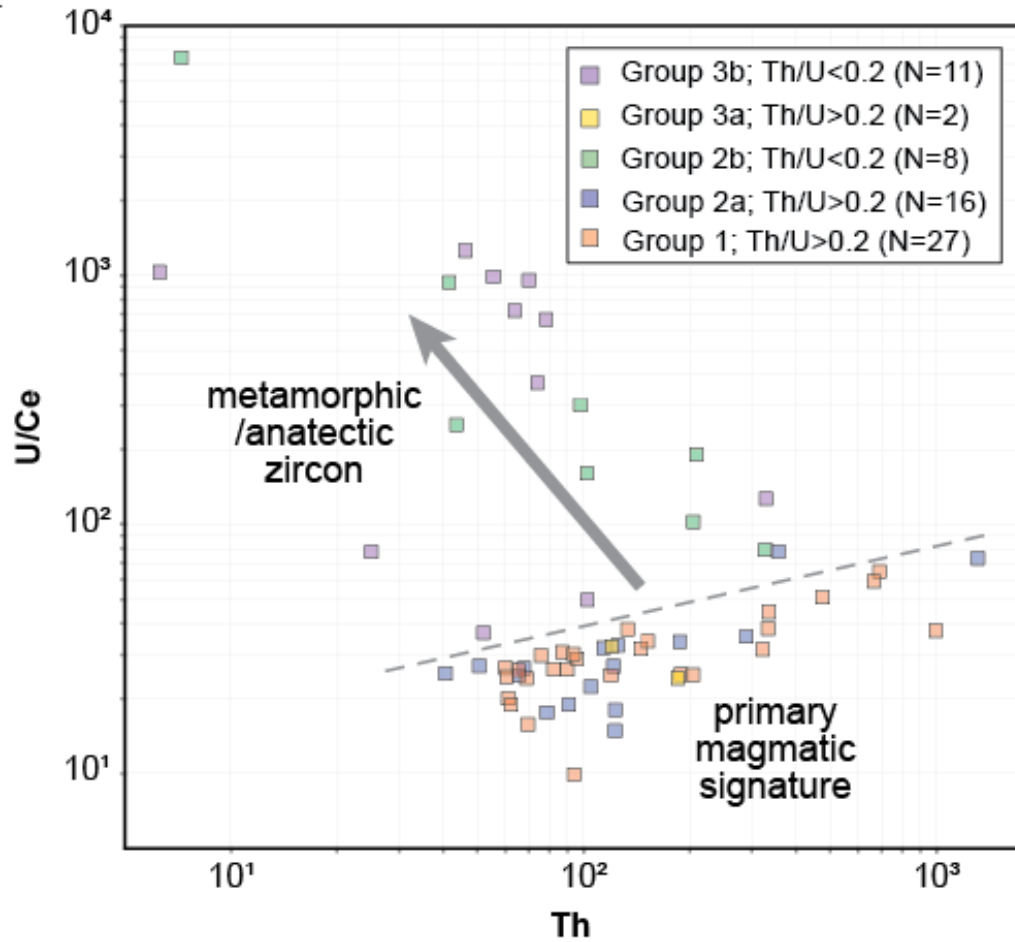


- Protoliths emplaced at **ca. 3550-3530 Ma**

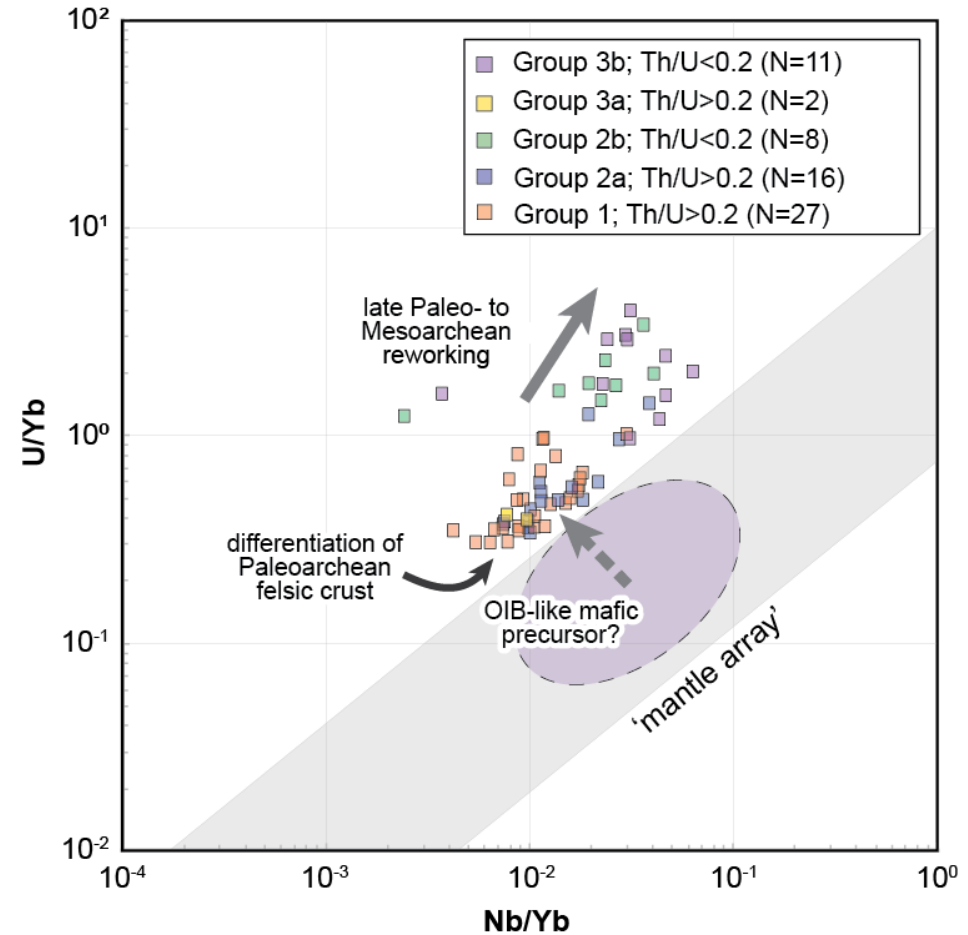
- Oldest rocks in the southern Superior Province of Canada



Cedar Lake Gneiss complex – Trace element results

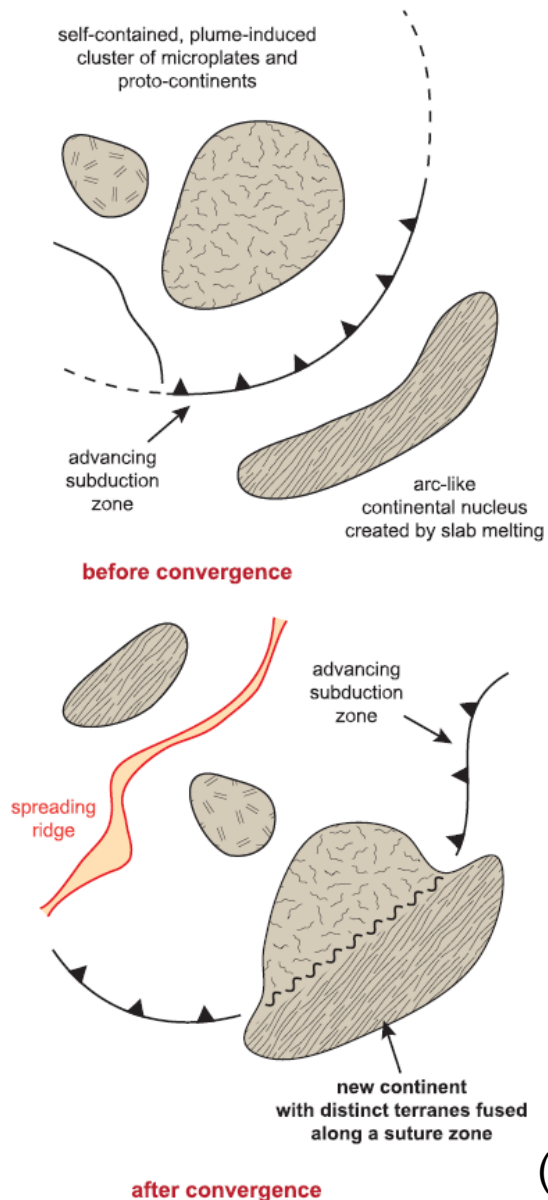


- Trace elements reveal distinct **age-composition groups**



- Initial U/Yb and Nb/Yb suggestive of differentiation from **OIB-like source**

Summary (1/4) – Winnipeg River study



- Cedar lake gneiss complex preserves the oldest rocks (ca. 3550-3530 Ma) in the southern Superior Province, Canada
- Further magmatism and reworking at ca. 3500-3450 Ma and ca. 3400-3300 Ma, respectively
- Differentiation from primitive, precursor crust/mantle reservoirs at ca. 3600 Ma (plume-drip tectonics?)
- Global comparisons suggest a major episode of crustal differentiation and stabilization occurred in the Paleoproterozoic (transition to mobile-lid tectonics?)

(Palin et al., 2020)

Neoarchean deformation– Regional localization



- In Neoarchean, Winnipeg River thrust over western Wabigoon

- Coeval localization along regional E- to NE-trending deformation zones



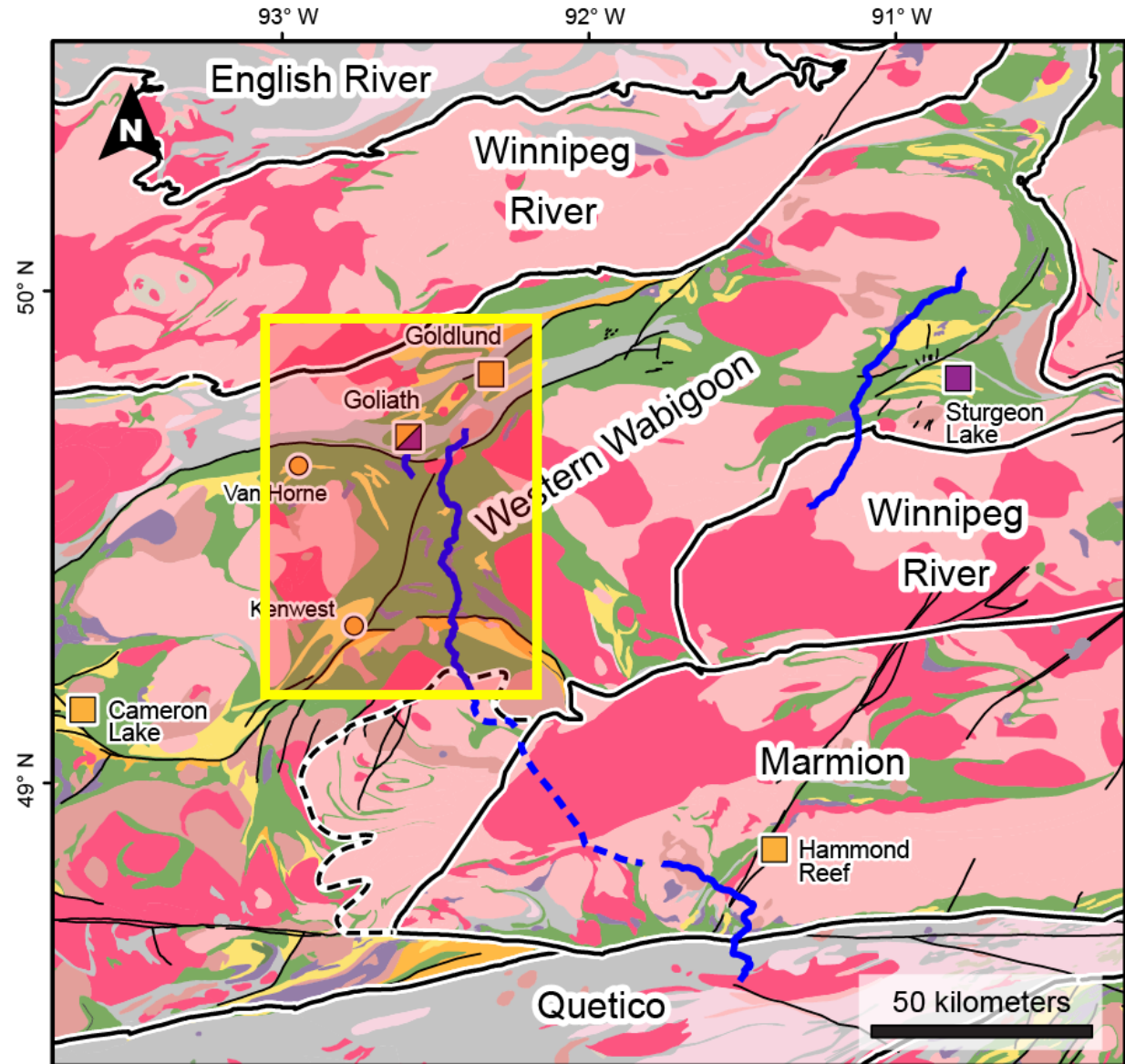
Intrusive rocks

- Muscovite-bearing granite
- Massive granodiorite to granite
- Massive to gneissic tonalite and granodiorite
- Diorite, monzonite, and/or granodiorite
- Mafic intrusions
- Ultramafic intrusions

Sedimentary rocks

- Fine-grained clastic
 - Coarse-grained clastic
 - Paragneiss
- ## Volcanic rocks
- Mafic to ultramafic
 - Mafic to intermediate
 - Felsic to intermediate

- Faults
- Subprovinces/domain boundary
- Proposed subprovince boundary
- Metal Earth geophysical line
- Developed gold prospect
- Gold deposit
- VMS deposit



Structural framework – Orogenic gold

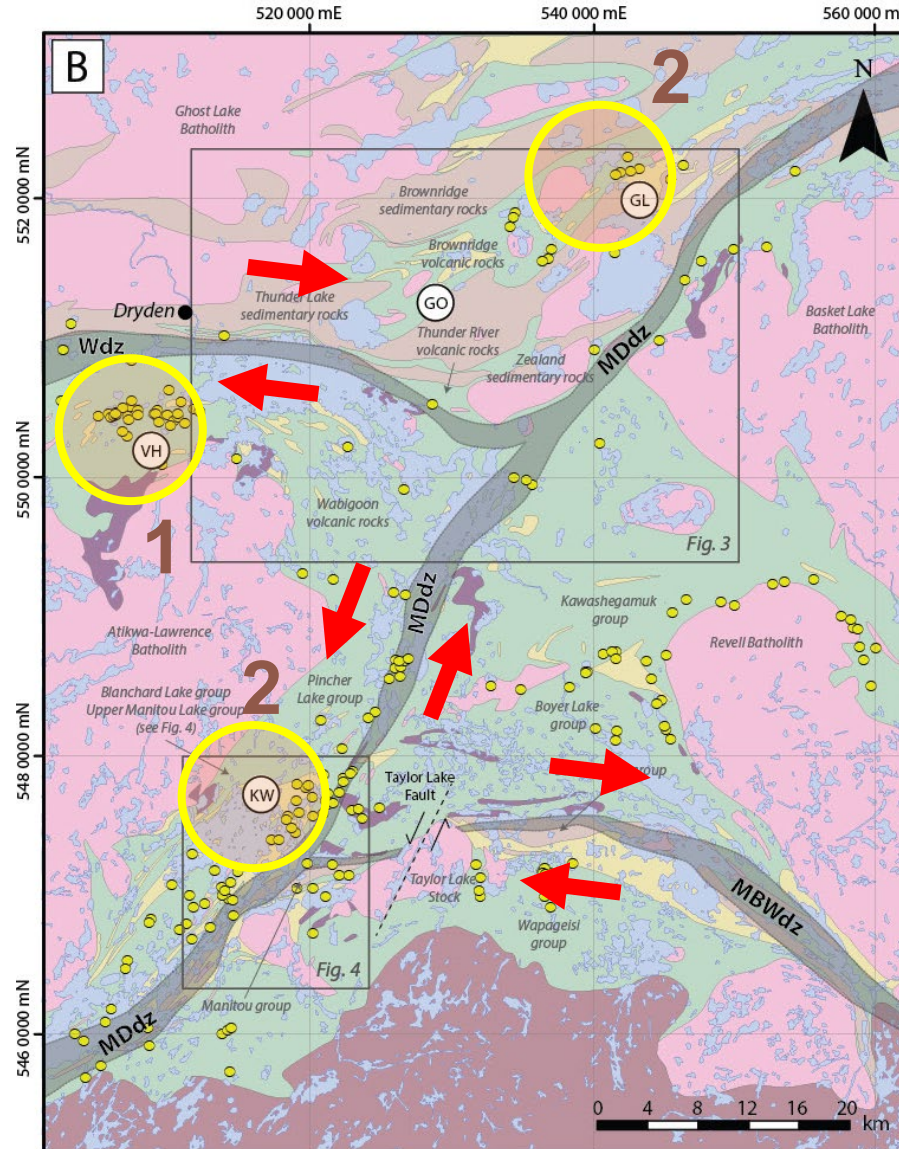


Lithologic Units

- Felsic intrusive rocks
- Mafic intrusive rocks
- Sedimentary rocks
- Felsic volcanic rocks
- Mafic volcanic rocks
- Marmion terrane

Symbols

- Dryden area
- Deformation zone (inferred)
- Fault
- Gold occurrences
- Gold prospects/deposits
GL = Goldlund deposit
GO = Goliath deposit
KW = Kenwest prospect
VH = Van Horne prospect



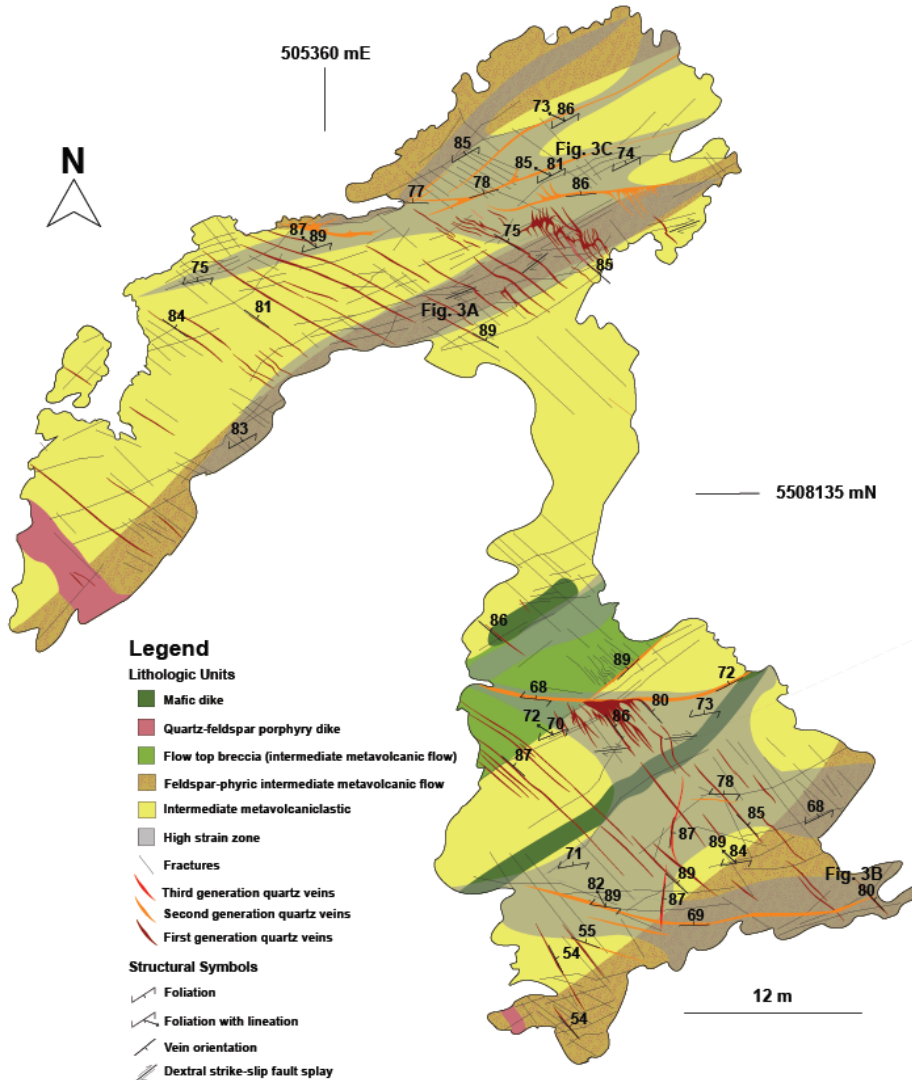
- Progressive N-S to NW-SE shortening
- Localization along major brittle-ductile deformation zones:
- 3 major, regional zones:
 - Wabigoon (Wdz)
 - Manitou-Dinorwic (MDdz)
 - Mosher Bay-Washeibemaga (MBWdz)

(Zammit, 2020; MSc thesis)



Van Horne – Glatz West mapping and sampling

Canada



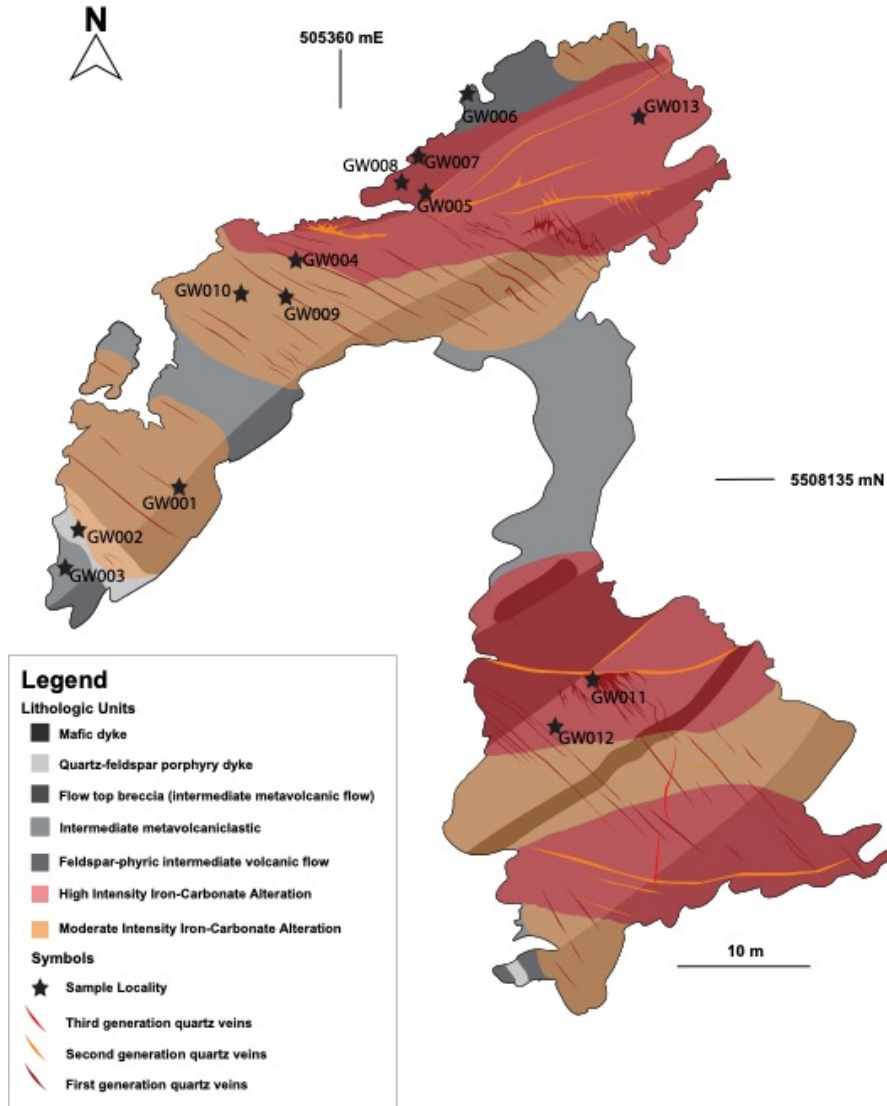
(Norenberg, 2020; BSc Thesis)

- Pillow basalt to intermediate volcanoclastic host rocks
- Multiple generations of quartz-carbonate veins
- Emplaced during progressive shortening to dextral transpression

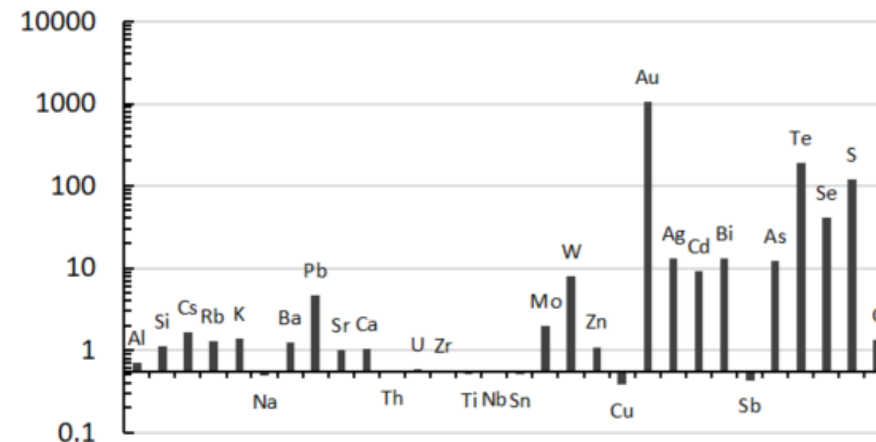
Vein Generation	Relative Timing	Deformation	Average Orientation	Alteration	Accessory Minerals	Mineralized?
V ₁	Early to syn-D ₂ deformation event	Dextrally offset from D ₂ , consistent thickness	310°/85°	No alteration observed	Calcite, Tourmaline	No
V ₂	Syn-D ₂ deformation event	Folded, fractured, variable thickness, multiple fluid injections	270°/75°	Intense Fe-carbonate alteration	Calcite, Ankerite	Yes
V ₃	Late to post-D ₂ deformation event	Minor folding, less prominent D ₂ effects than V ₂ veins	355°/80°	No alteration observed	Calcite, Tourmaline	No



Van Horne – Glatz West mapping and sampling



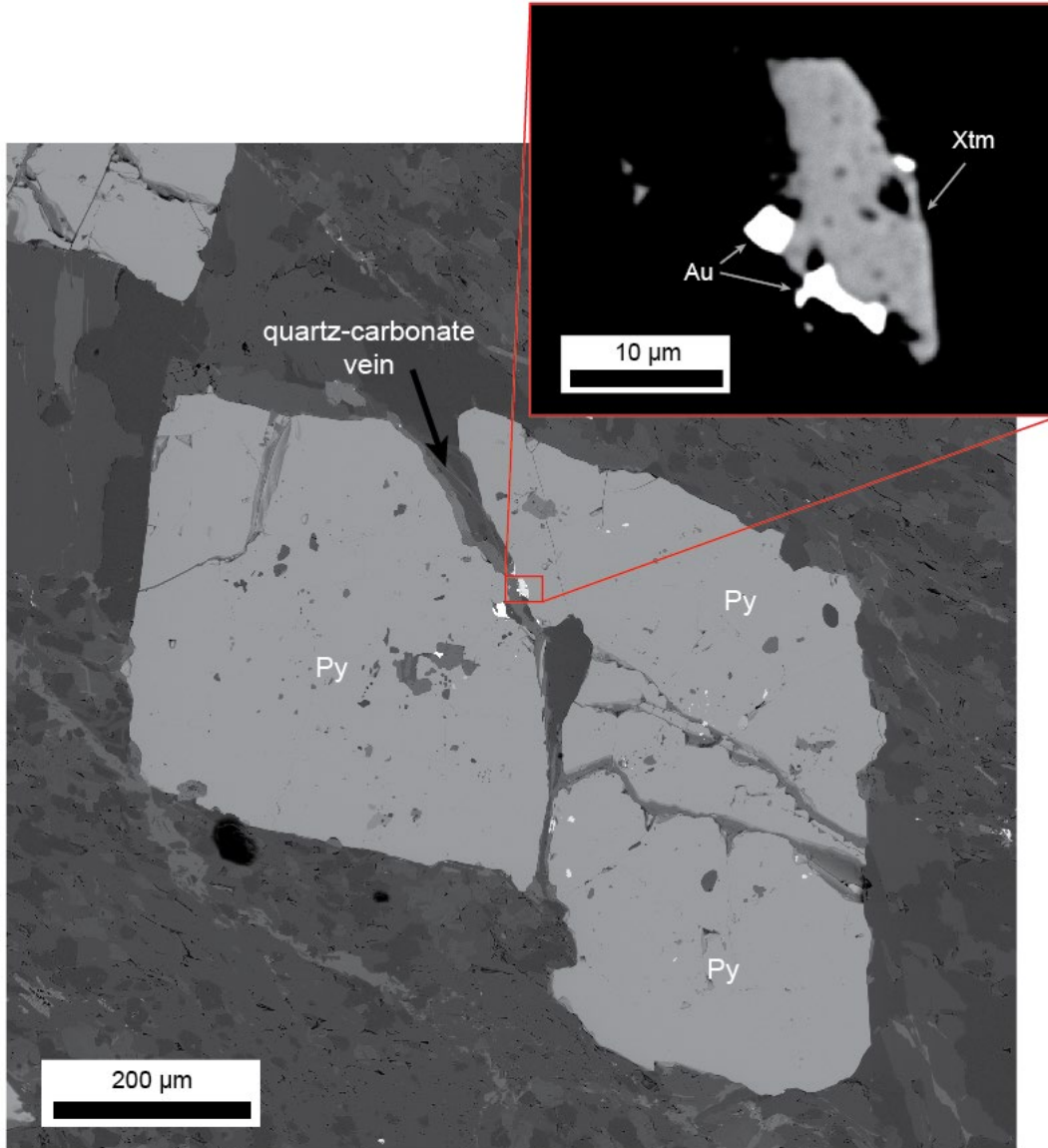
- Intensity of alteration delineated
- Mass balance reveal signature of alteration
- Enrichments in Au, Ag, Te, S, C, Pb, W, and Mo



(Peterzon, 2020; BSc Thesis)

Van Horne – Glatz West mapping and sampling

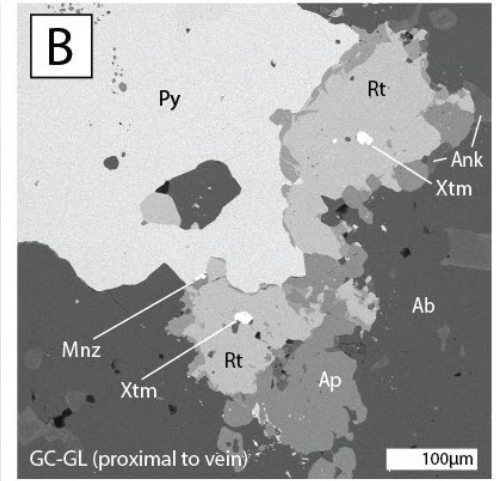
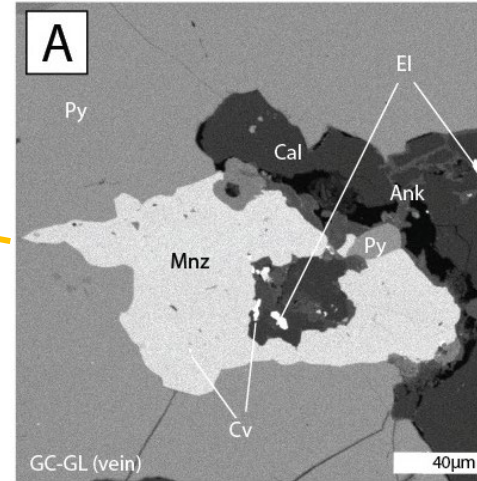
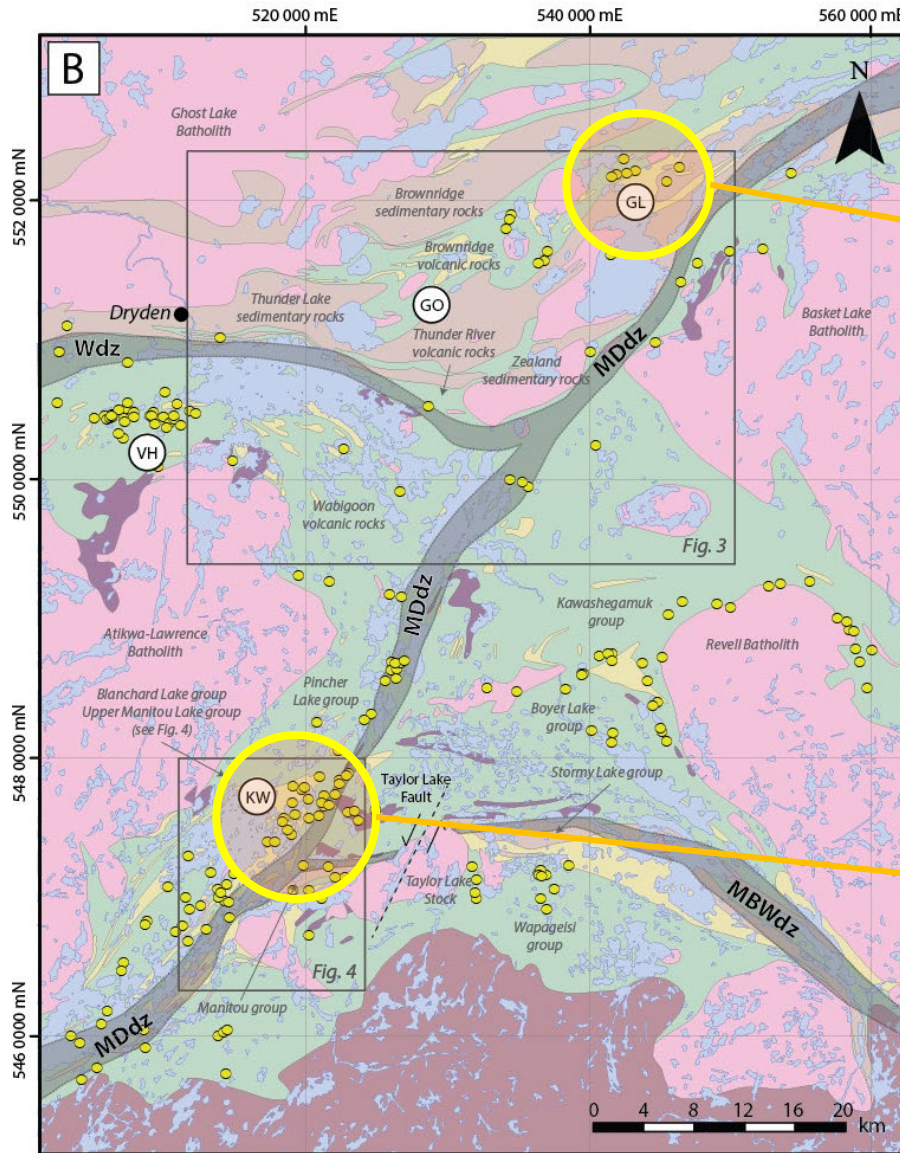
Canada



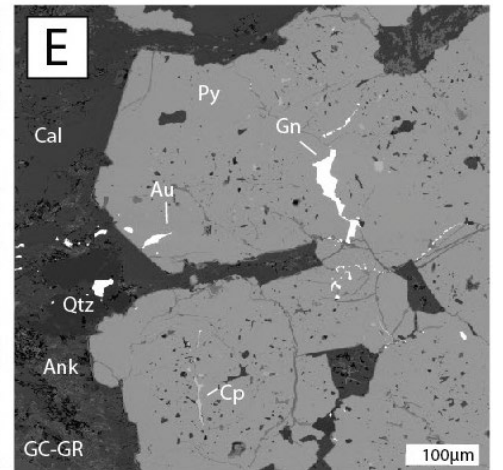
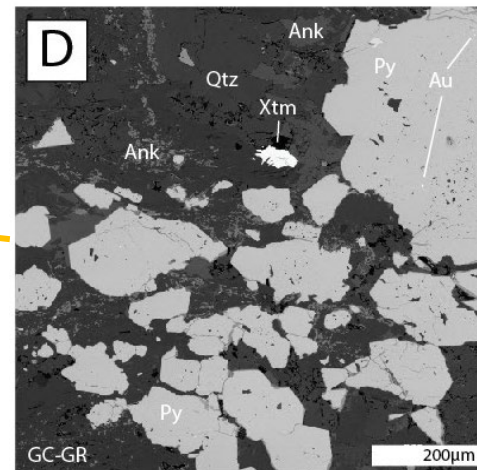
- Veins emplaced during D₂ dextral shear
- Absolute timing of mineralizing events?
- Can constrain by U-Pb dating of xenotime



Timing of hydrothermal events – MDdz samples



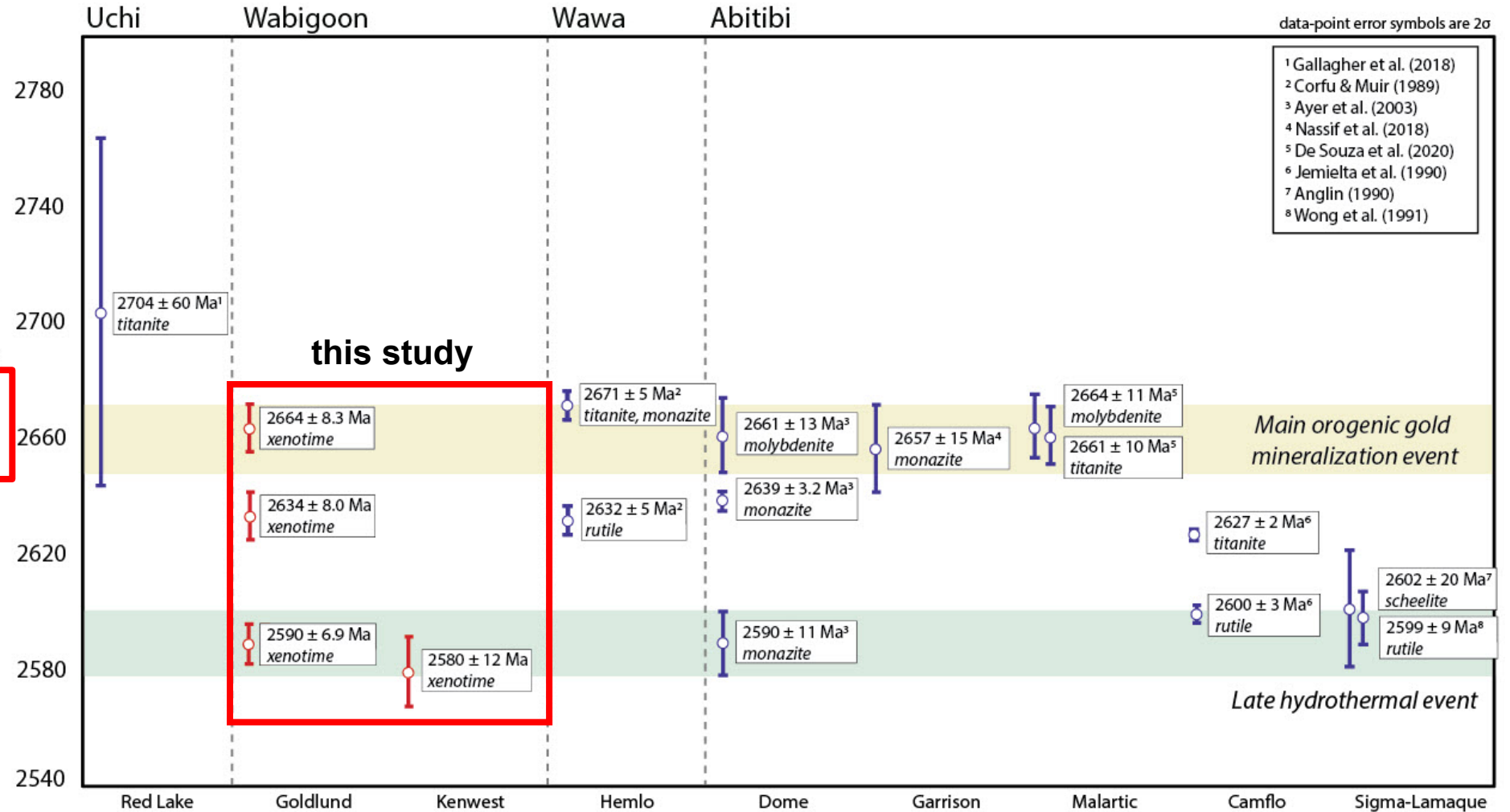
Broader sampling suite



Hydrothermal events – A southern Superior view



Van Horne/
Goliath??



- Gold-bearing fluid flow occurred at similar times

Summary – Student-driven investigations

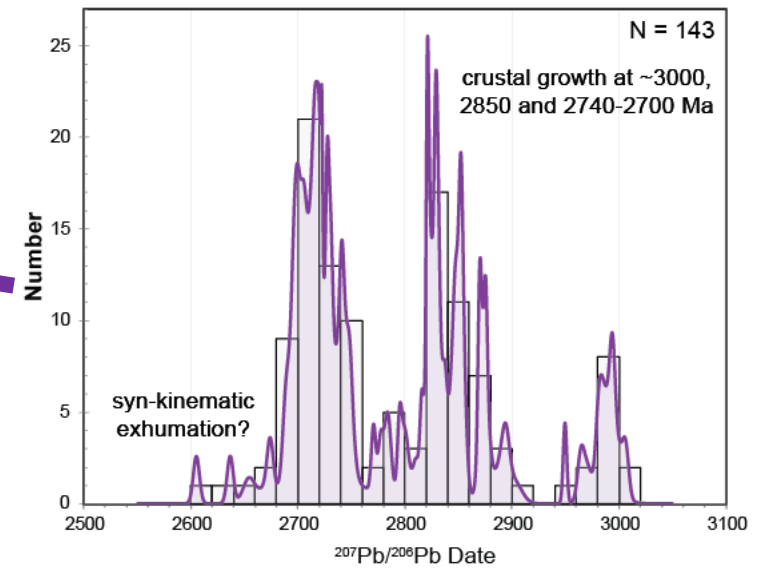
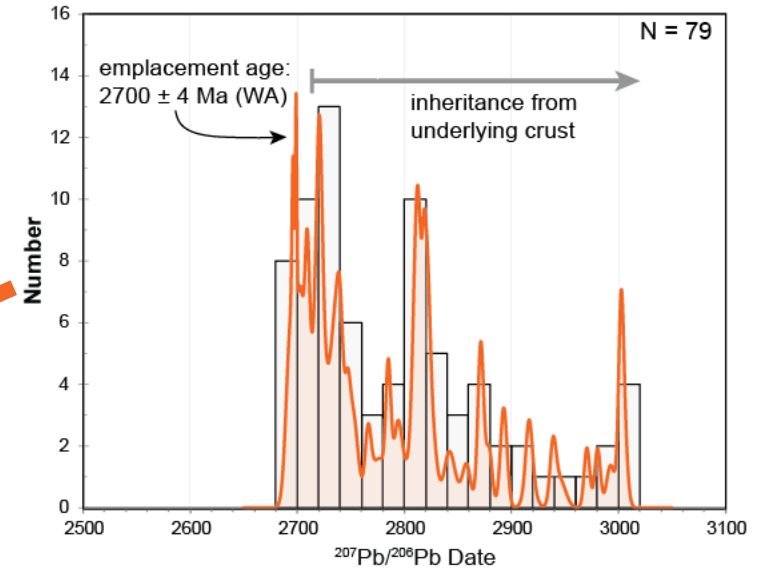
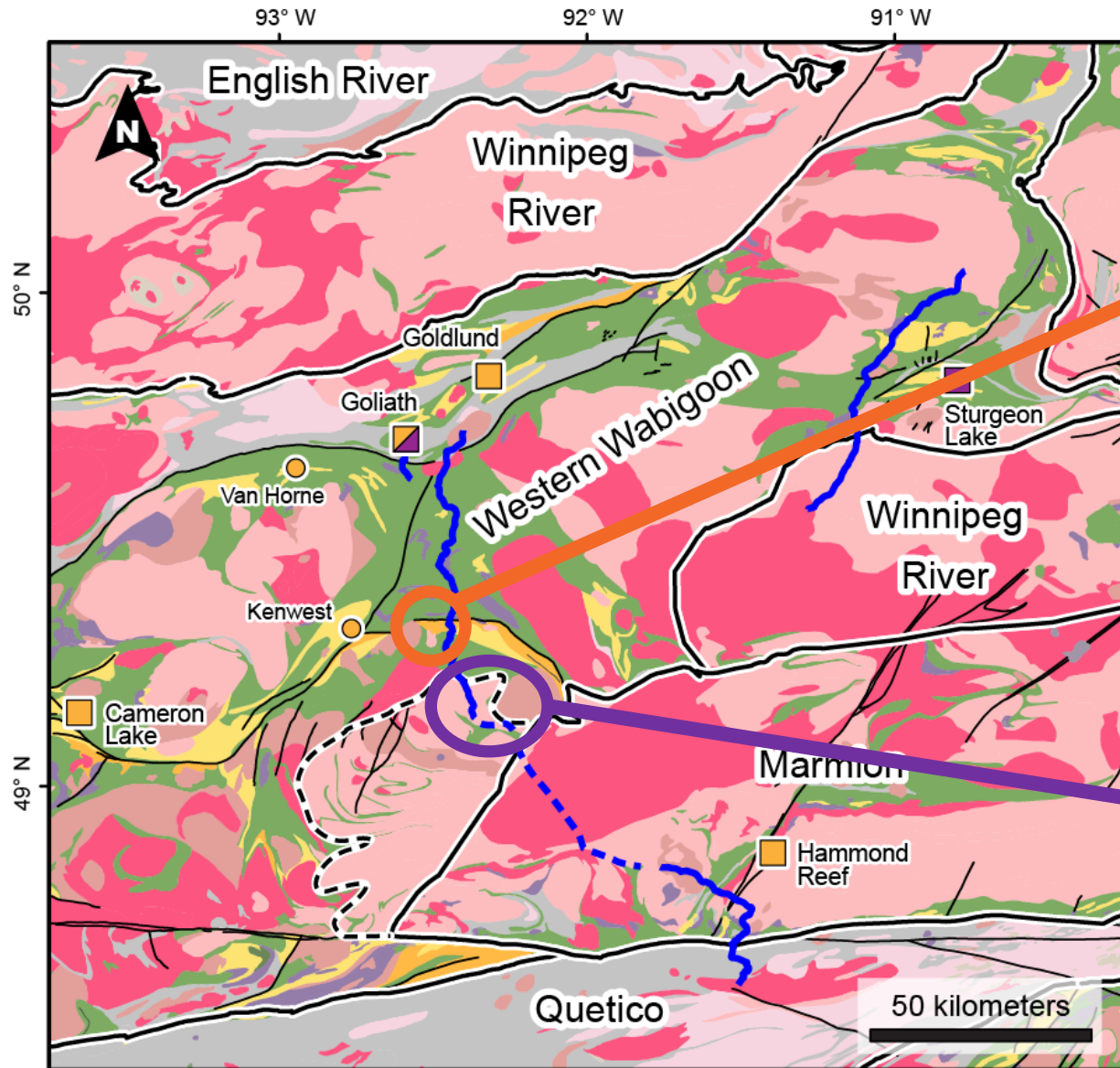
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- Orogenic gold mineralization occurred in brittle-ductile deformation zones
- Au-bearing fluids emplaced at a similar time to the Abitibi subprovince
- Prospective zones occur along the Wdz and MDdz
- South-central study region contains less known Au
- Broader architectural control?

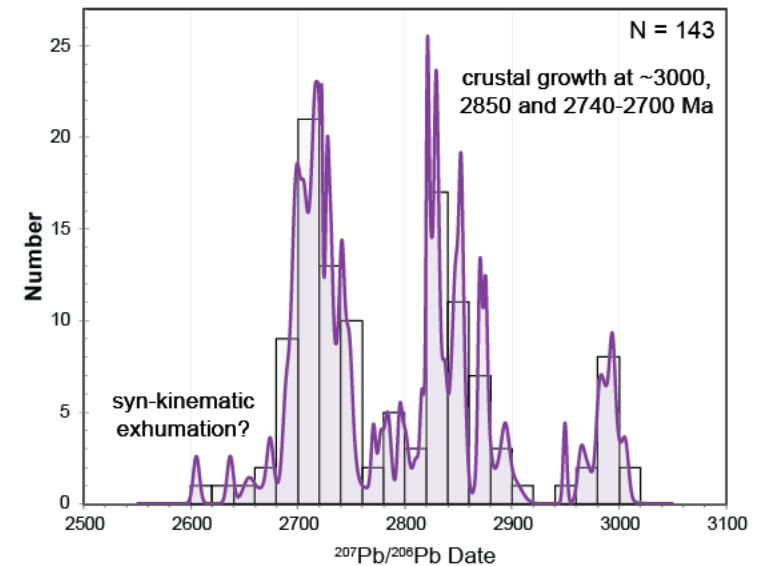
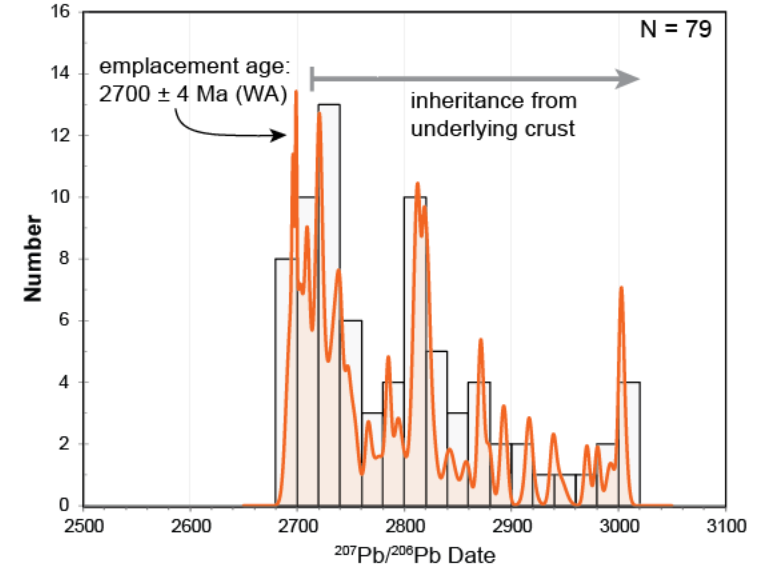
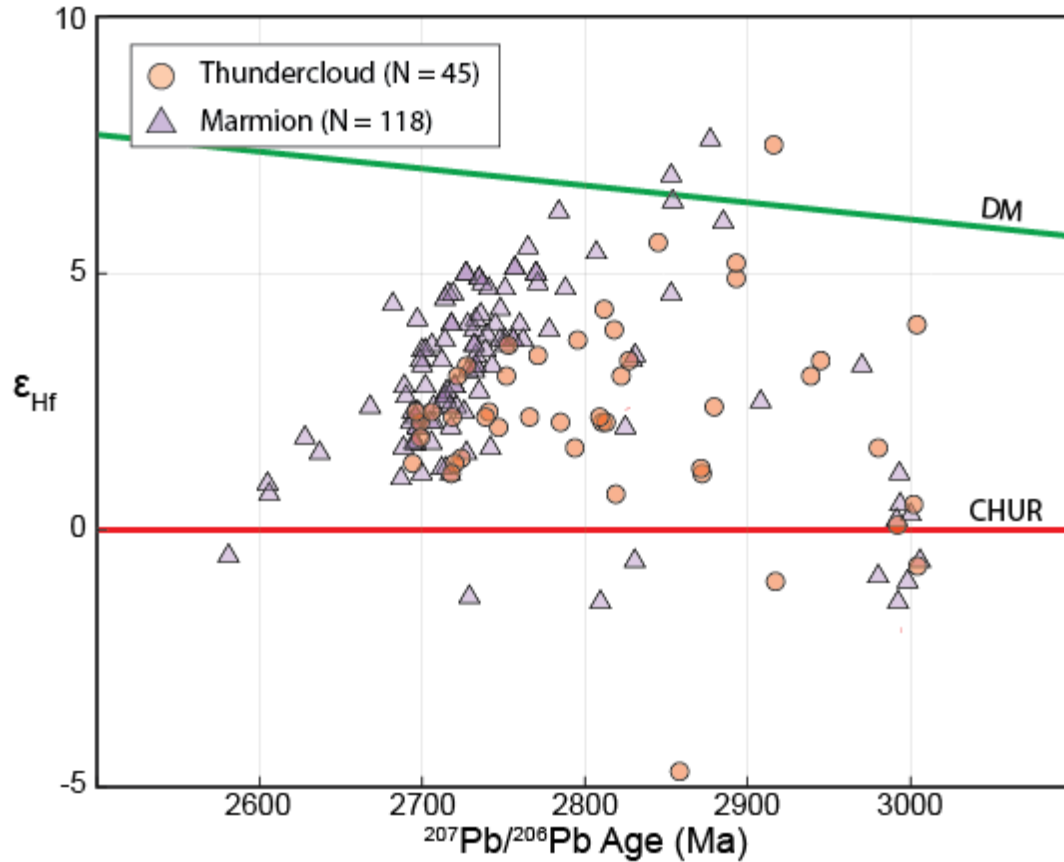


South-central subprojects – Insight from zircon



South-central subprojects – Insight from zircon

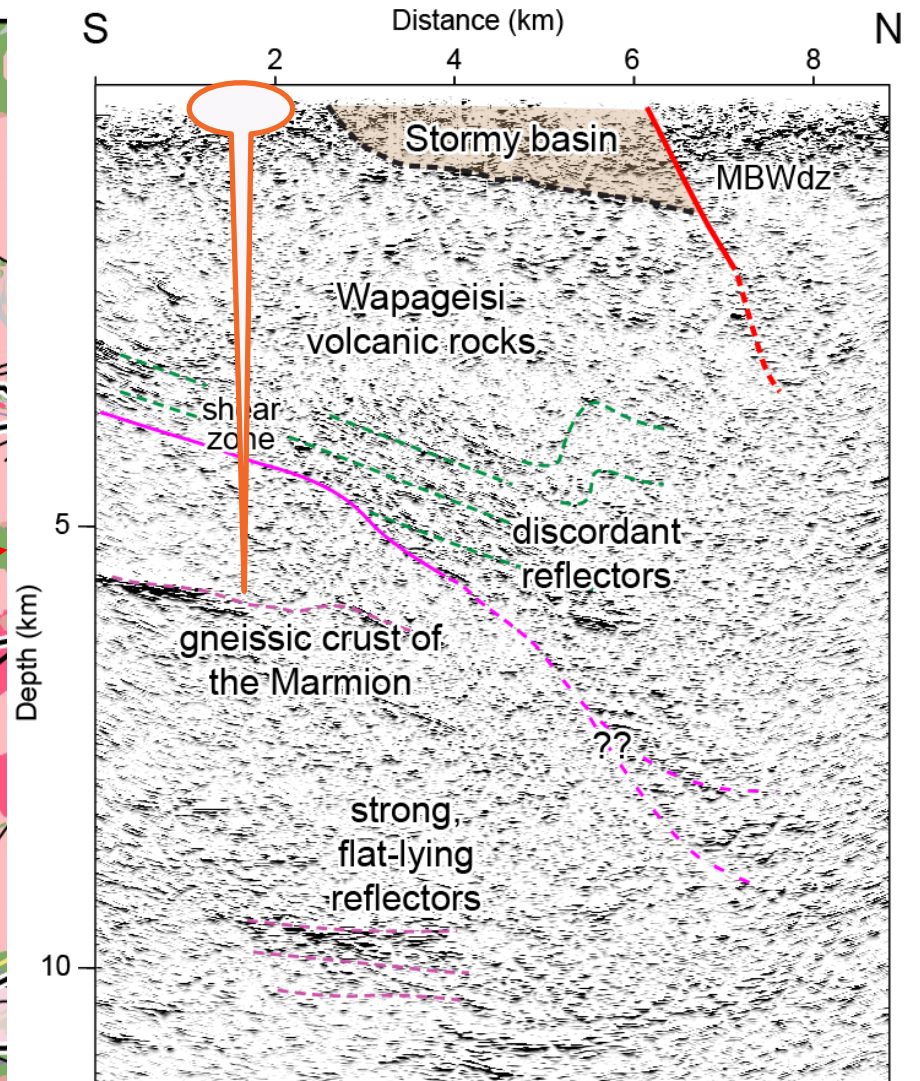
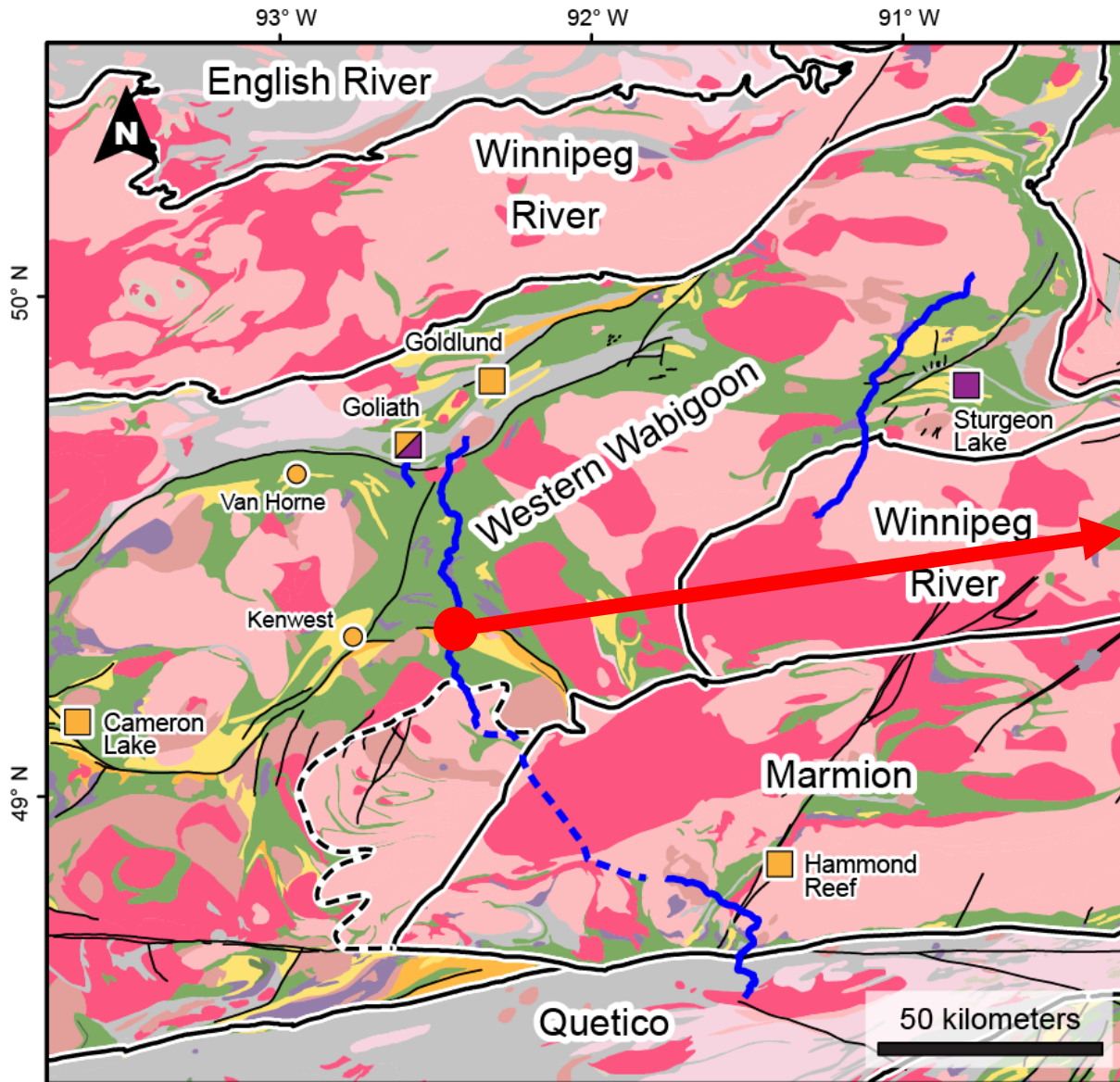
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- Zircon isotope record provides insight into distribution of underlying Marmion crust



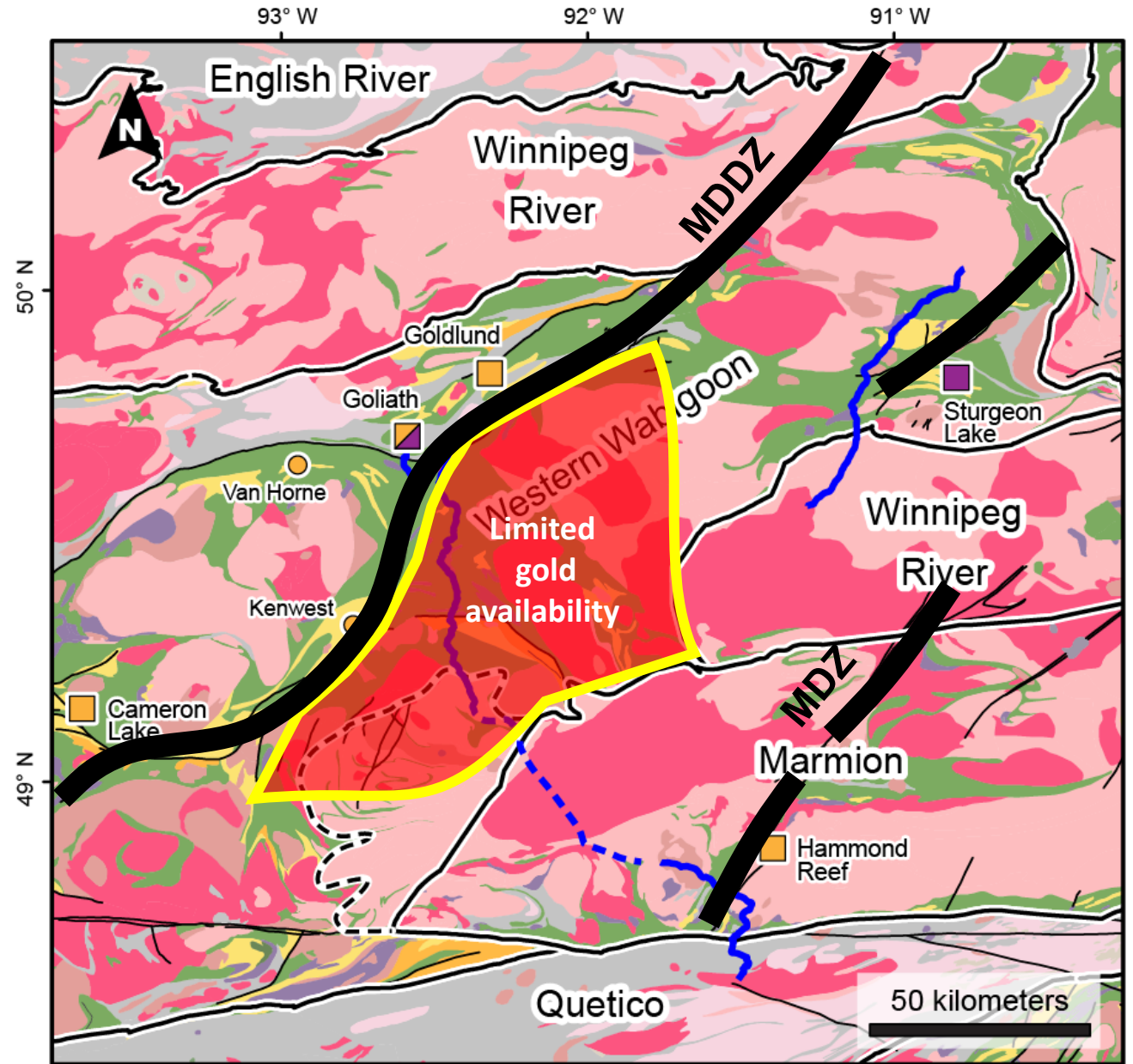
South-central subprojects – Insight from seismic



R2 line

Major implications:

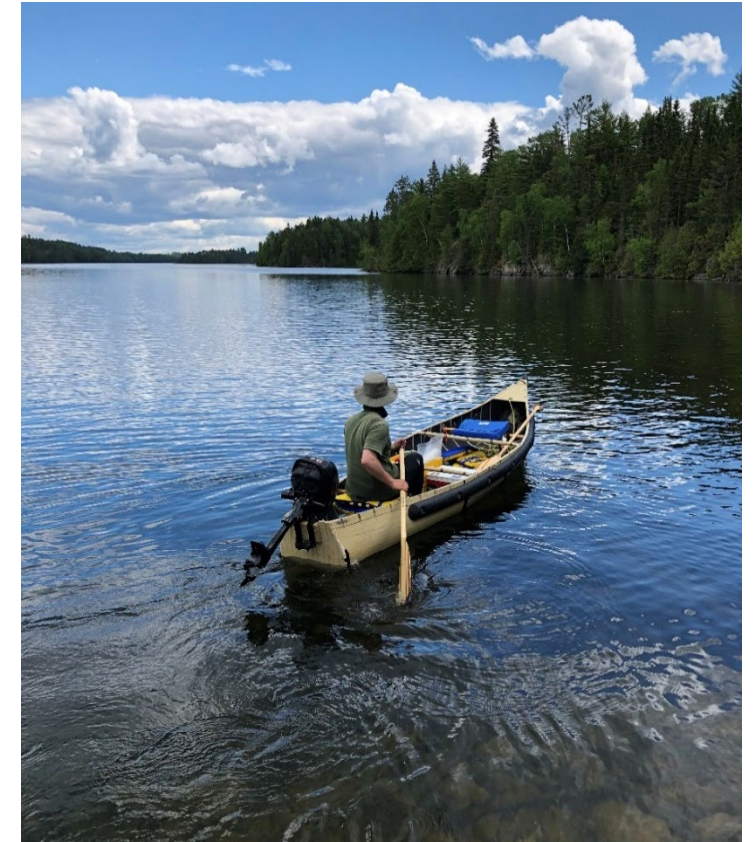
- Multiply reworked, gneissic crust of the Marmion partially underlies the belt
- Underlying, dry & infertile crust limited the gold endowment in portions of the Wabigoon
- In part, regional deformation zones (e.g., MDdz) mark long-lived, lithospheric-scale structure



Conclusions – New perspectives from Metal Earth

Southwestern Superior Province preserves a billion years of Archean history!

- Origin in late Eo- to early Paleoproterozoic (~3600-3500 Ma)
- Further stabilization of continental crust in the Mesoproterozoic (Marmion & Winnipeg River)
- Western Wabigoon formed in a pericontinental setting (continental arc to back-arc and/or intracratonic rift?)
- Similar structural evolution & timing of major hydrothermal events to the Abitibi
- Metallogenic history strongly influenced by earlier geodynamic processes and heterogeneity in lithospheric-scale architecture



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