Crustal Architecture and Endowment of the Timmins-Matheson Camps

John Ayer

Mineral Exploration Research Centre,

Harquail School of Earth Sciences, Laurentian University

Part 1. Timmins Region Crustal Architecture and Endowment

Part 2. Matheson Region Architecture and Endowment

Part 3. Timmins Camp AMT Results

METAL EARTH

A Canadian research initiative funded by Canada First Research Excellence Fund

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MERC
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at the HARQUAIL School of Earth Sciences

Laurentian University Université Laurentienne
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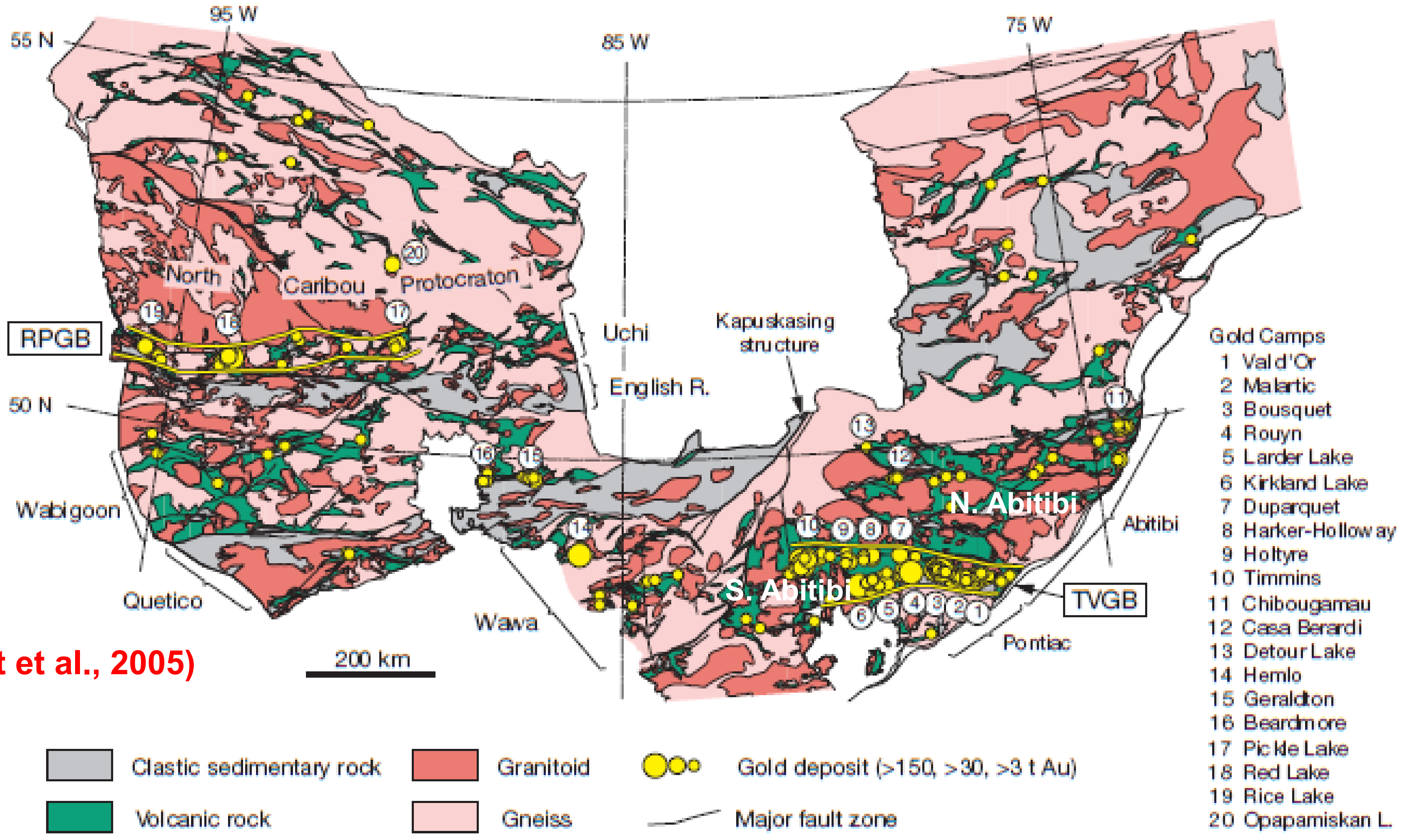
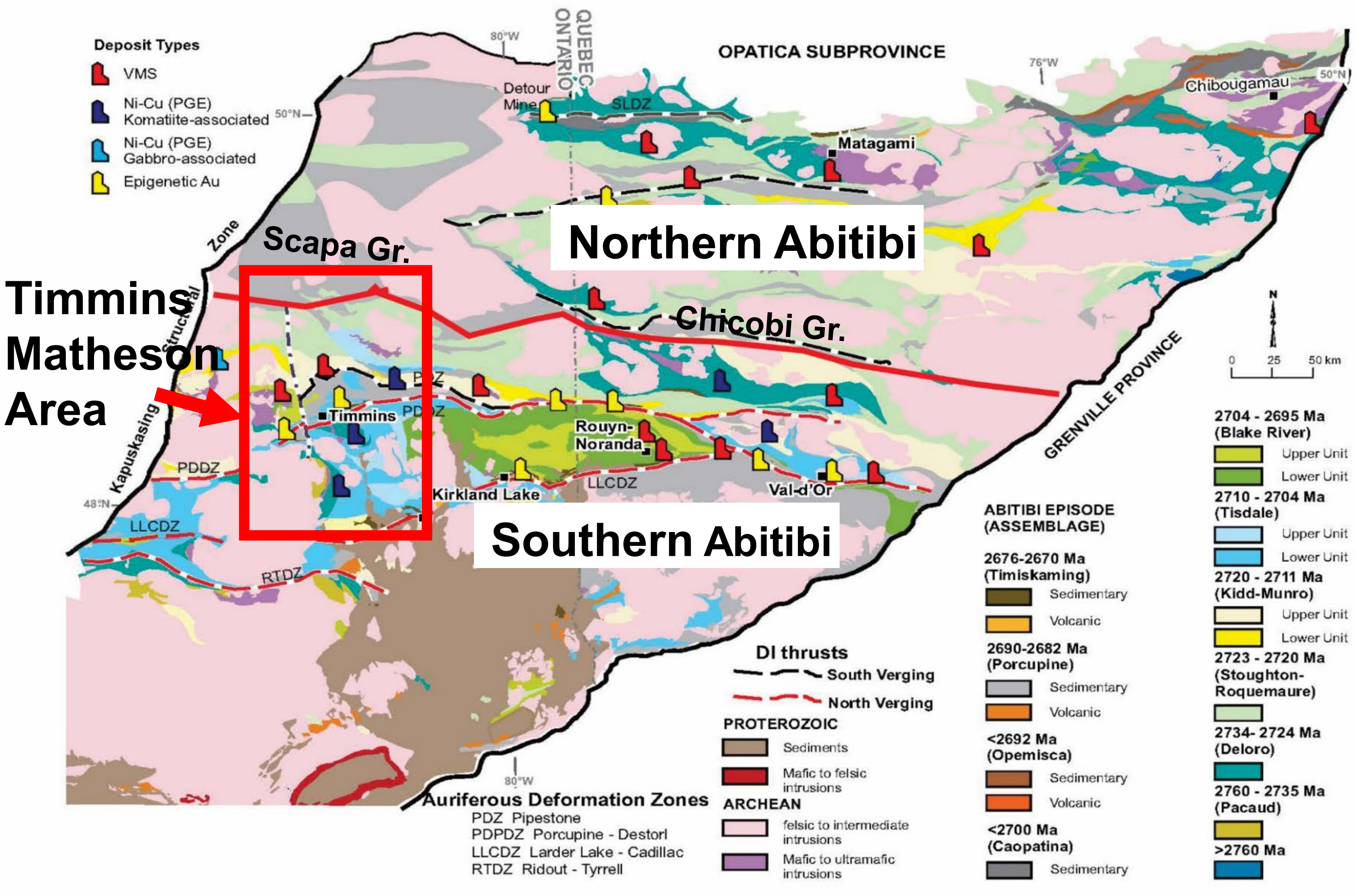
Superior Orogenic Gold Deposits



(Robert et al., 2005)

Abitibi Stratigraphic Map



Thurston et al., 2008

Tectonic and Metalogenic implications of key differences of North & South Abitibi?

The N-S Abitibi boundary occurs at the south contact of the Scapa and Chicobi Gr. turbidites (>2700 Ma.).

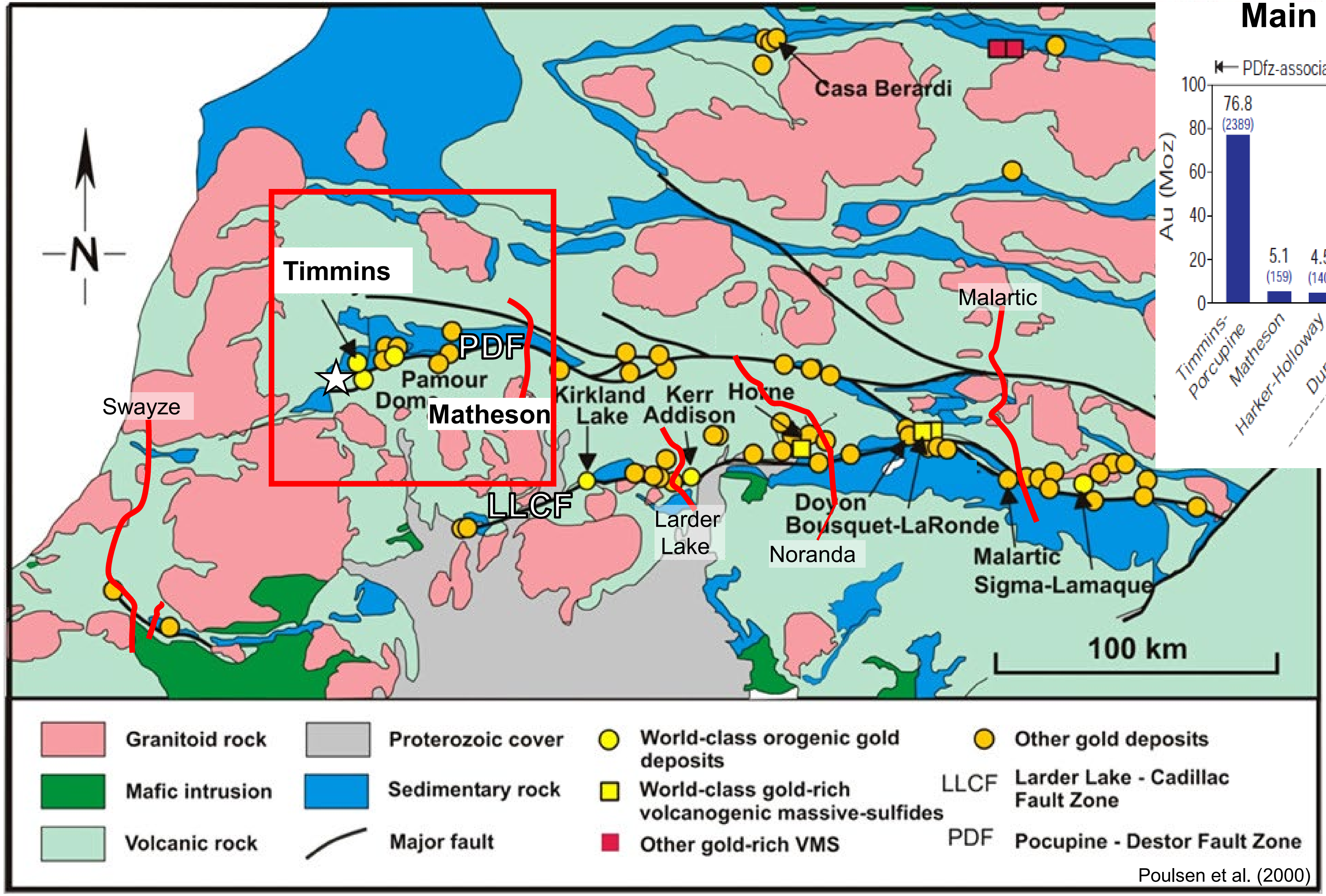
The Tisdale & Blake River volcanic assemblages (2710-2695 Ma) only occur in the Southern Abitibi

Turbidites units (Porcupine assemblage >2690 Ma) in the Southern Abitibi are ~10 to 15 Ma younger

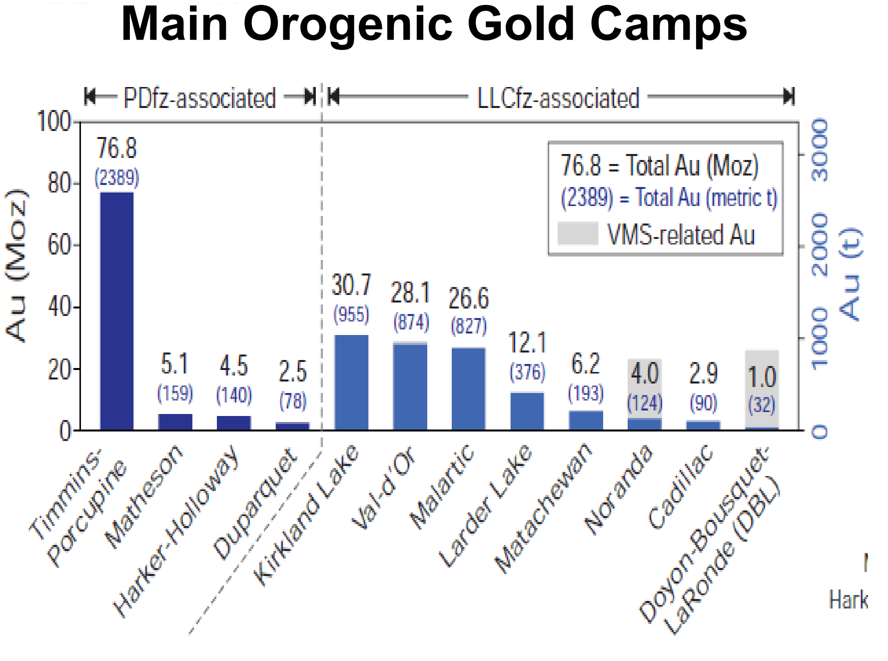
Deformation events and orogenic gold deposits in Northern Abitibi are also 10-15 Ma older

Northern Abitibi less Au endowed

Transect scale research – Abitibi greenstone belt and orogenic gold

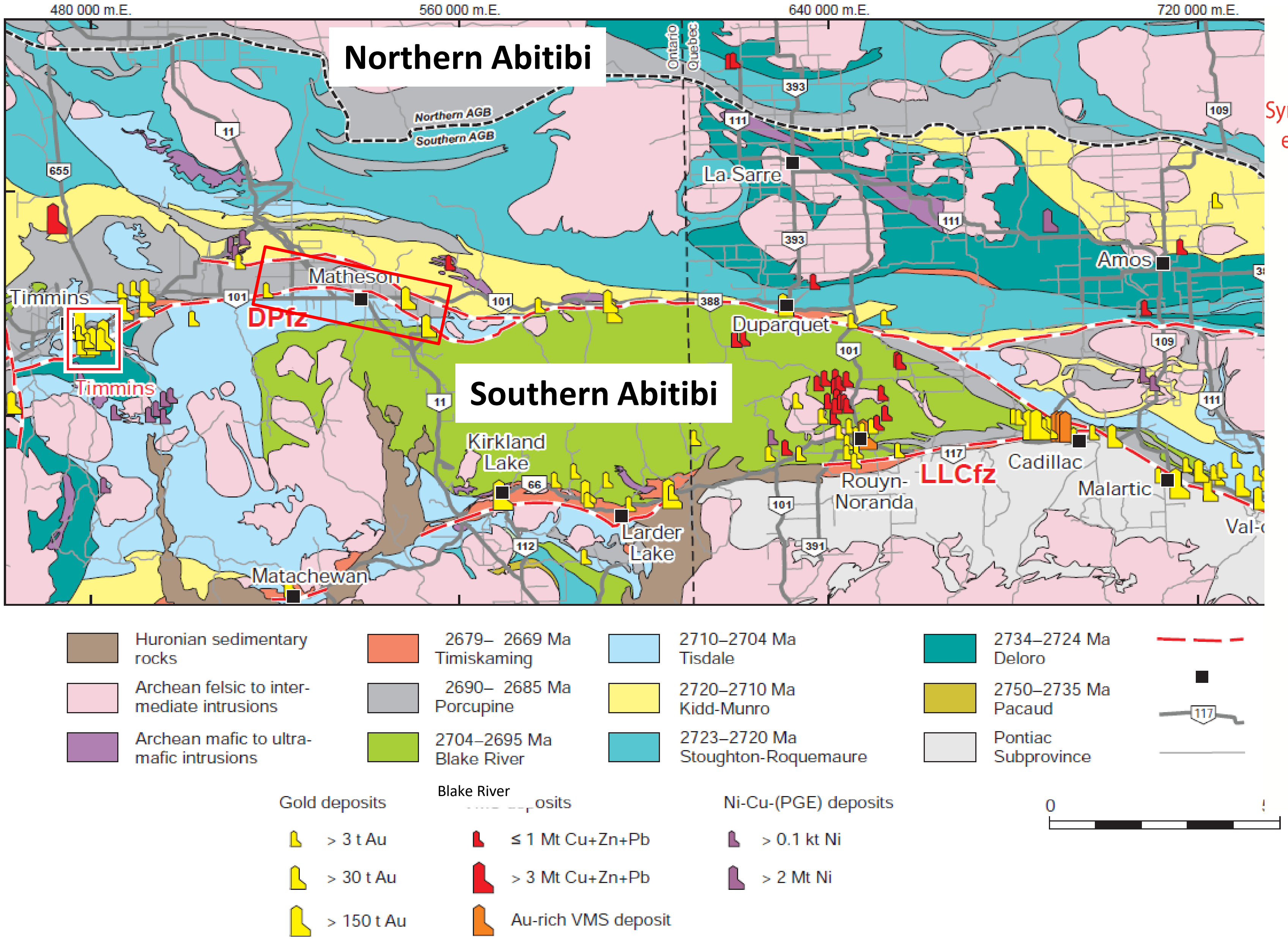


Poulsen et al. (2000)

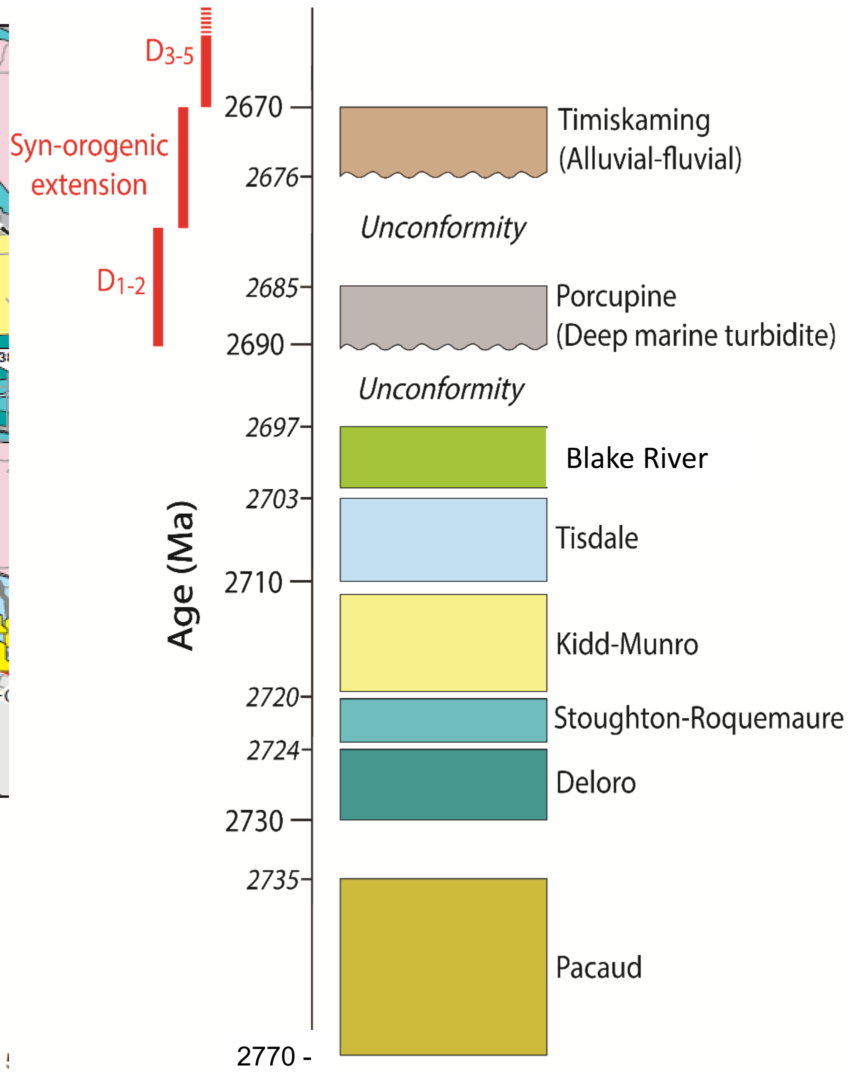


Monecke et al. (2017)

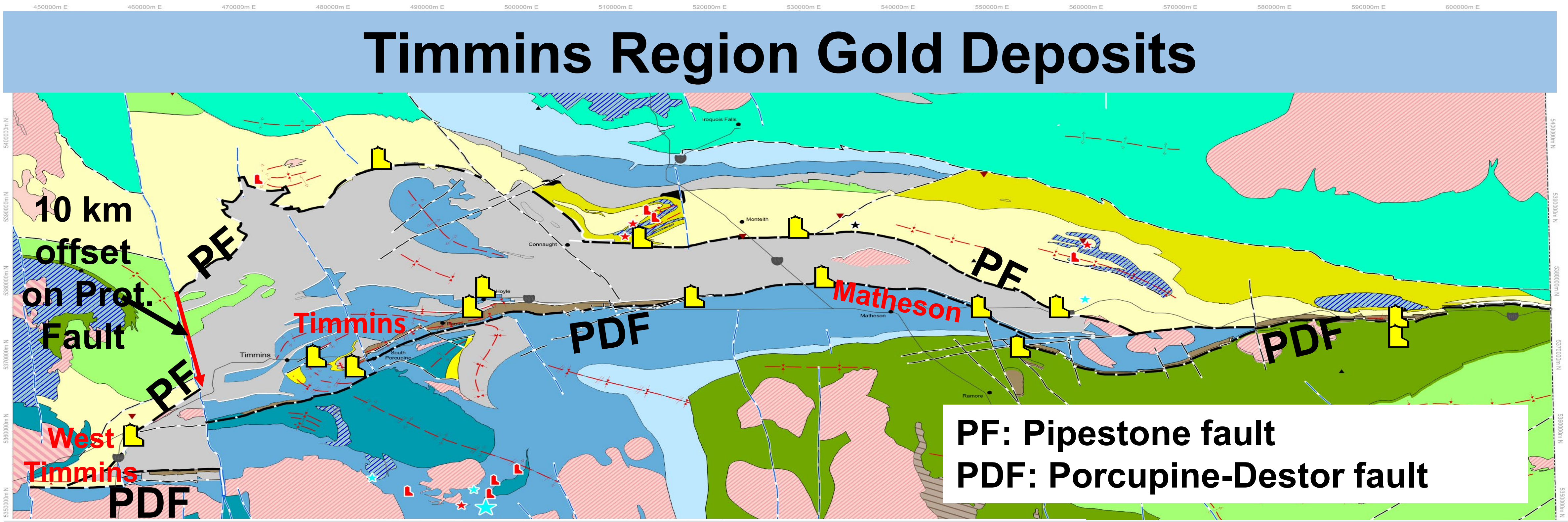
Southern Abitibi Stratigraphy



Southern Abitibi Stratigraphic section



Timmins Region Gold Deposits

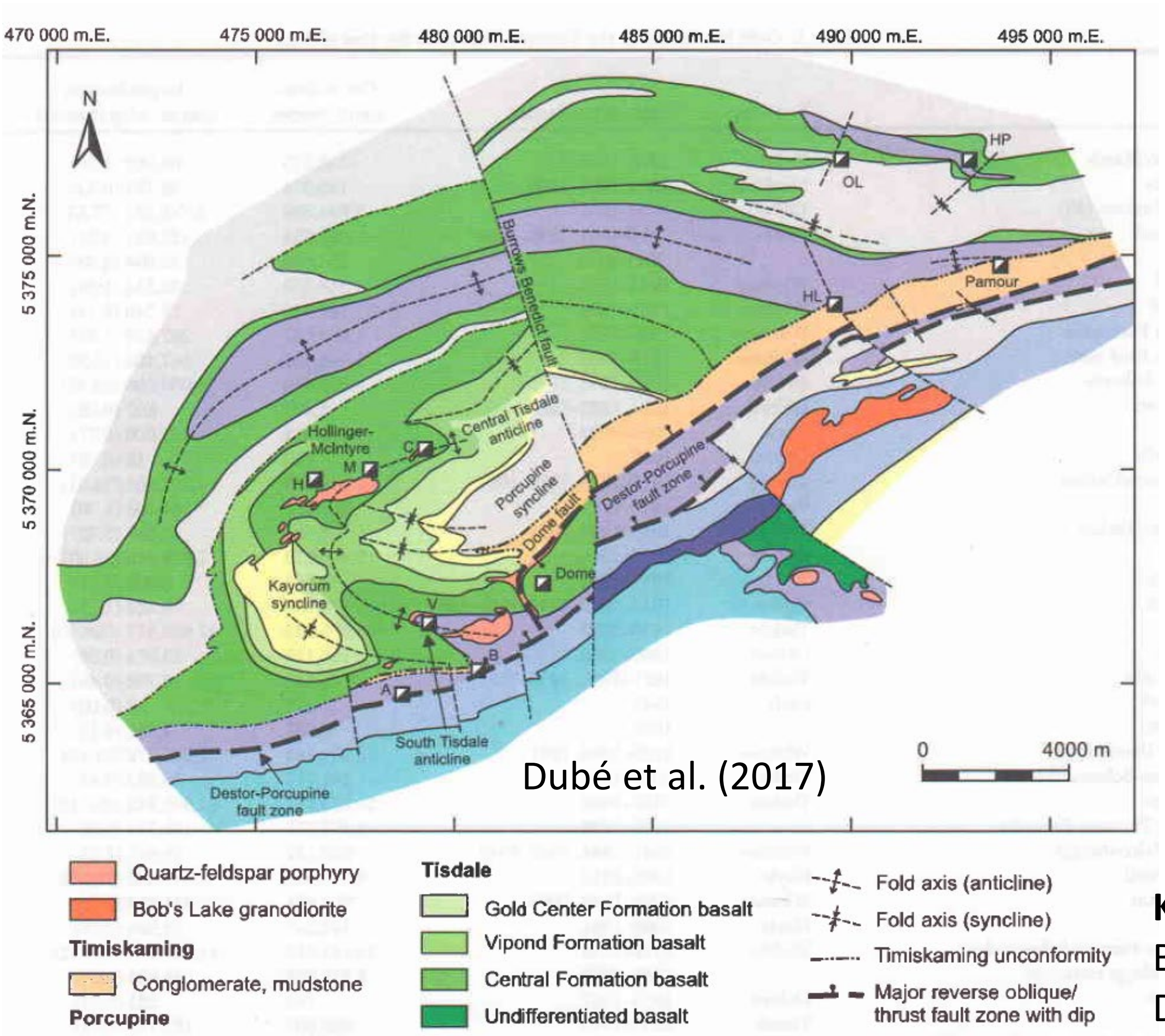


Au Deposits Occurs Along Two Major Faults

North: Pipestone Deformation Zone: D_1 thrust with Kidd-Munro volcs (2720-10 Ma) thrust south over Porcupine turbidites (2690-80 Ma); Au<2680 Ma.

South: Porcupine Destor Deformation Zone: D_2 thrust associated with Timiskaming conglomerates & sandstones (2676-70 Ma); Au<2670 Ma.

Pre-Timiskaming deformation events



Dubé et al. (2017)

Timmins camp

Timiskaming unconformity at base of Timiskaming basin

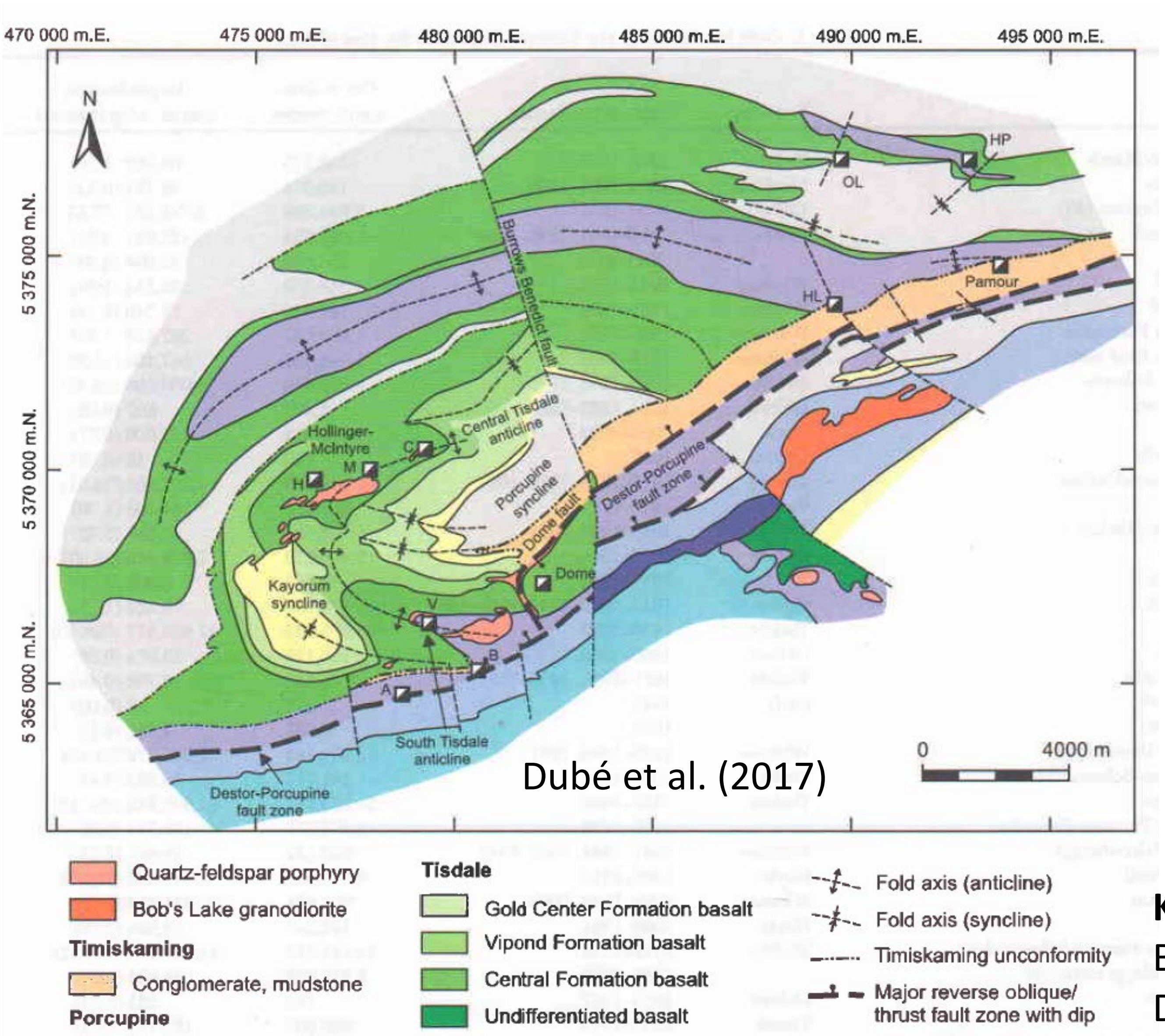
D2 Folding and Formation of the Porcupine syncline

Porcupine unconformity at base of Porcupine basin

D1 Thin-skinned thrusting
Formation of Central Tisdale Anticline

Key references: Bateman et al. (2008); Bleeker (2012, 2015); Dubé et al. (2017); Dubé and Mercier-Langevin (2020)

Post-Timiskaming deformation events



Dubé et al. (2017)

Timmins camp

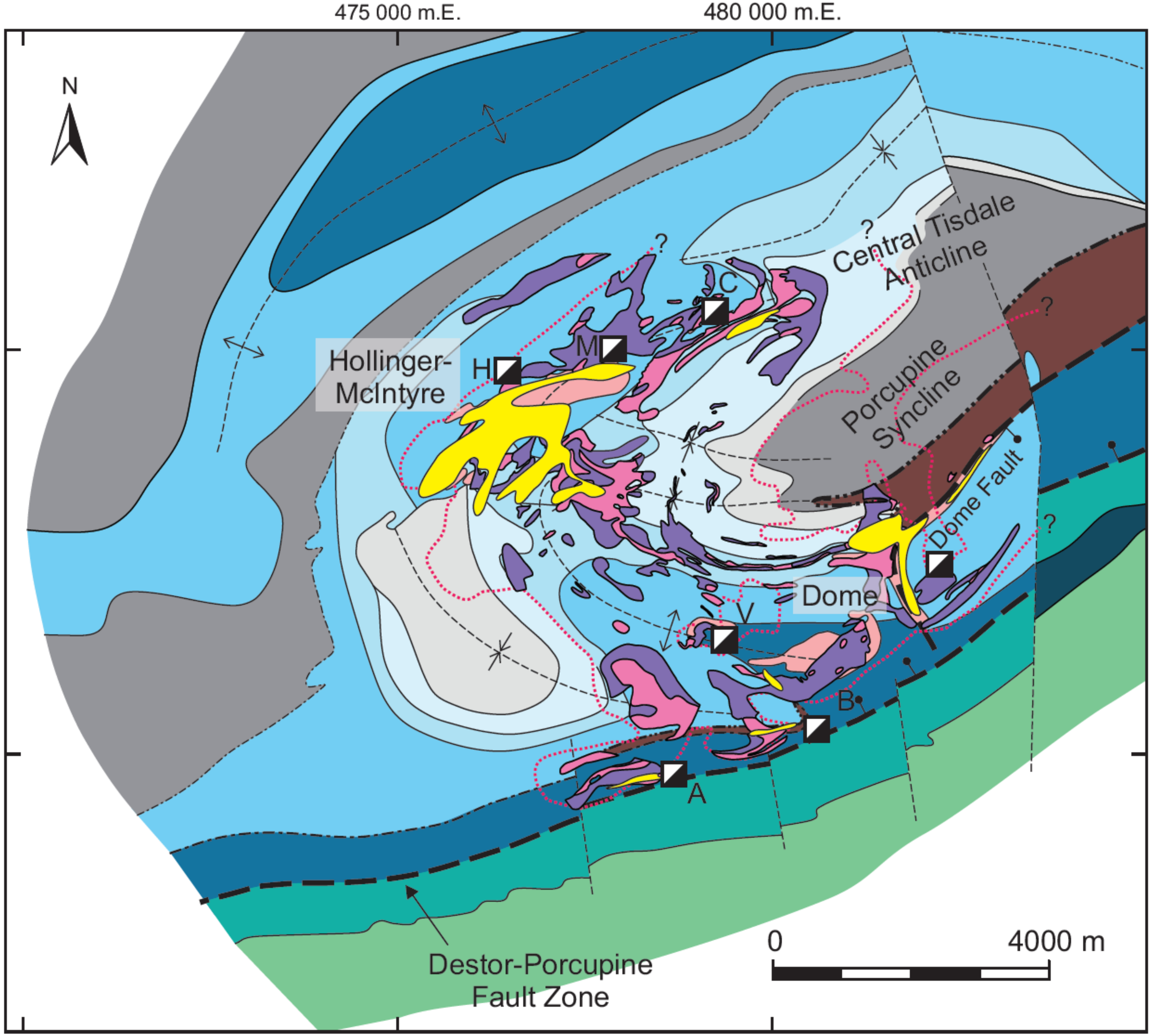
D4 & D5 Sinistral and dextral strike-slip reactivation of the Porcupine-Destor Fault

D3 F3 Folding and Formation of regional S3 cleavage and Porcupine-Destor Fault

Timiskaming unconformity at base of Timiskaming basin

Key references: Bateman et al. (2008); Bleeker (2012, 2015); Dubé et al. (2017); Dubé and Mercier-Langevin (2020)

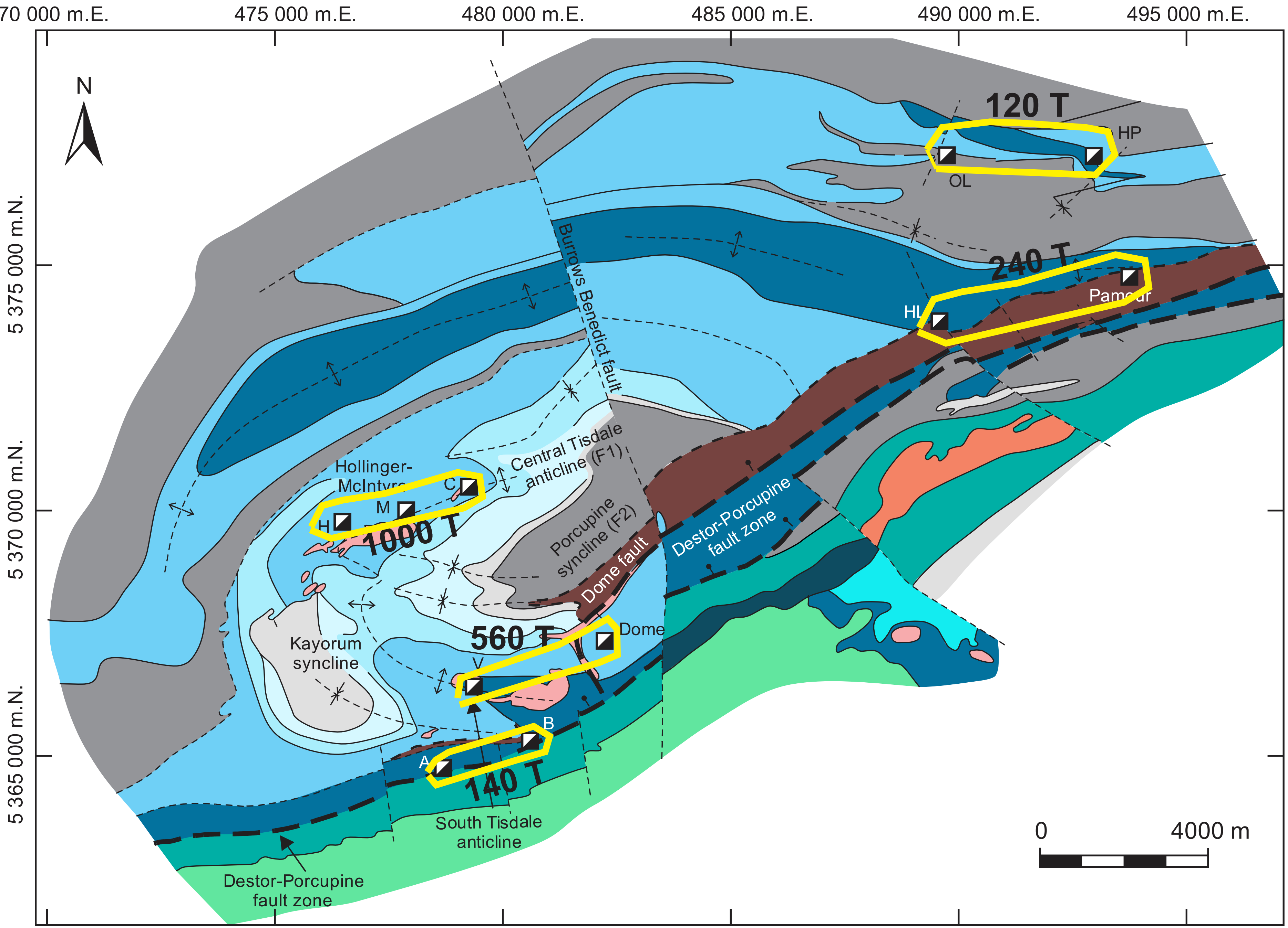
Timmins Camp Mineralization & Alteration



Alteration footprint and quartz-carbonate veins network

- Chlorite-calcite (distal)
- Ankerite - chlorite (intermediate)
- Ankerite - sericite - pyrite (proximal)
- Au quartz-carbonate veins network with auriferous fine disseminated pyrite in selvages
- Fold axis (anticline)
- Fold axis (syncline)
- Timiskaming unconformity
- Major reverse oblique/ thrust fault zone with dip
- Dip-slip/thrust fault/ high-strain zone
- Late strike-slip fault
- Gold deposit

(Dubé et al., 2017)



Timmins Camp

Worlds' Largest Archean Orogenic Gold Camp

~2200 T (80 Moz) gold avg. grade 6.5 g/t

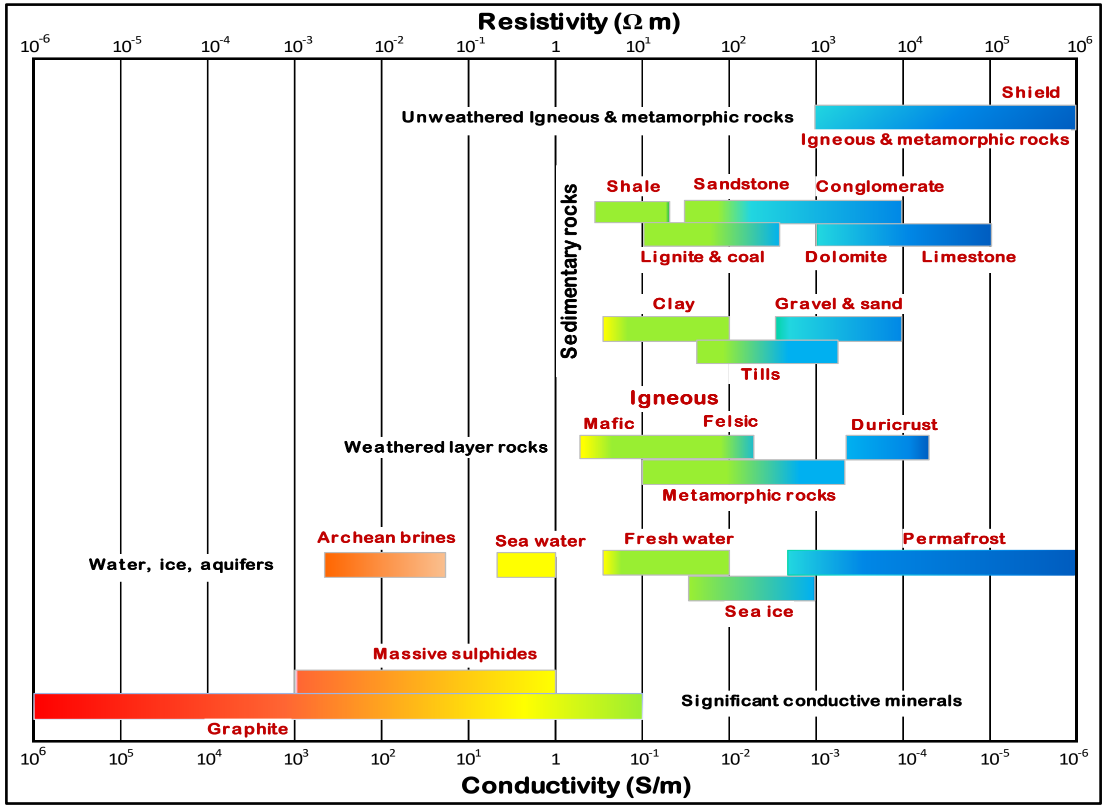
-Five major clusters:

1000T	Hollinger-McIntyre
510T	Dome-Paymaster
240T	Pamour-Halnor
140T	Aunor-Delinite
120T	Hoyle-Owl

(Dubé et al., 2017)

Introduction to the MT method

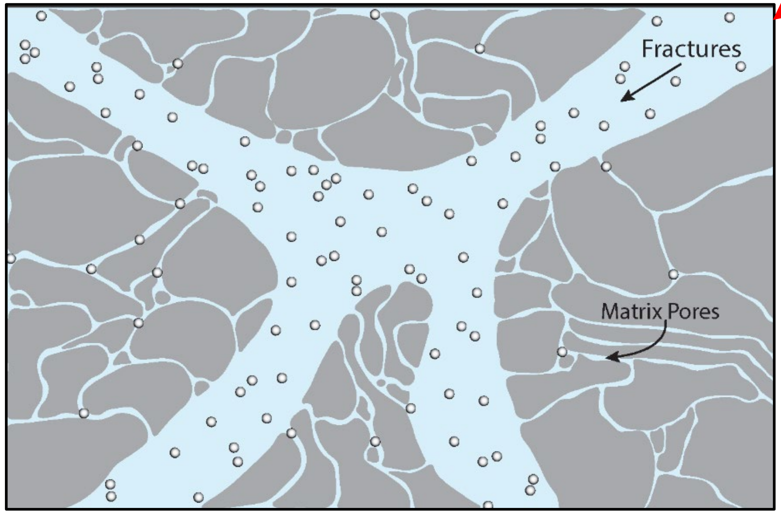
Property: electrical conductivity



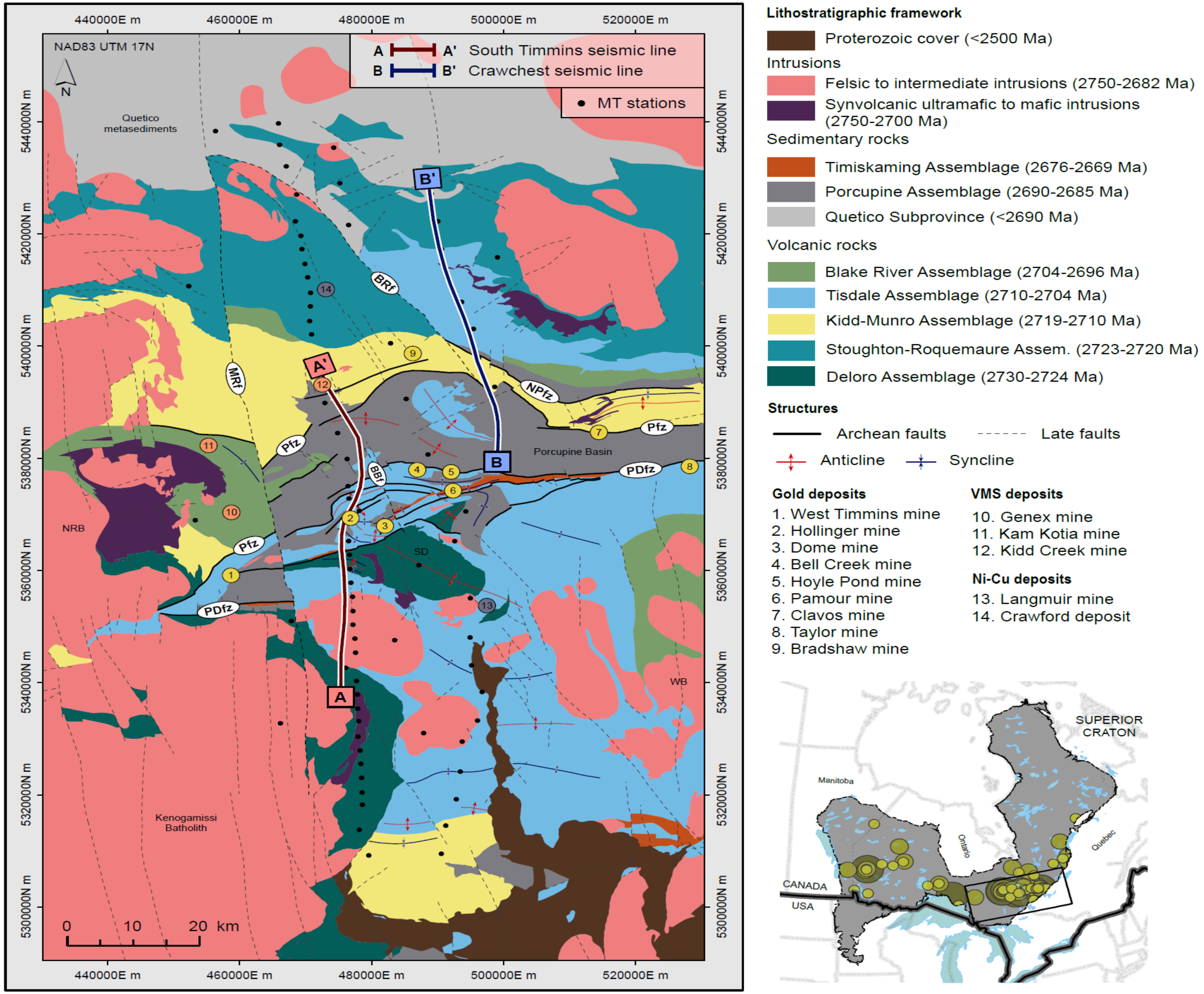
modified from Palacky, 1988

High conductivity (low resistivity) can be caused by large scale interconnected networks of:

- **Fluids**
- **Ores**
- **Melts**
- **Graphite**
- **Sulphide**

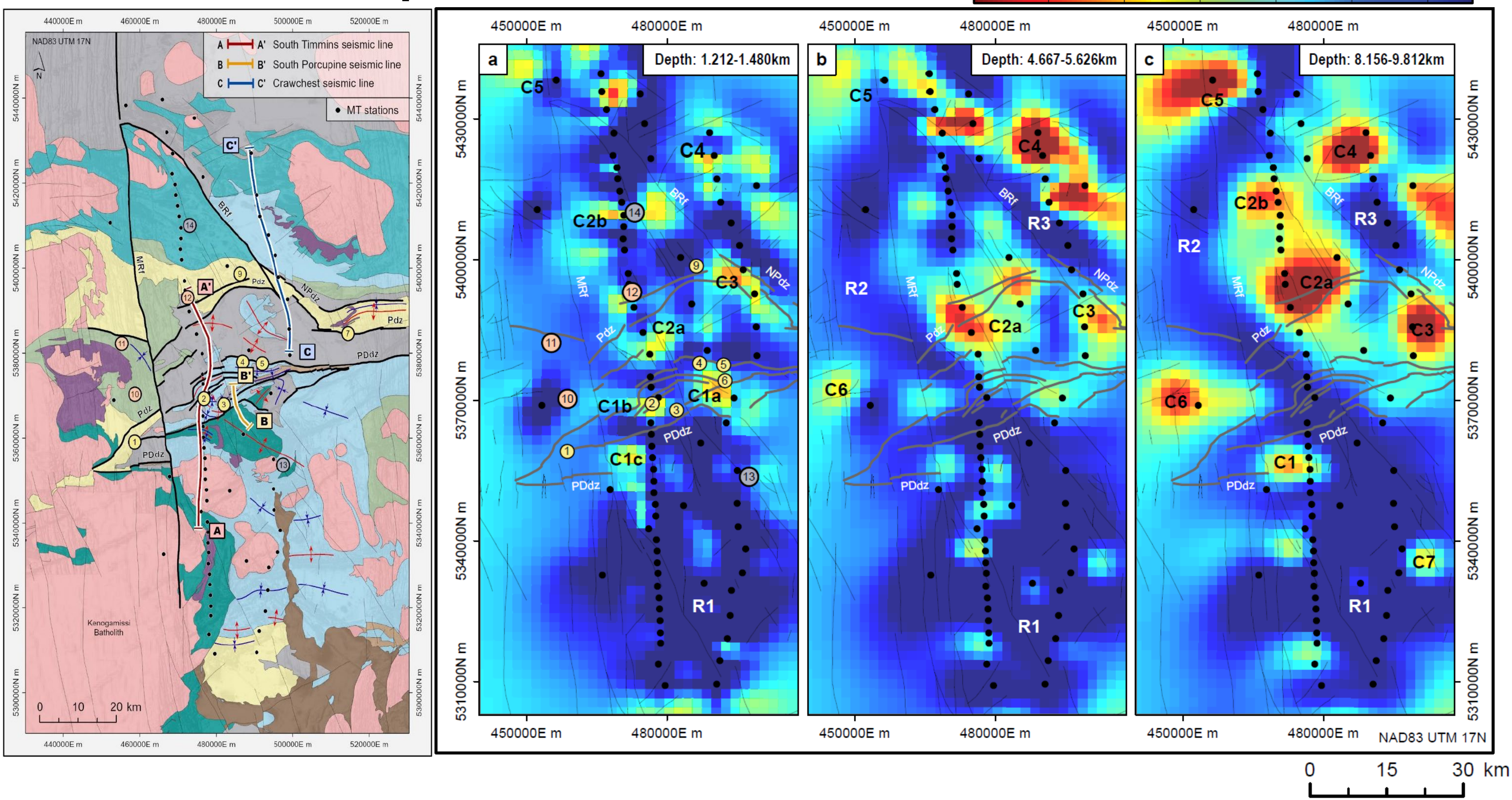


Timmins Regional Geophysics

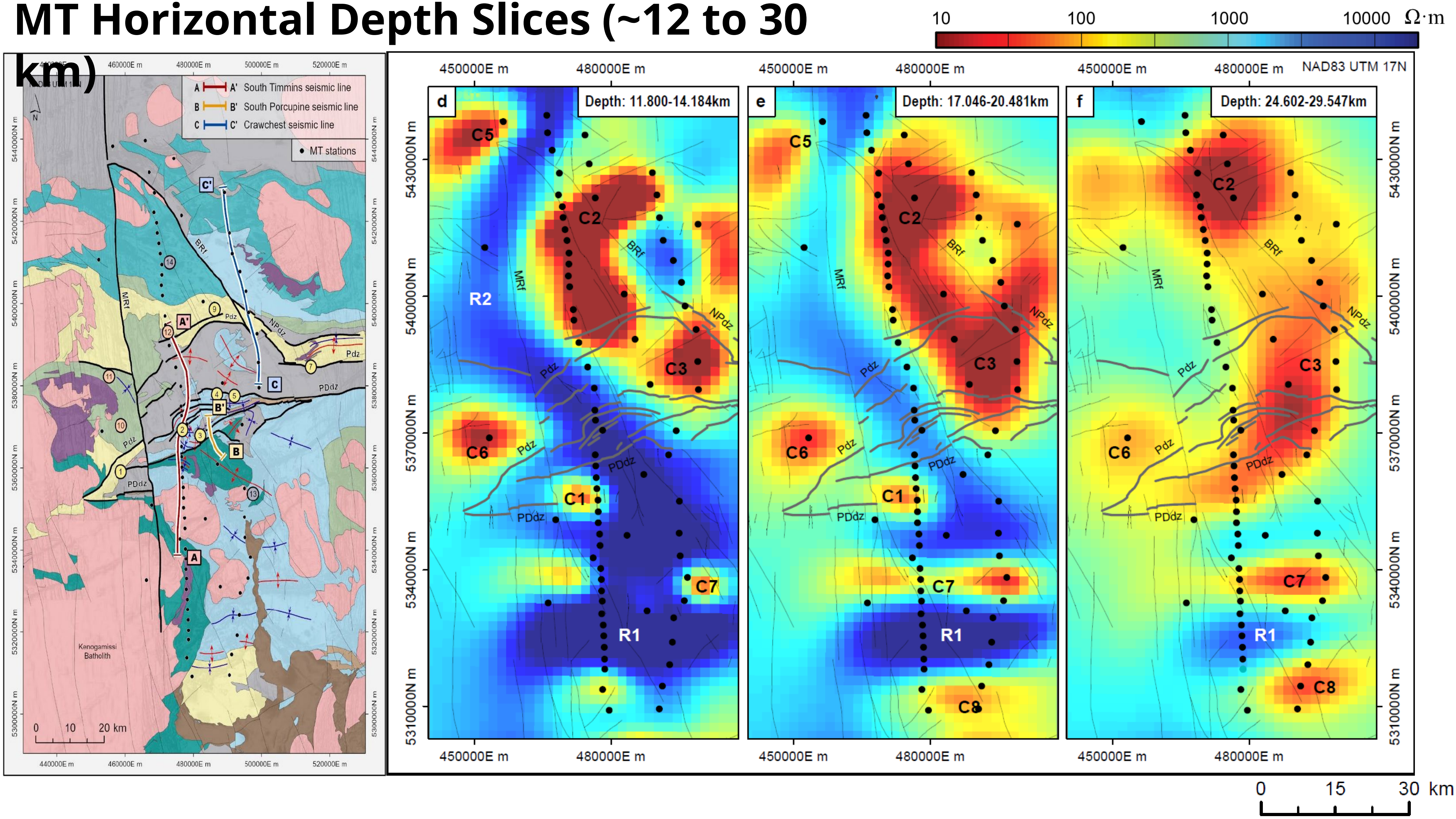


- **ME's 80 MT stations (dots) modelling ~10,000 Km²**
- **Combined with DA's 2 major N-S seismic lines**
- **Improves understanding of:**
  - **Crustal architecture & conductive corridors/fault zones**
  - **Region host world's largest Archean gold camp 80 M oz Au**
  - **Also endowed with base metals**
    - **VMS @ Kidd Creek >170 Mt & Kamiskotia ~7 Mt**
    - **Magmatic Ni-Cu-PGE deposits**

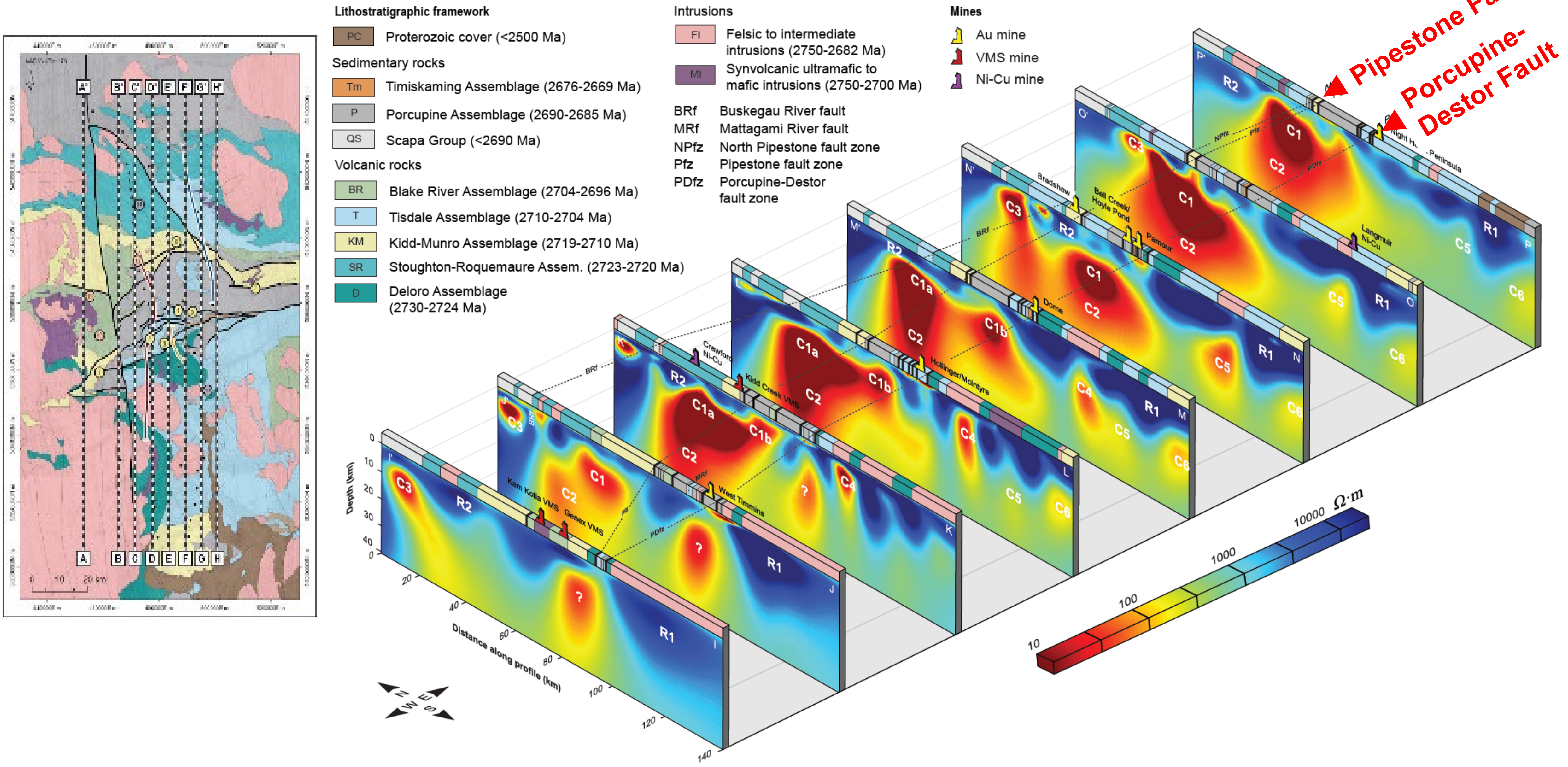
MT Horizontal Depth Slices (~1 to 10



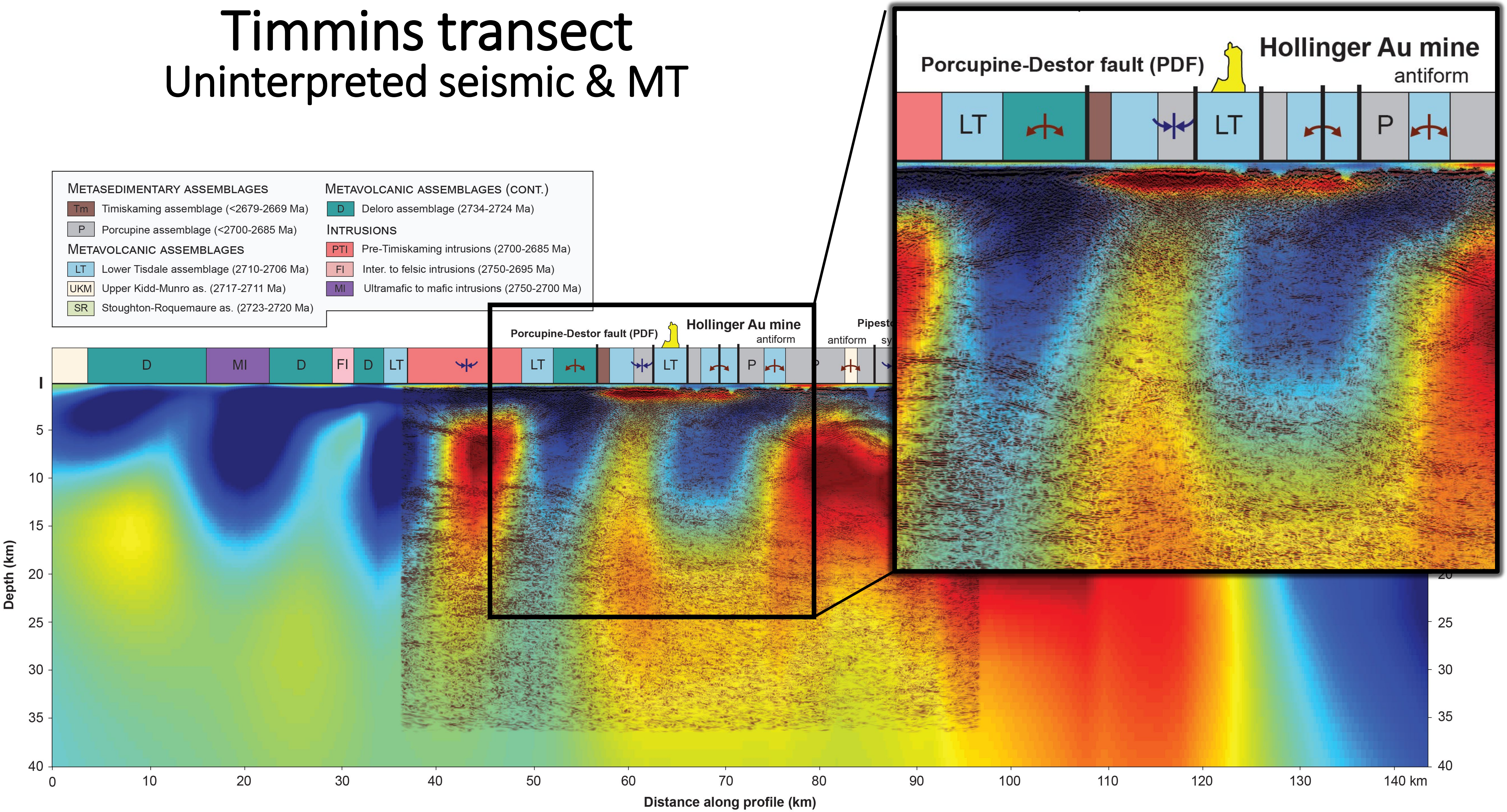
MT Horizontal Depth Slices (~12 to 30 km)



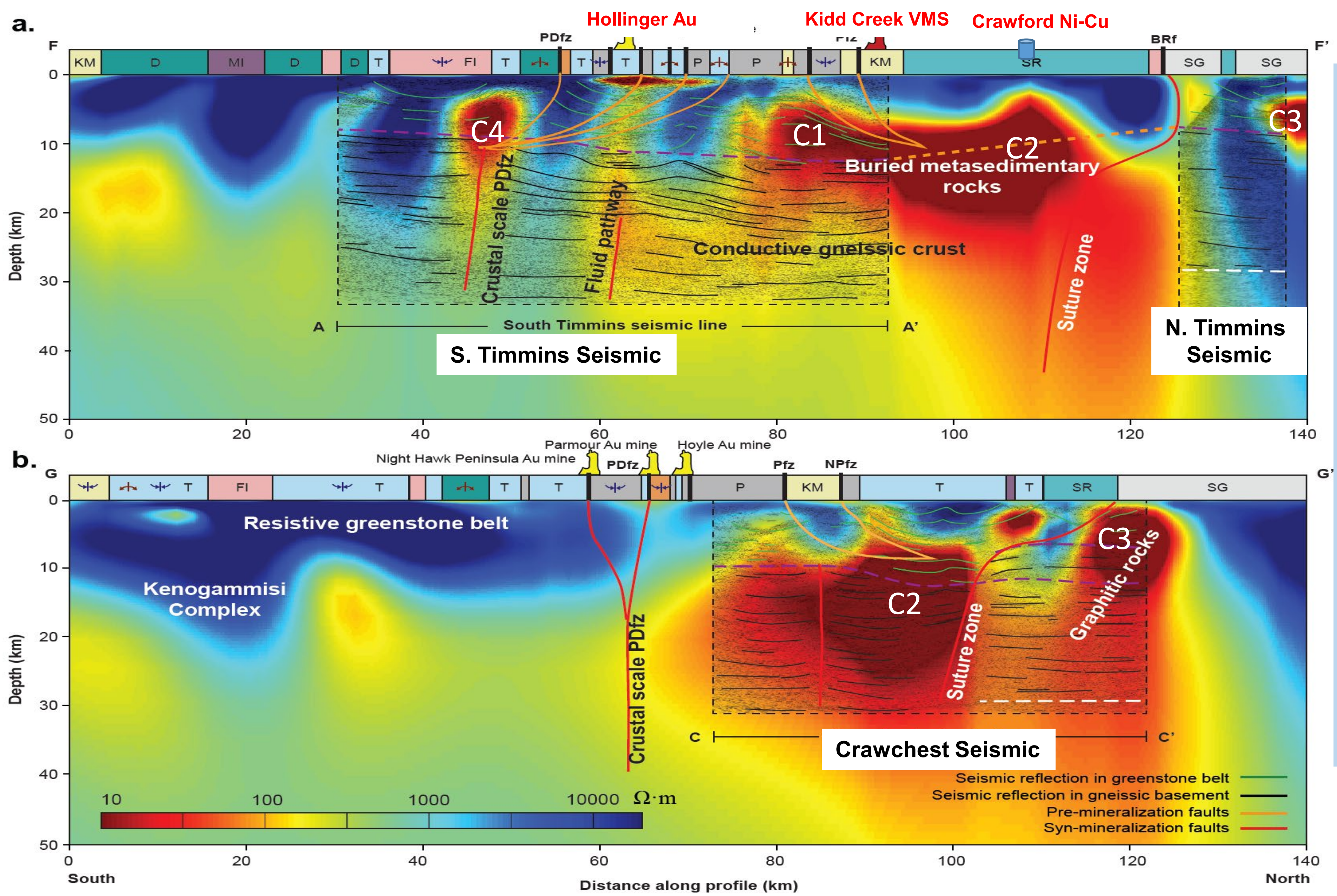
MT Model Vertical Slices



Timmins transect
Uninterpreted seismic & MT



Combined MT and Seismic for Timmins and Crawchest Sections



Greenstones - seismic reflectors folded (green) & faulted (orange)

MT conductive zones C1 & C2 (red) extend north beneath Porcupine. C3 beneath Scapa to north

PDF dips & connects to C4 conductor

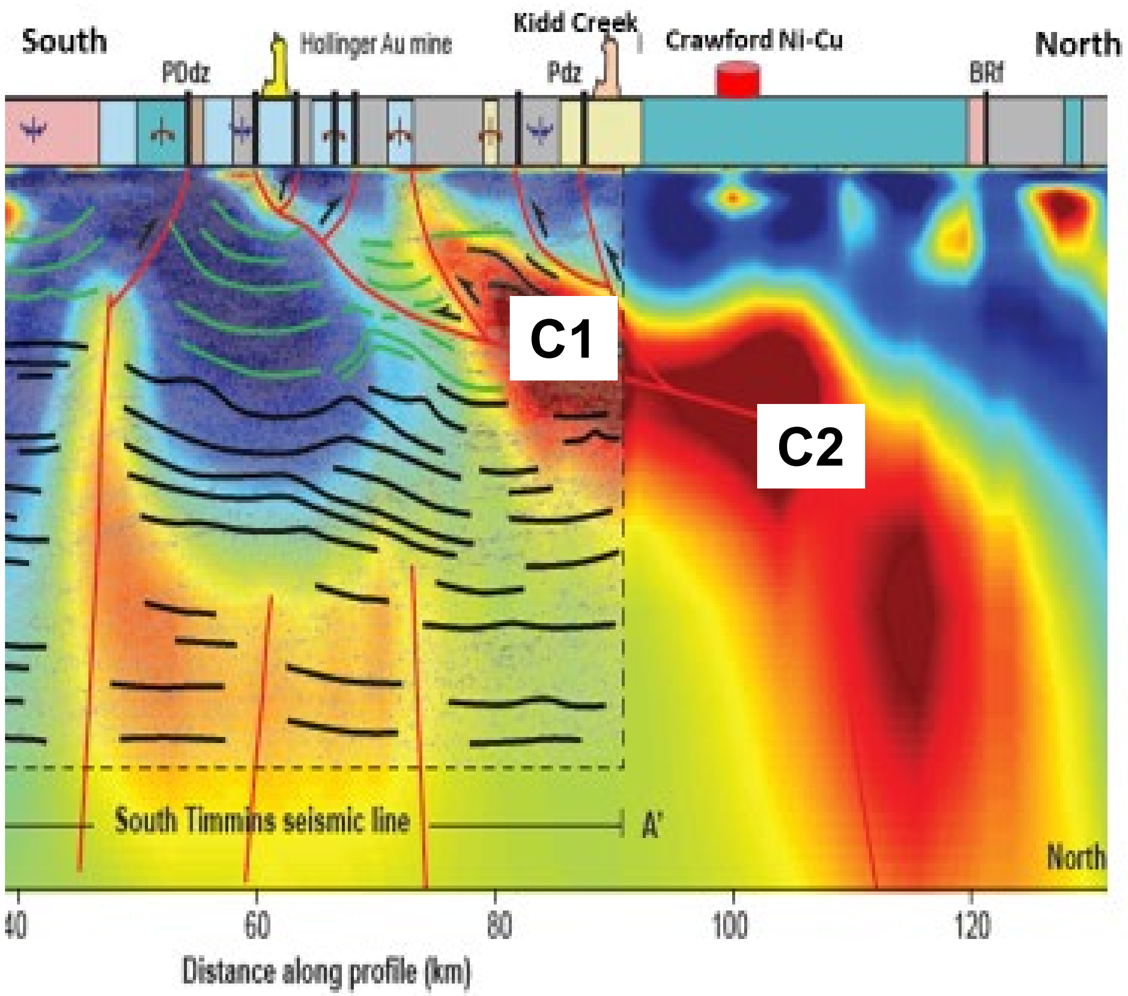
Mid-crust - shallow reflectors with vertical zones of seismic transparency & moderate conductivity indicating some faults (PDF) continue to depth

Adetunji et al., submitted 2024

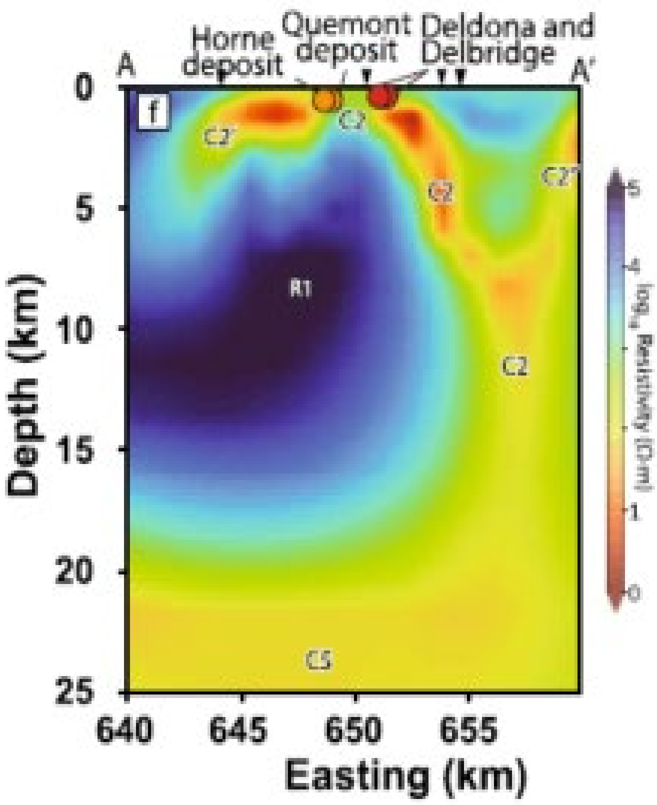
Conductors also possibly associated with base metals deposits?

- **C1-C2 conductors extend to the mid-crust similar to Noranda**
- **Also associated with Kidd Creek VMS (2016 Ma) & Crawford Ni-Cu (2005 Ma).**
- **C1 upper crustal position modified by post-2690 Ma folds & thrusts?**

Kidd Creek N-S Section ~60km



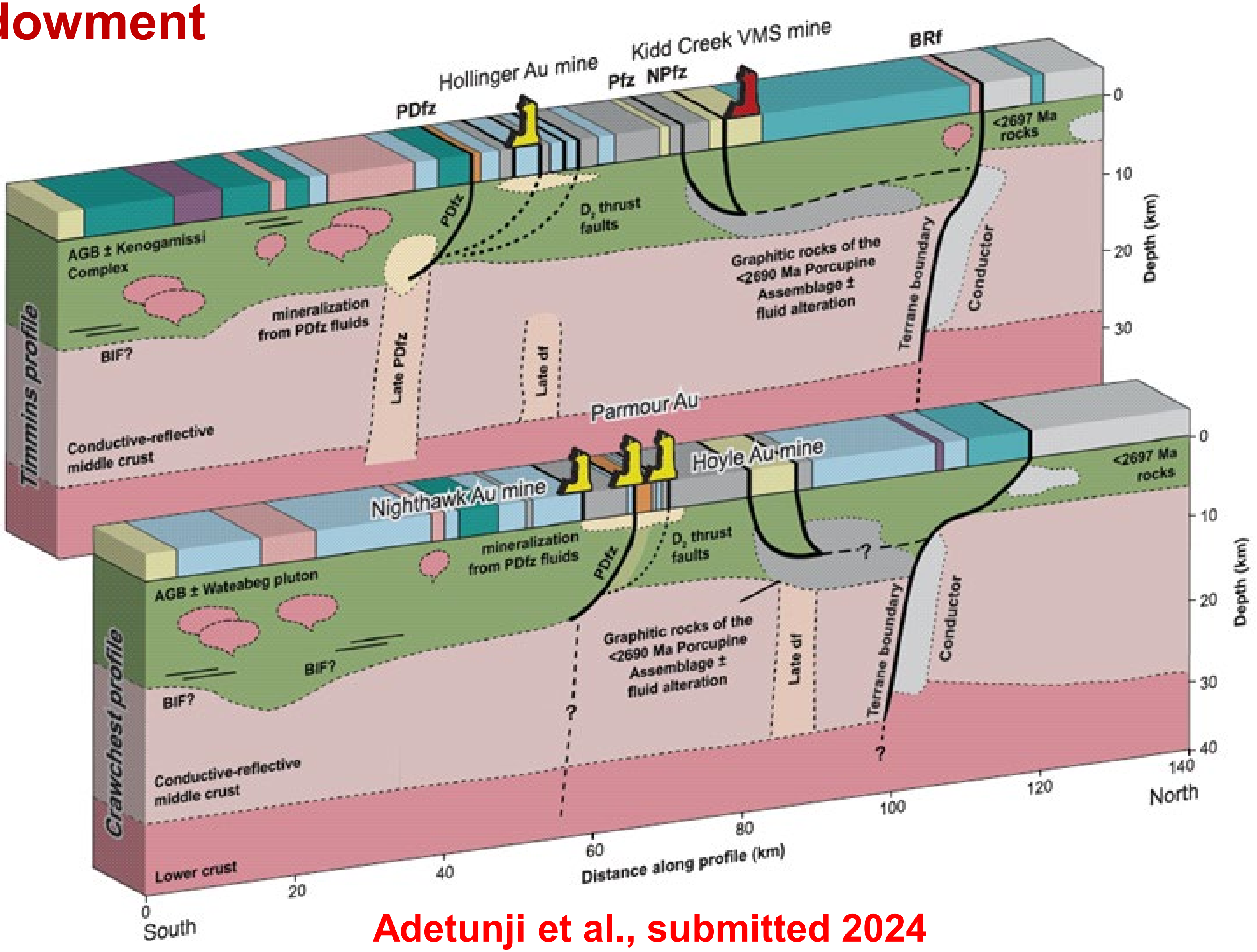
Noranda NE-SW Section ~20km



Jørgensen et al., 2022

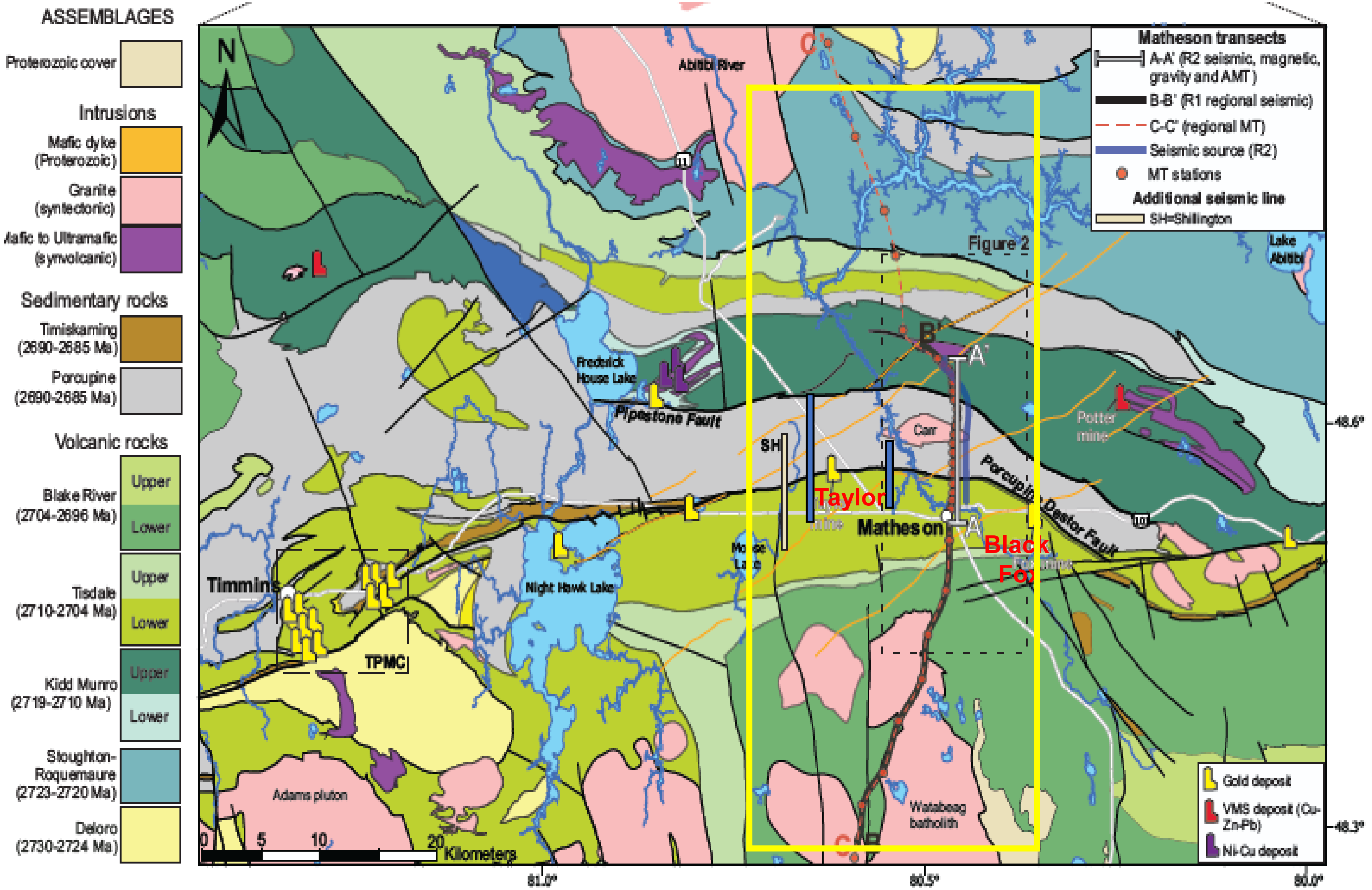
Timmins region 3D Interpretation of Tectonic and Endowment

1. Strongest conductor in Superior Craton associated with largest Au & VMS deposits
2. PDF marks upper crustal resistivity contrast & matches the distribution of sedimentary rocks, subsidiary faults, and Au mineralization
3. Conductors & seismic support early south-dipping PDF with later superimposed faulting
4. Truncations of seismic reflectors and conductors at all crustal levels suggests a terrane boundary north of Timmins



Adetunji et al., submitted 2024

III - Matheson Architure & Endowment (Haugaard et al., 2021, Econ. Geol.)

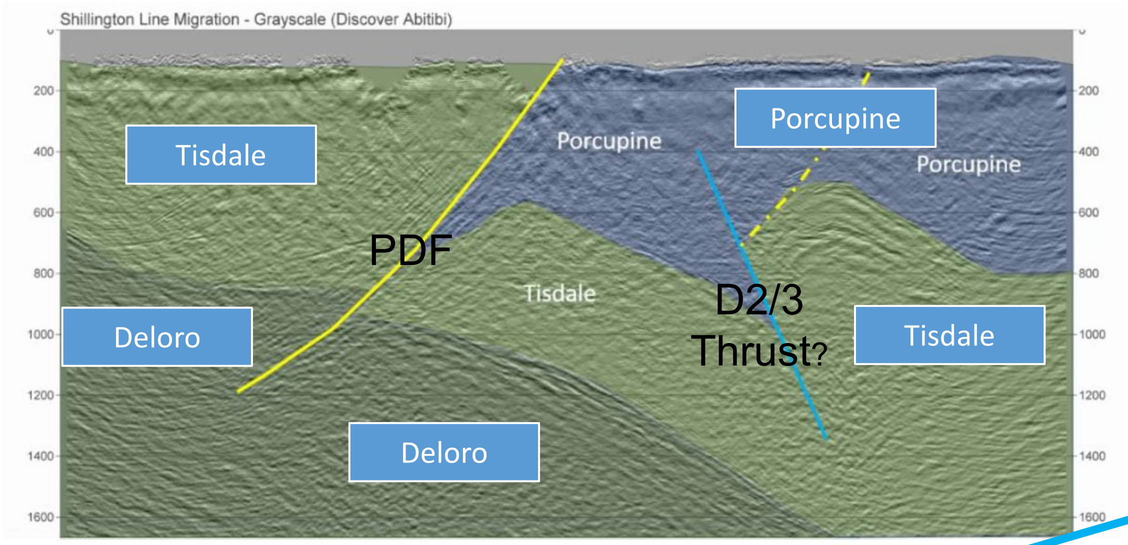


Crustal scale geology – Modelling key greenstone belt assemblages and fault geometry by integrating surface geology, gravity, MT & seismic (regional & high resolution)

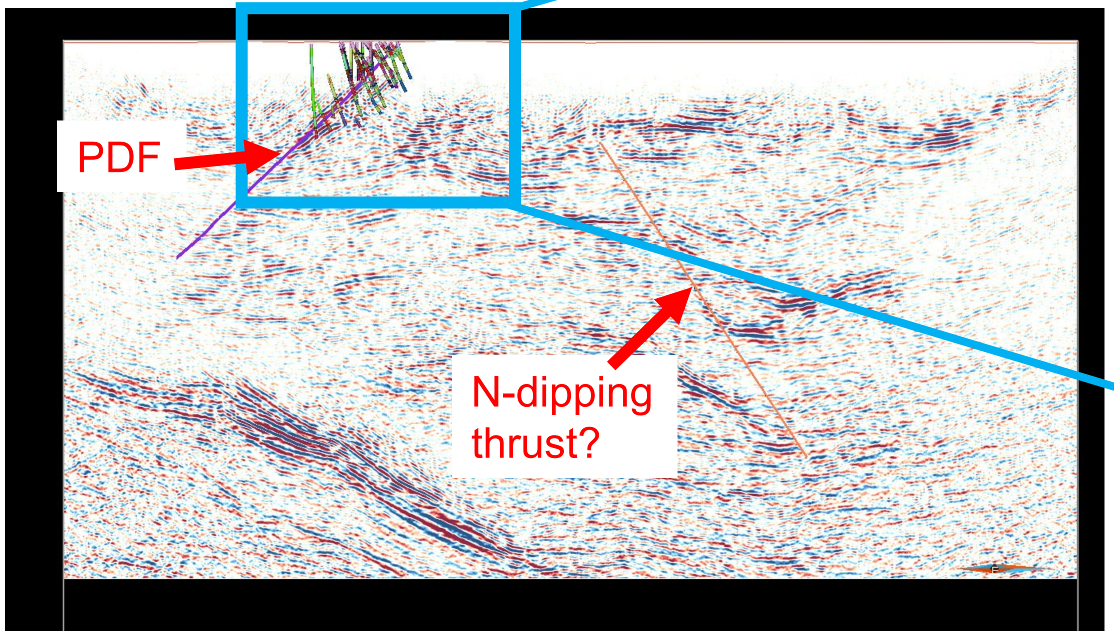
Determine metallogenic fingerprints of the transect including characterizing potential deep-seated mineralizing fault systems

Matheson Area High Resolution Reflection Seismic Lines

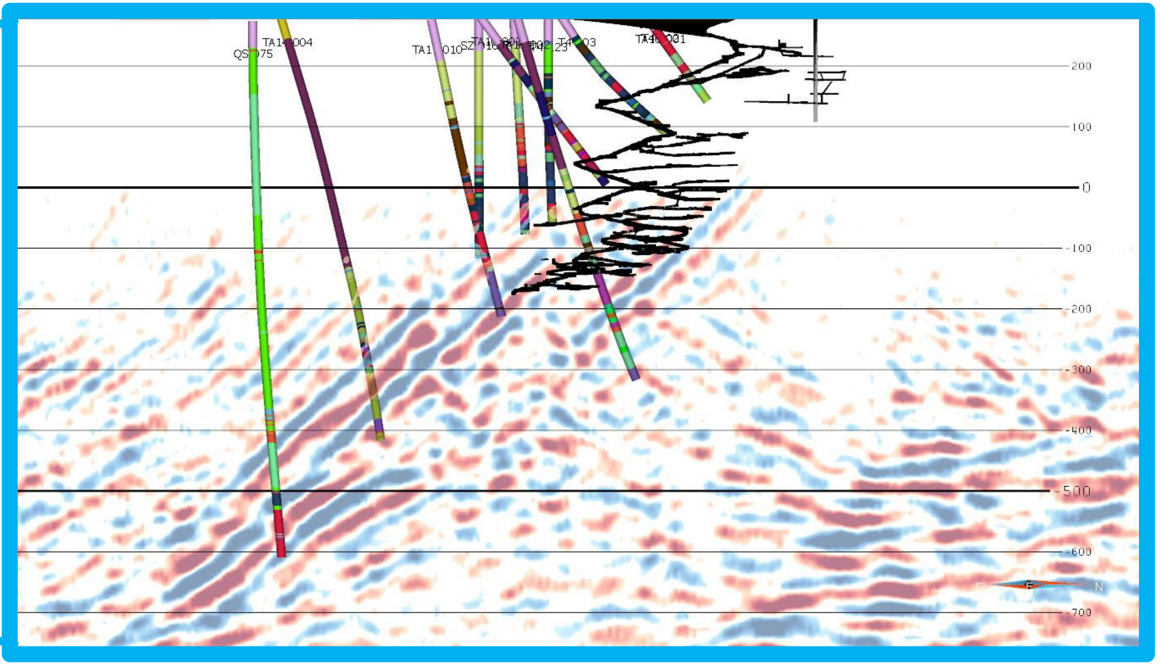
D.A. Shillington R2 Line (after Snyder 2008)



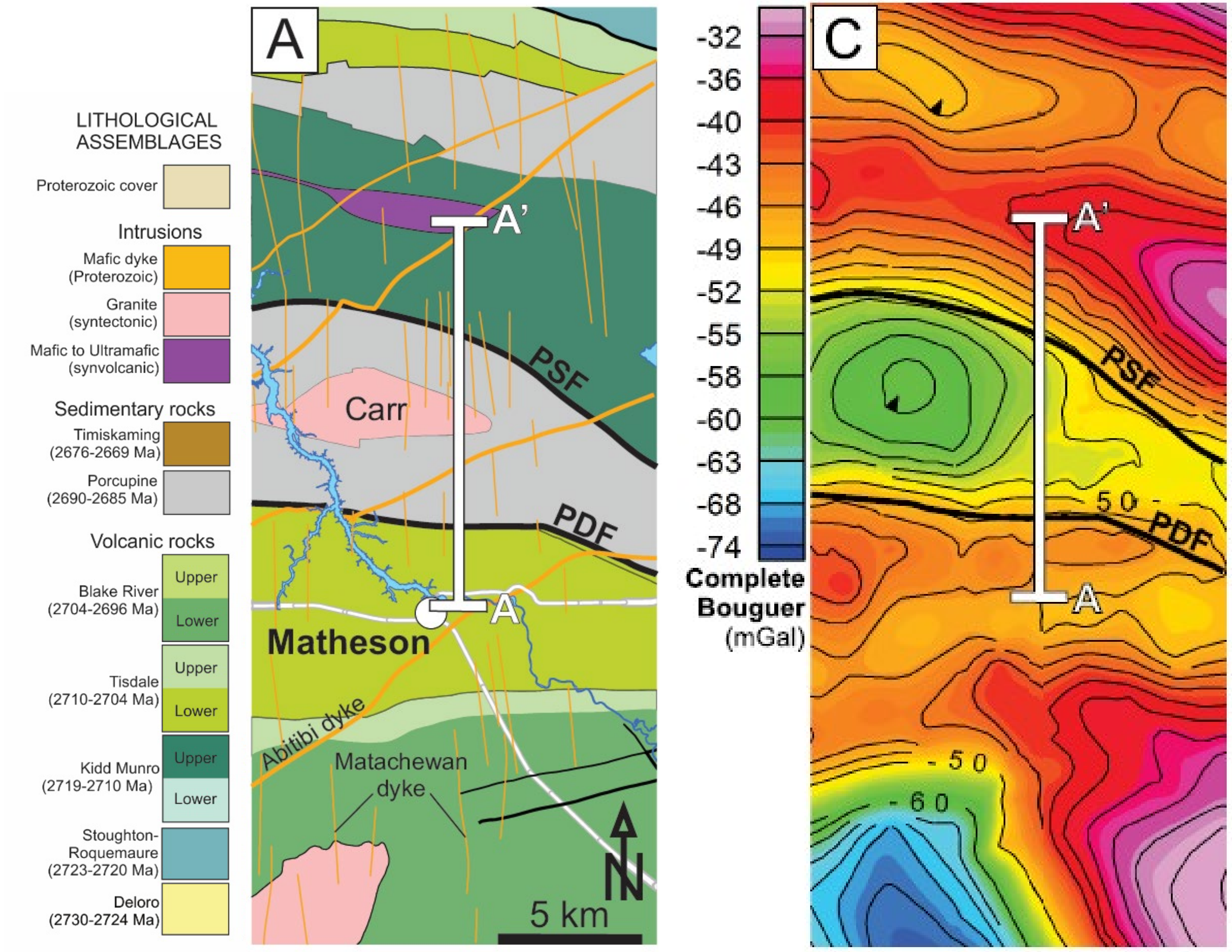
M.E. Val Gagne R2 Line (2017)

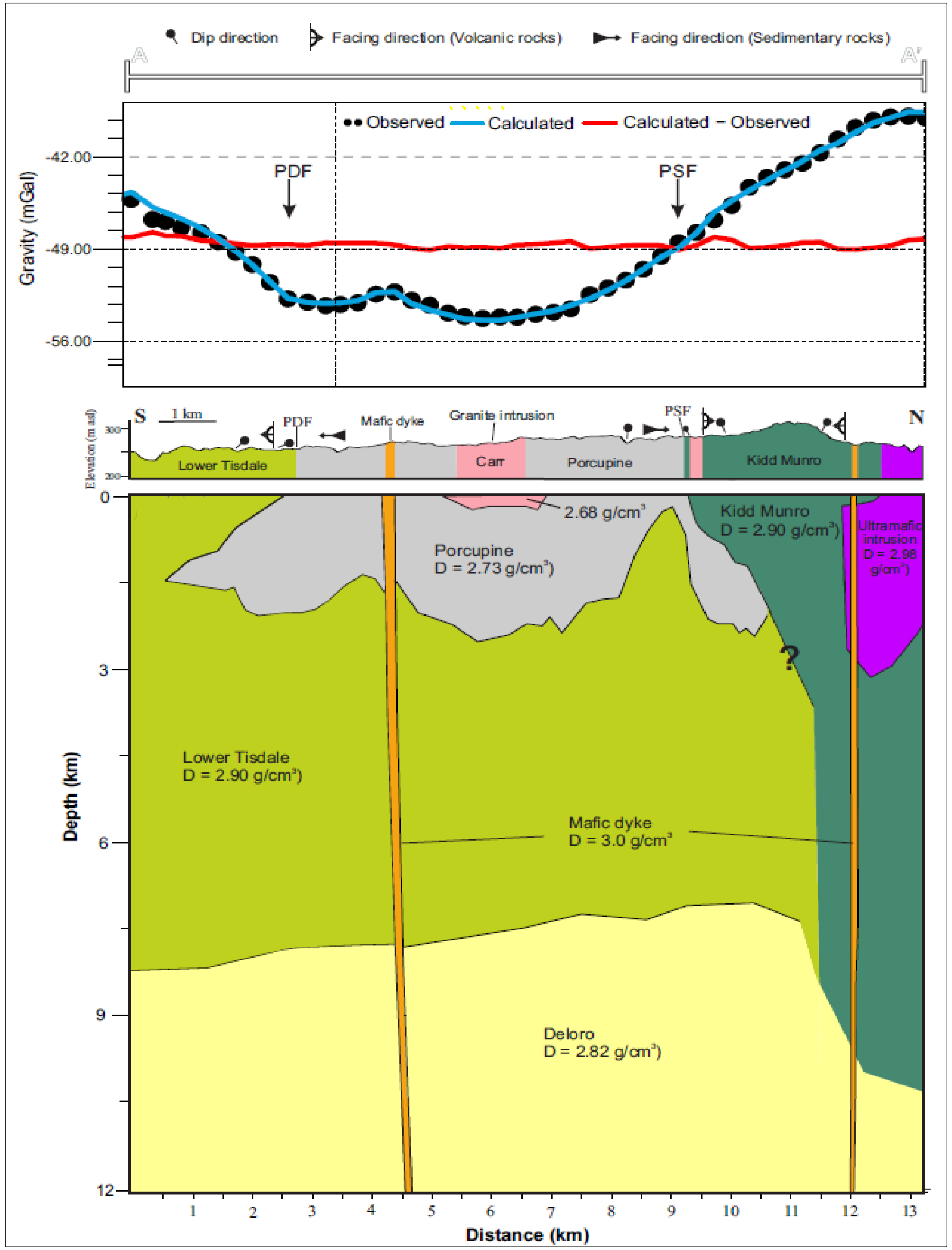


Val Gagne R2 Line detail with DDHs & Taylor Mine workings



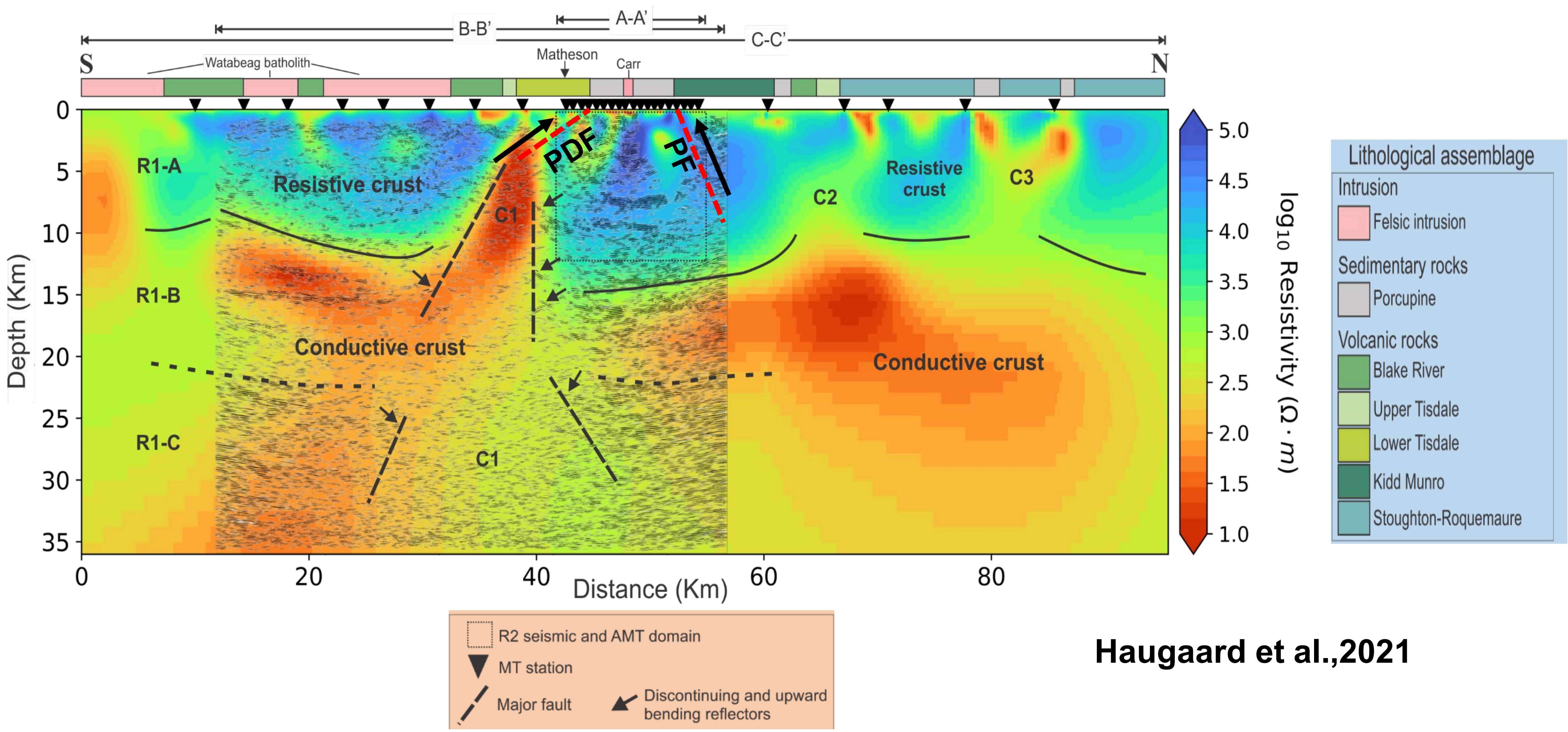
Matheson – 2.5D forward gravity modelling (Della Justina et al., 2024)





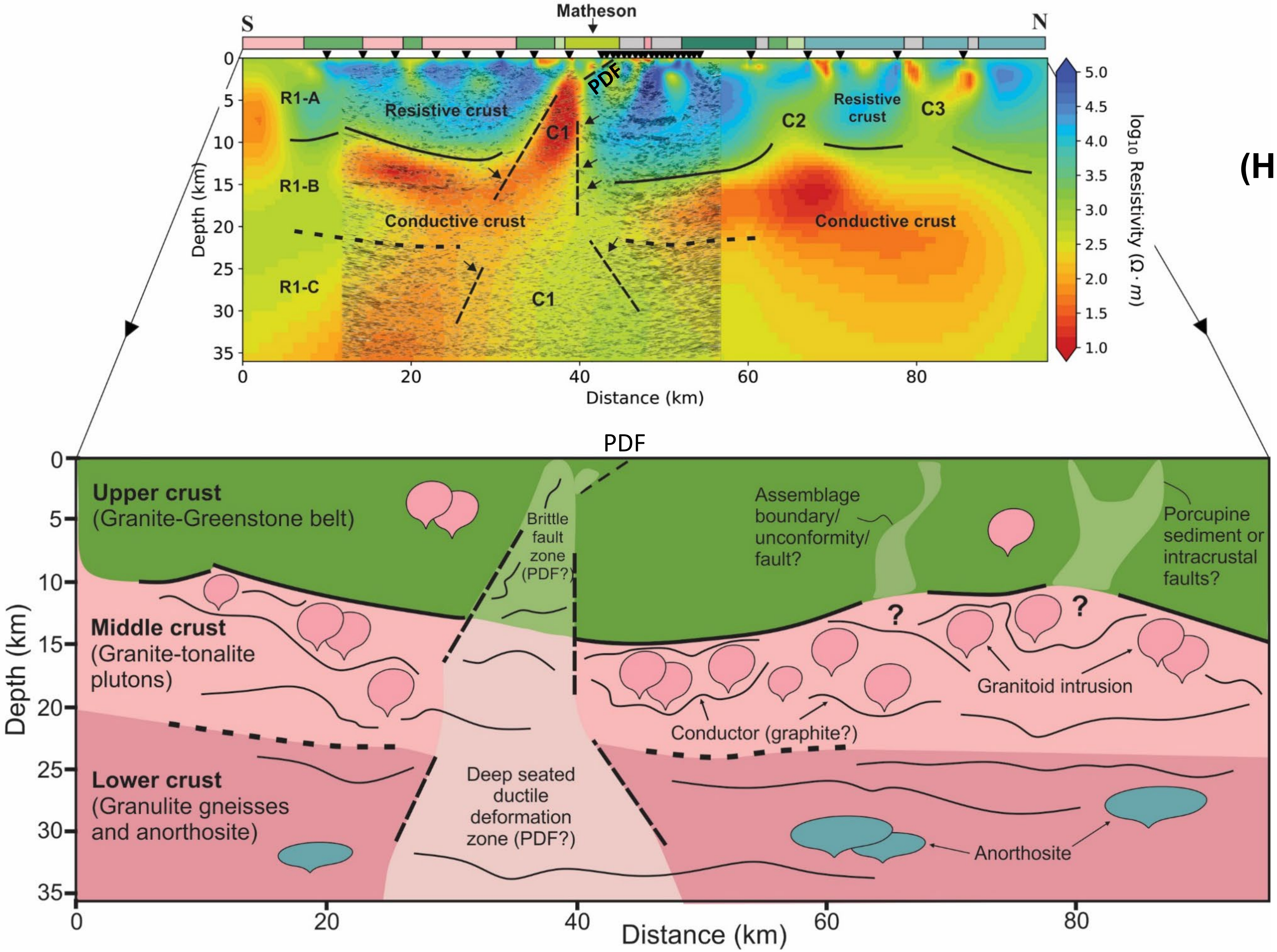
Della Justina et al., 2024, GEOPHYSICS

Matheson Seismic and MT Section - Moderately Au Endowed



Haugaard et al.,2021

Matheson Seismic and MT Section - Moderately Au Endowed



(Haugaard et al., 2021, Econ. Geol.)

- C1 feature may represent a regional crustal-scale fault
- The shallow dipping PDFthrust fault at Matheson is a second order structure possibly linked to the C1 feature at depth?
- Did the deep-rooted C1 feature focus and transport hydrothermal fluids into the PDF in Matheson?
- Graphitization is a by-product of late-stage thermal events following craton stabilization

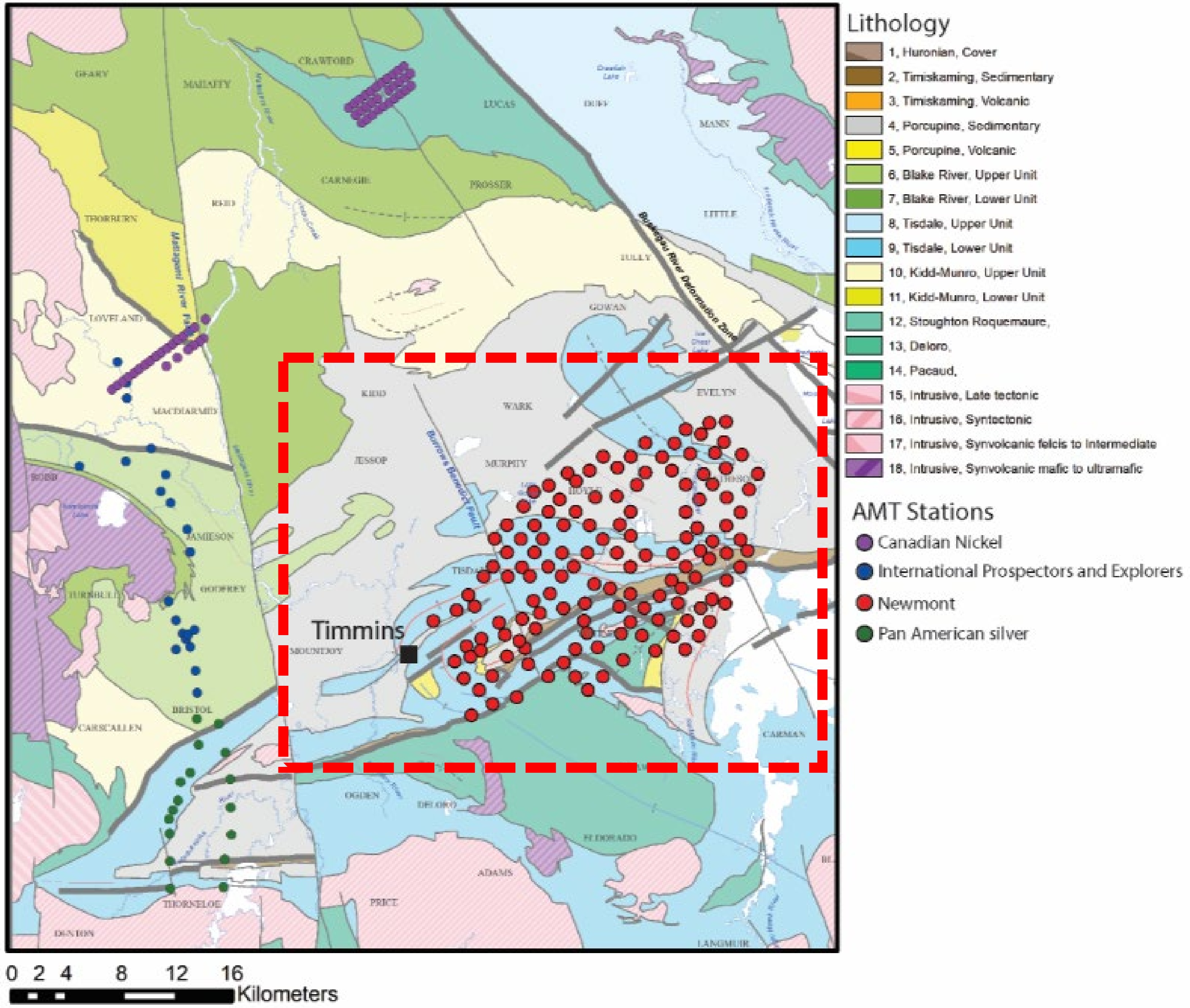
III - Interpretation of Timmins Camp AMT results

Ademola Adetunji & Gaetan Launay

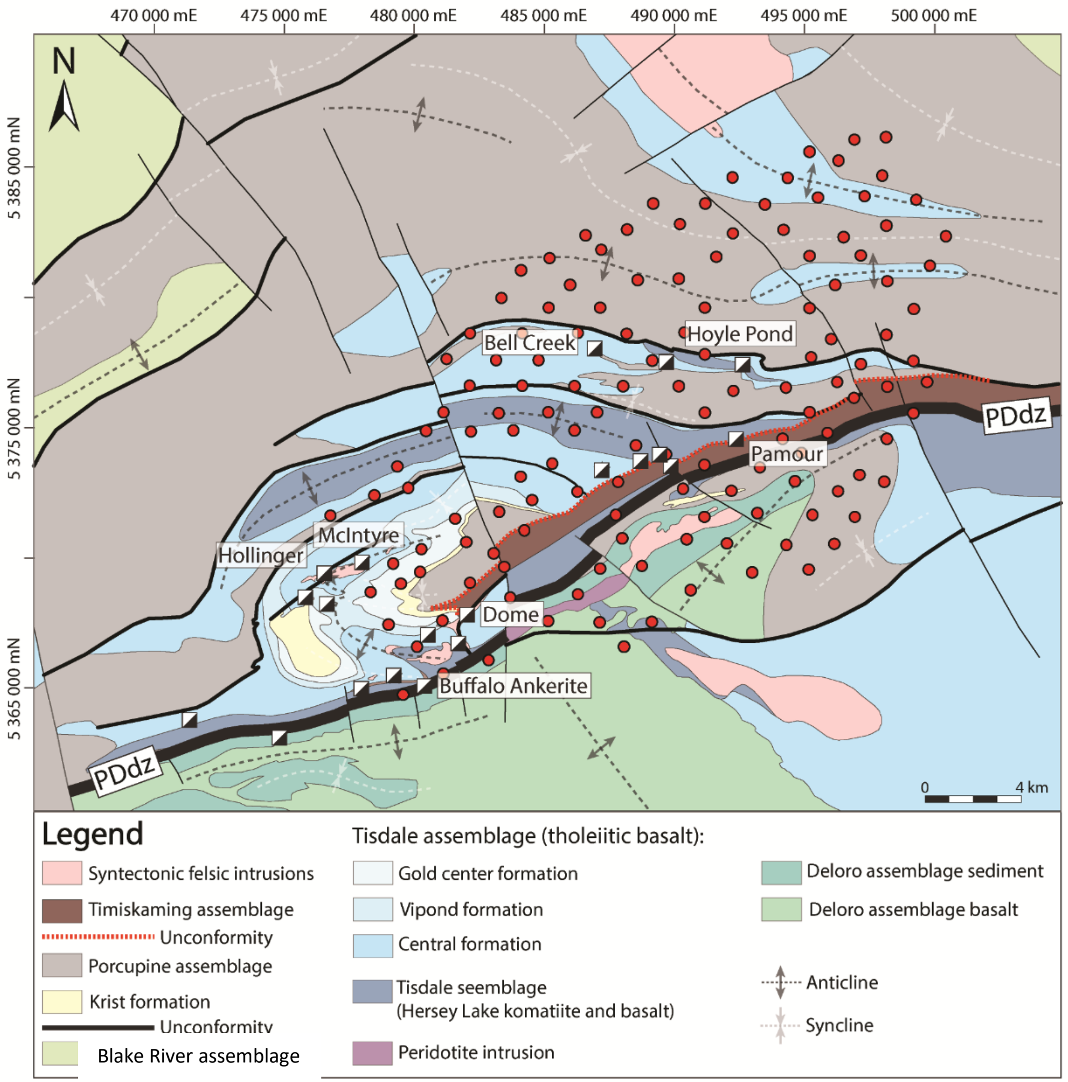
Timmins - AMT Data

- 250 AMT stations
  - Newmont – 150
  - Canada Nickel – 59
  - Inter. Expl. & Prospectors – 24
  - Pan American Silver – 18

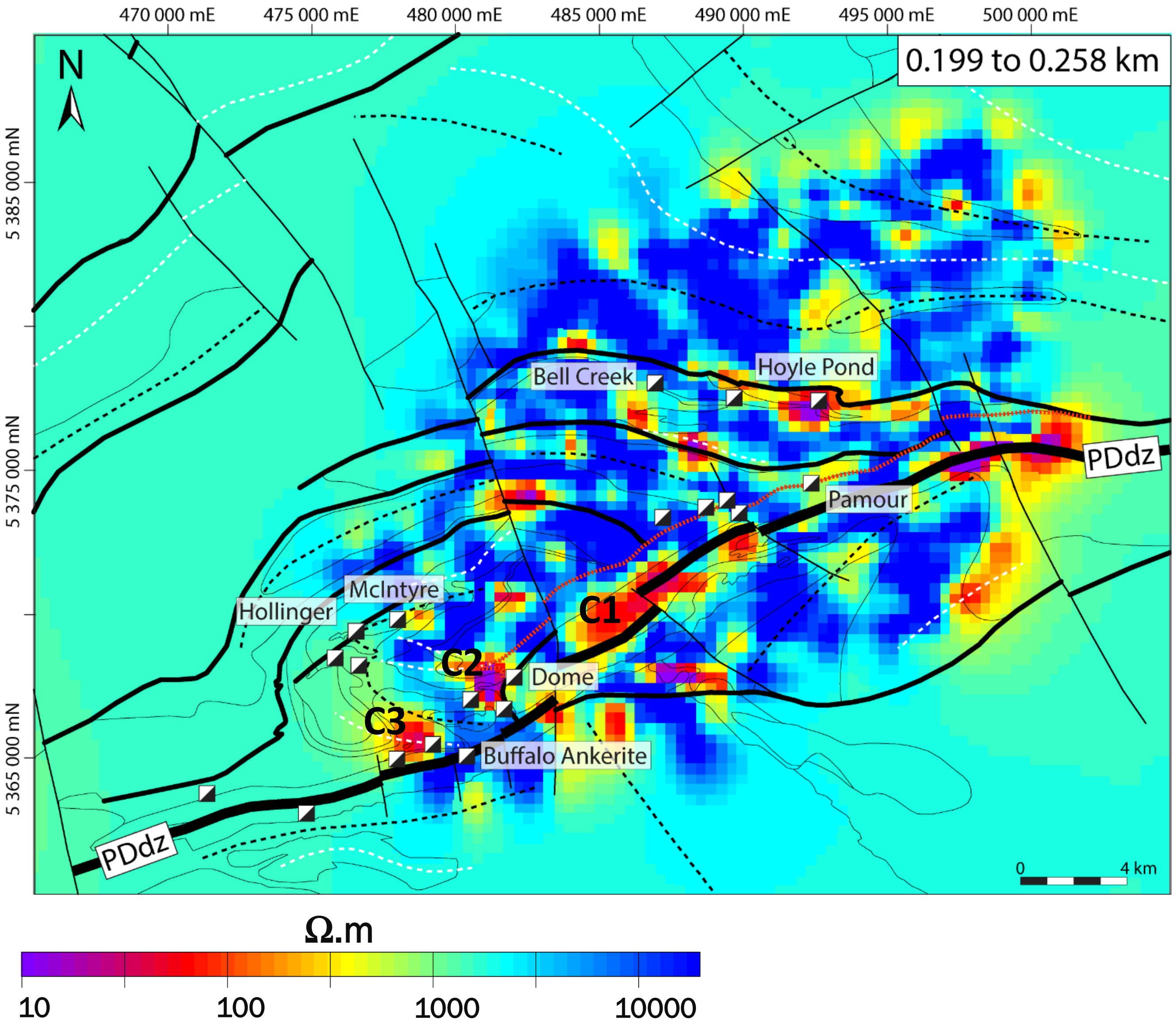
- **Investigate the upper crustal to ~4 km depth**



AMT - Depth slices

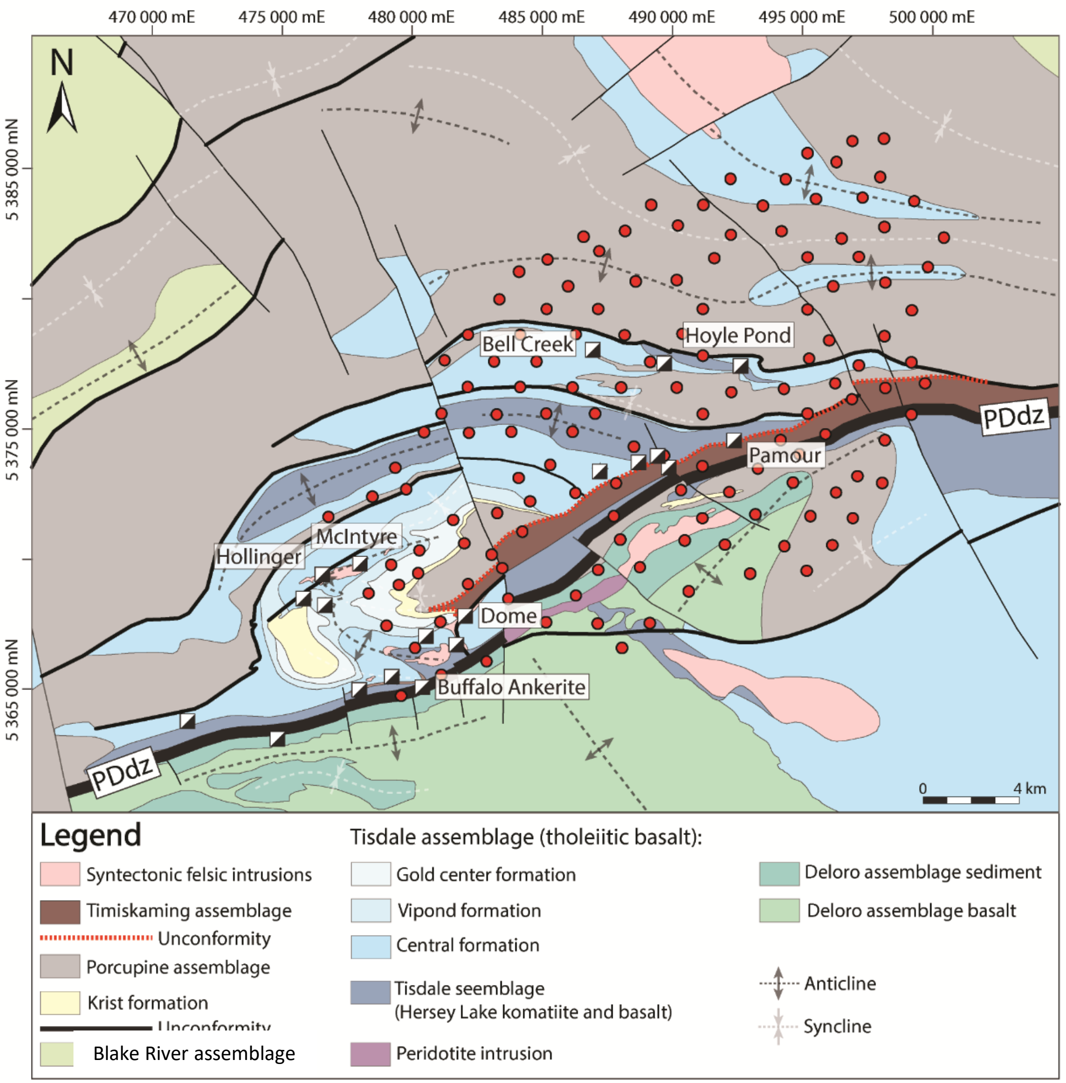


Geological map showing AMT data locations and deposits



Depth slices from the final 3-D model showing conductivity structures as they relate to mineral deposits and large scale geological structures

AMT - Depth slices



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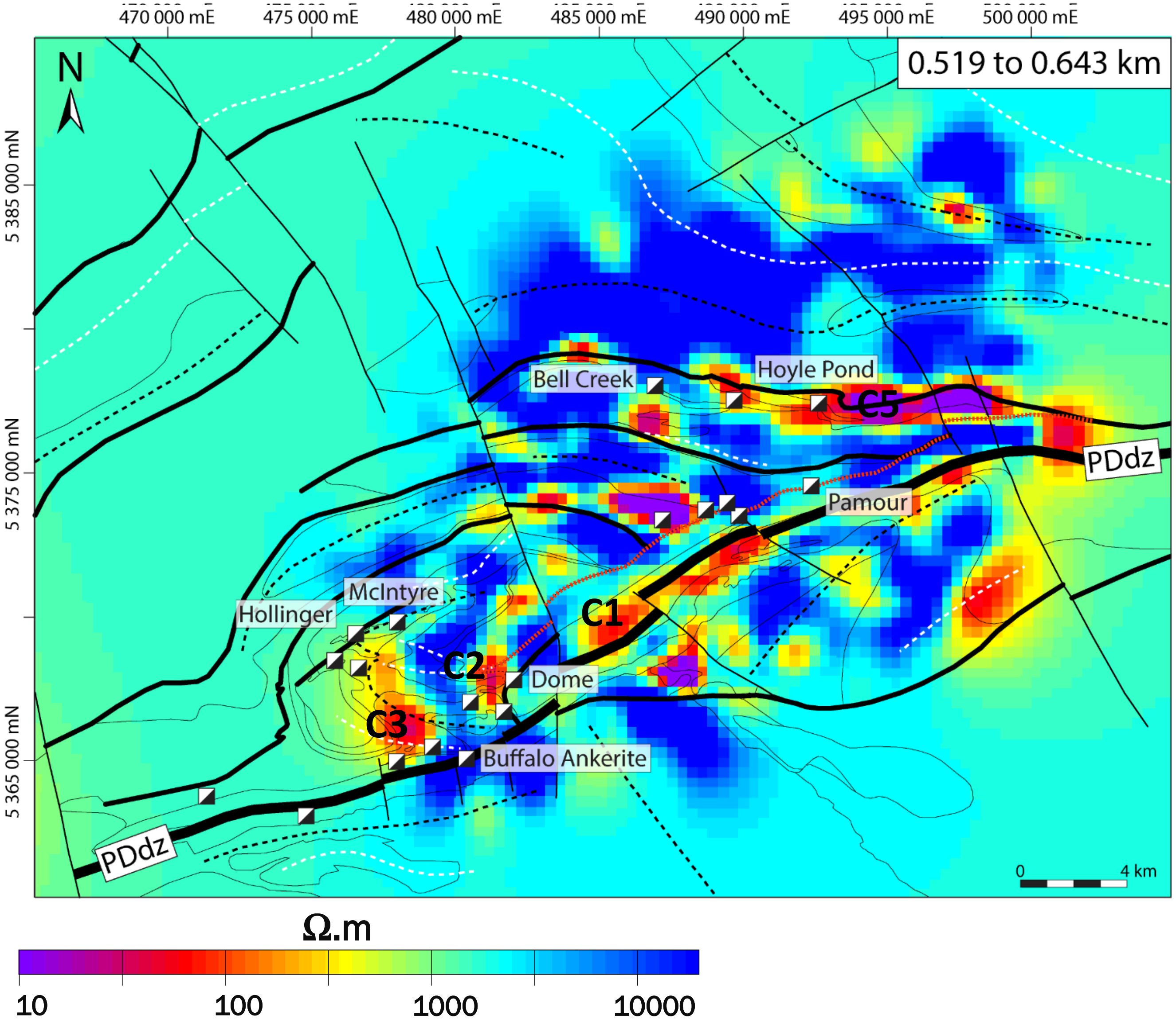

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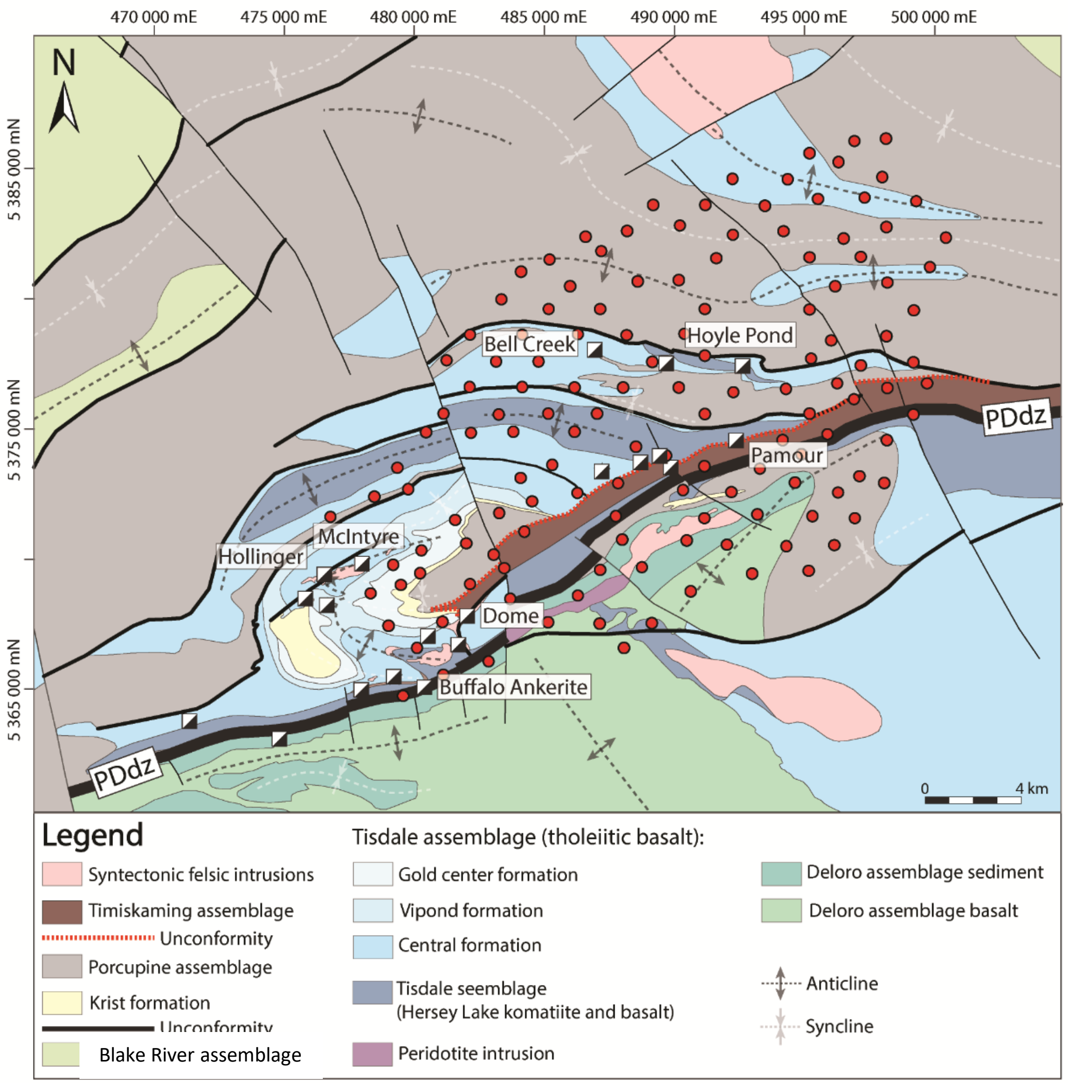

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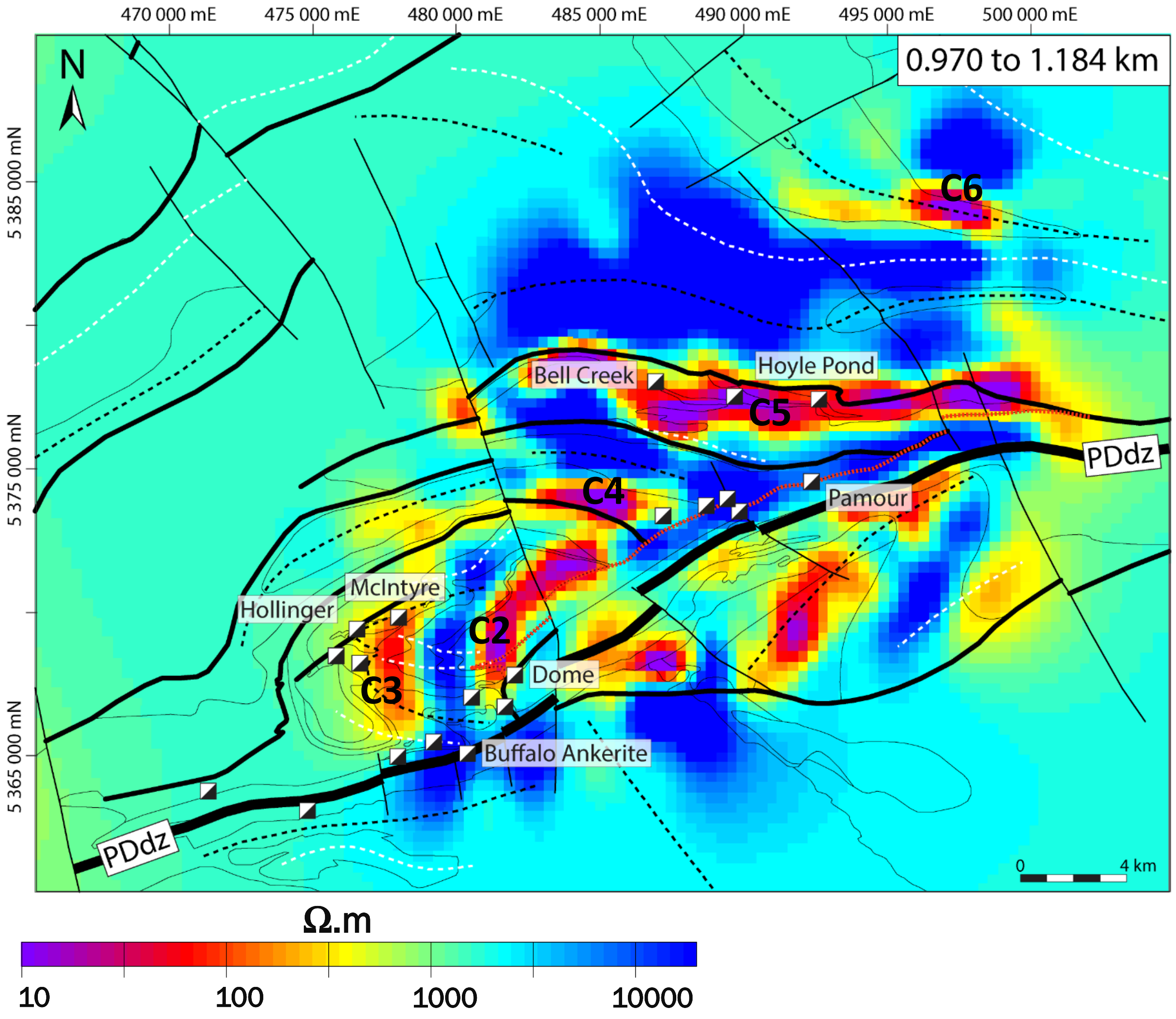

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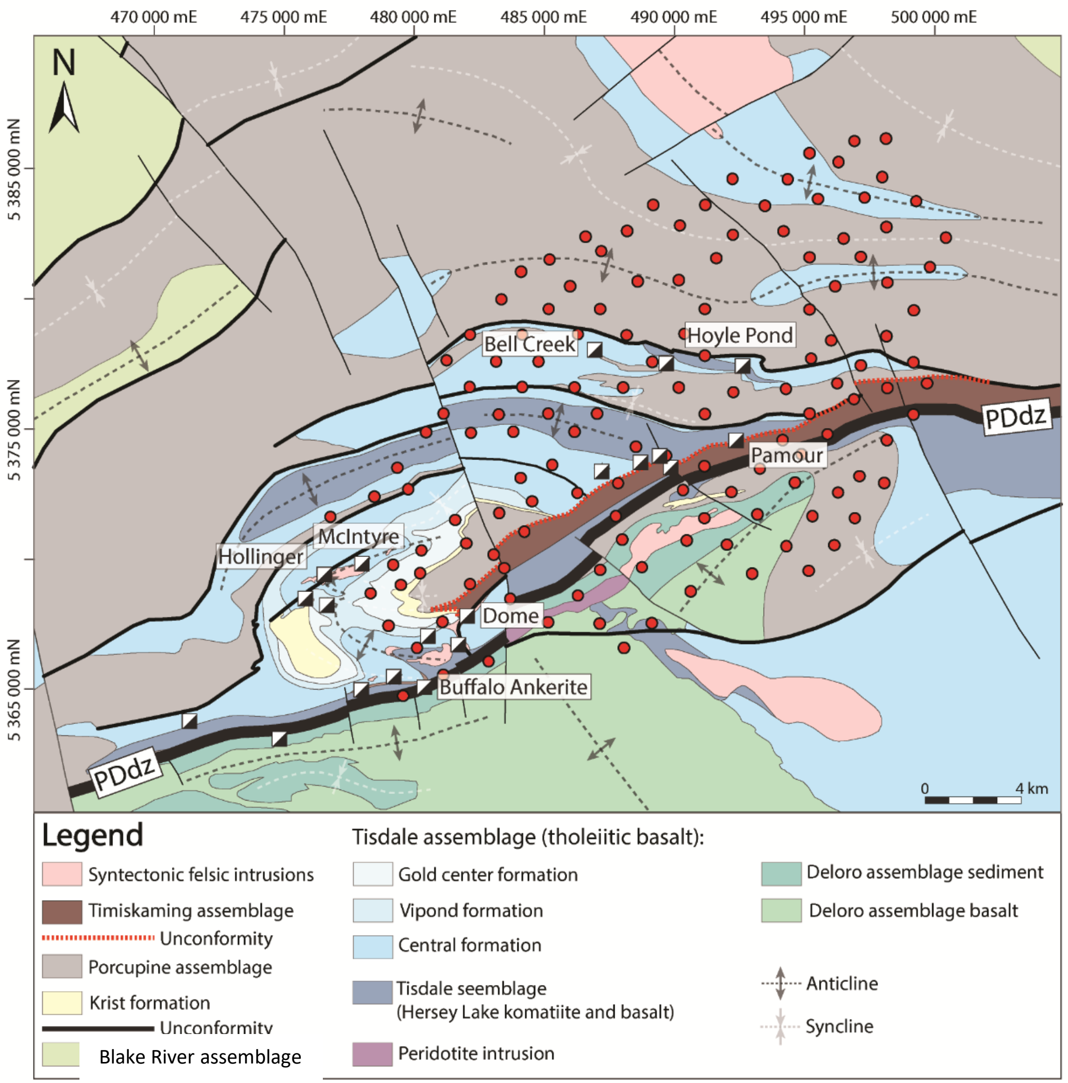
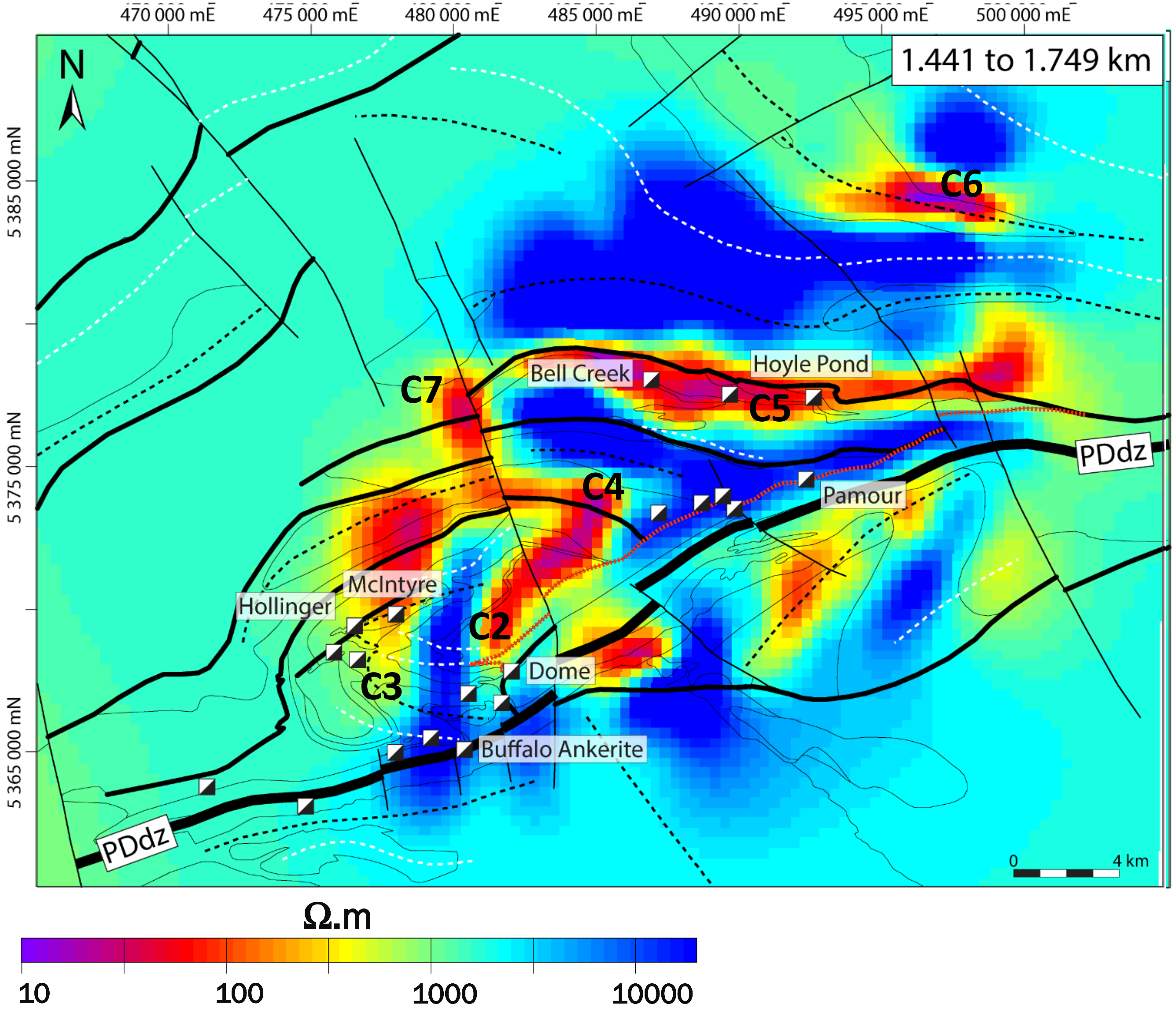
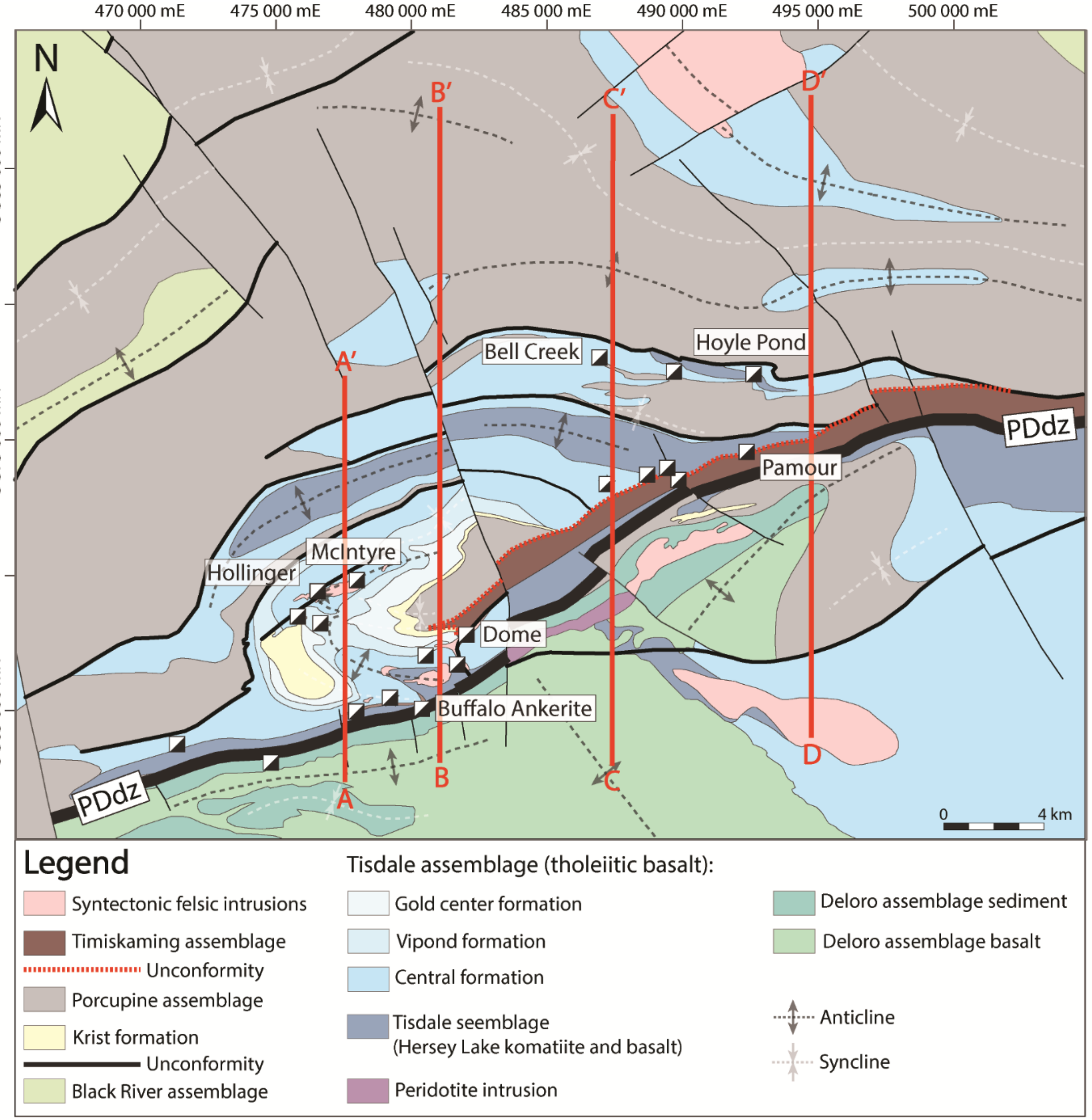


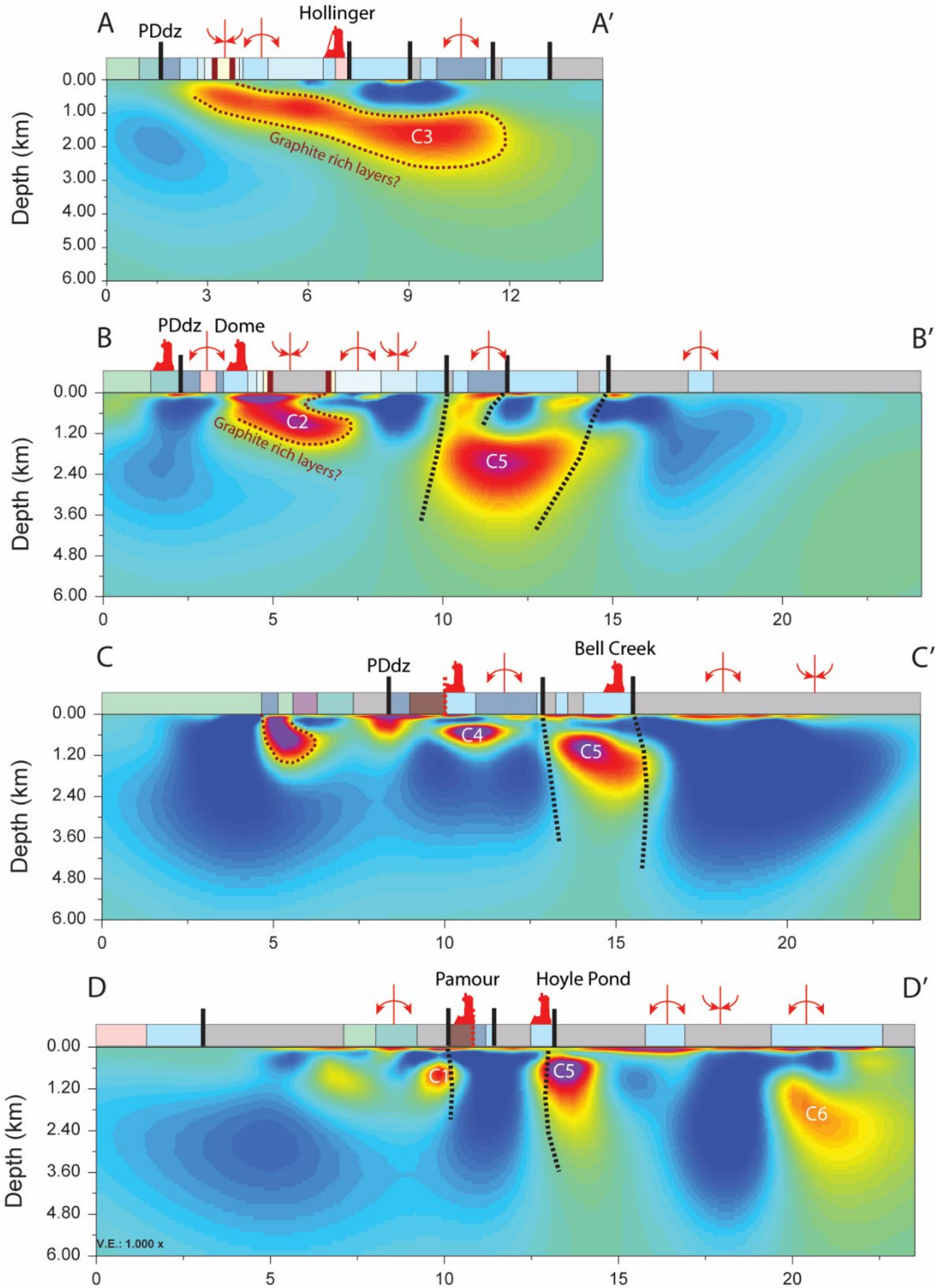
Geological map showing AMT data locations and deposits



Depth slices from the final 3-D model showing conductivity structures as they relate to mineral deposits and large scale geological structures

AMT - Vertical slices



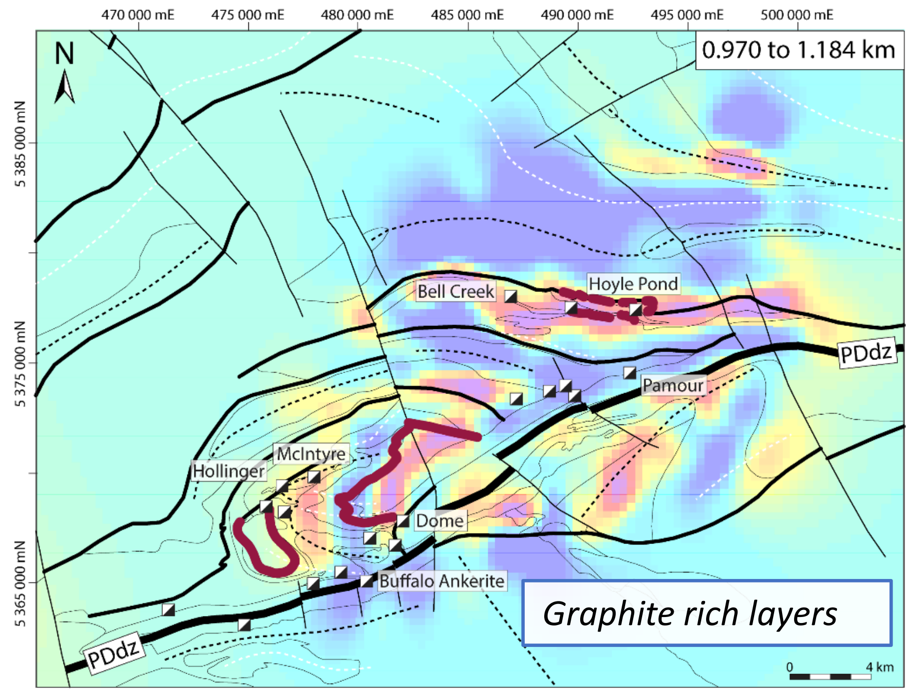


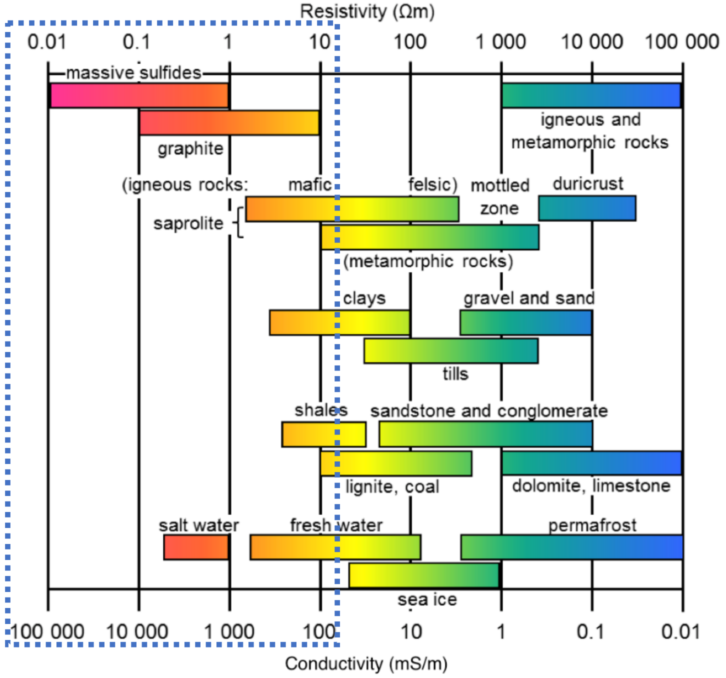
East – West trending conductivity anomaly

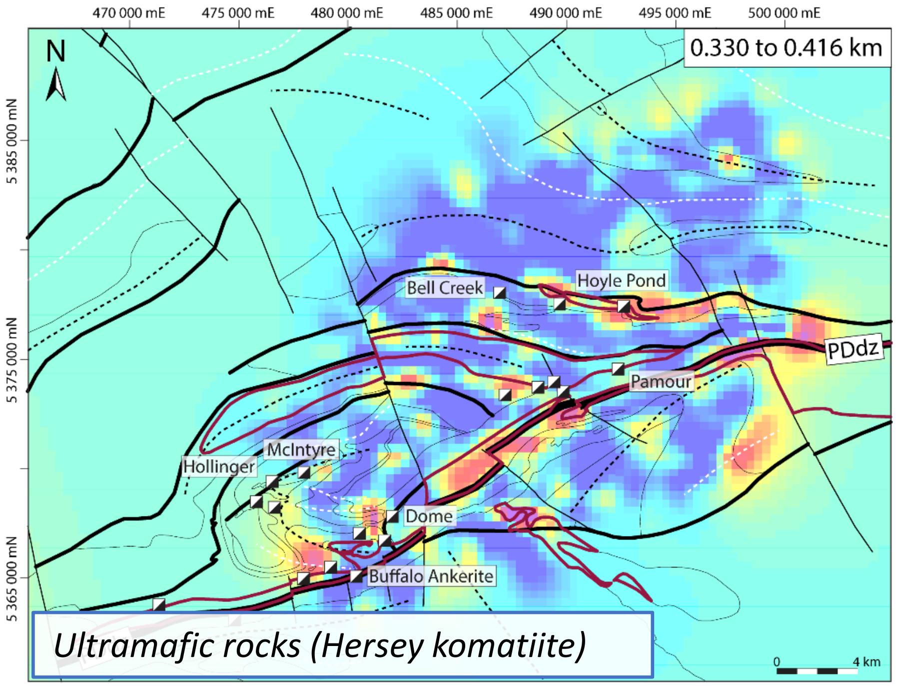
Potential causes of the conductive anomalies

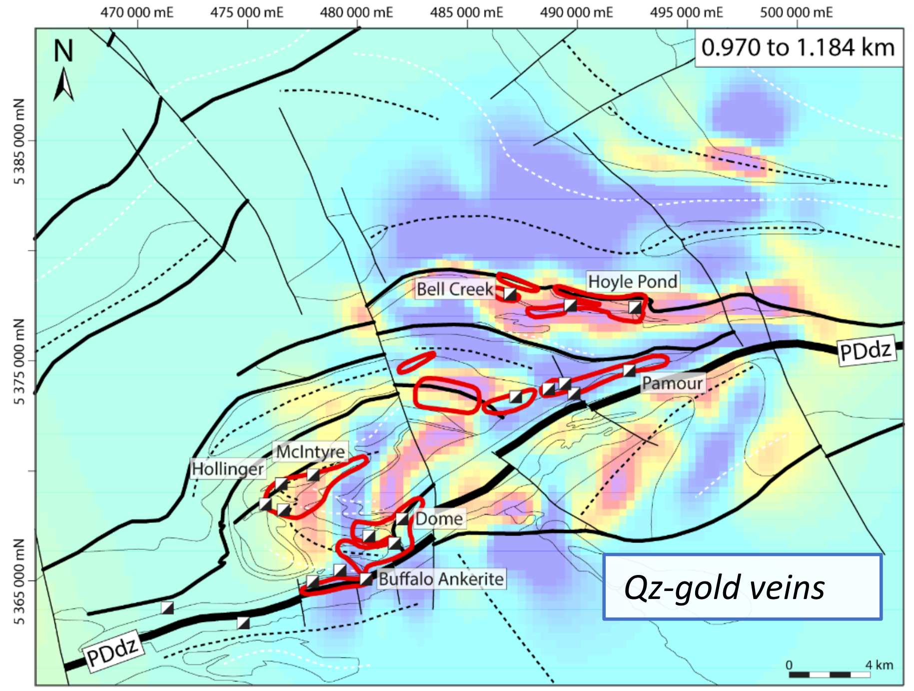
Large scale electrical conductors spatially related to main gold deposits:

- **Graphitic rich layers in argillites and carbonaceous interflow sediments that may have had important controls on the position and orientation of mineralized shear zones which locally exploit them (Rhys 2012)**
- **Graphitic-pyrite alteration zones associated with Qz-gold bearing veins ("grey zones" in Hoyle Township)**
- **Altered ultramafic intrusions (Hersey Komatiite), serpentinization with formation of magnetite**









250 Petrophysical Property Samples were collected from drill core in AMT surveys areas

All samples were analysed at the Geological Survey of Canada Petrophysics Laboratory for:

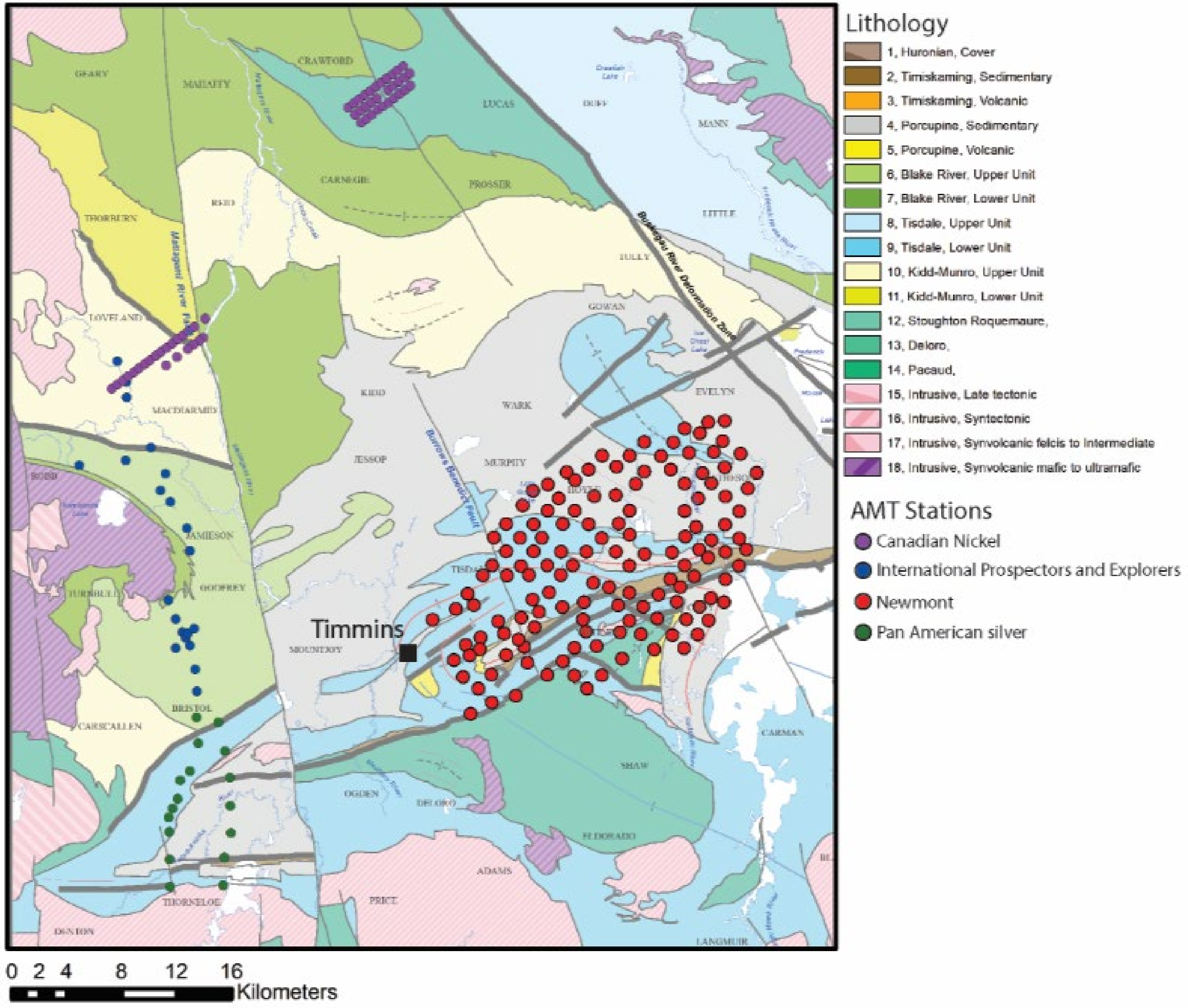
Resistivity

Chargeability

Porosity

Magnetic Susceptibility

Density

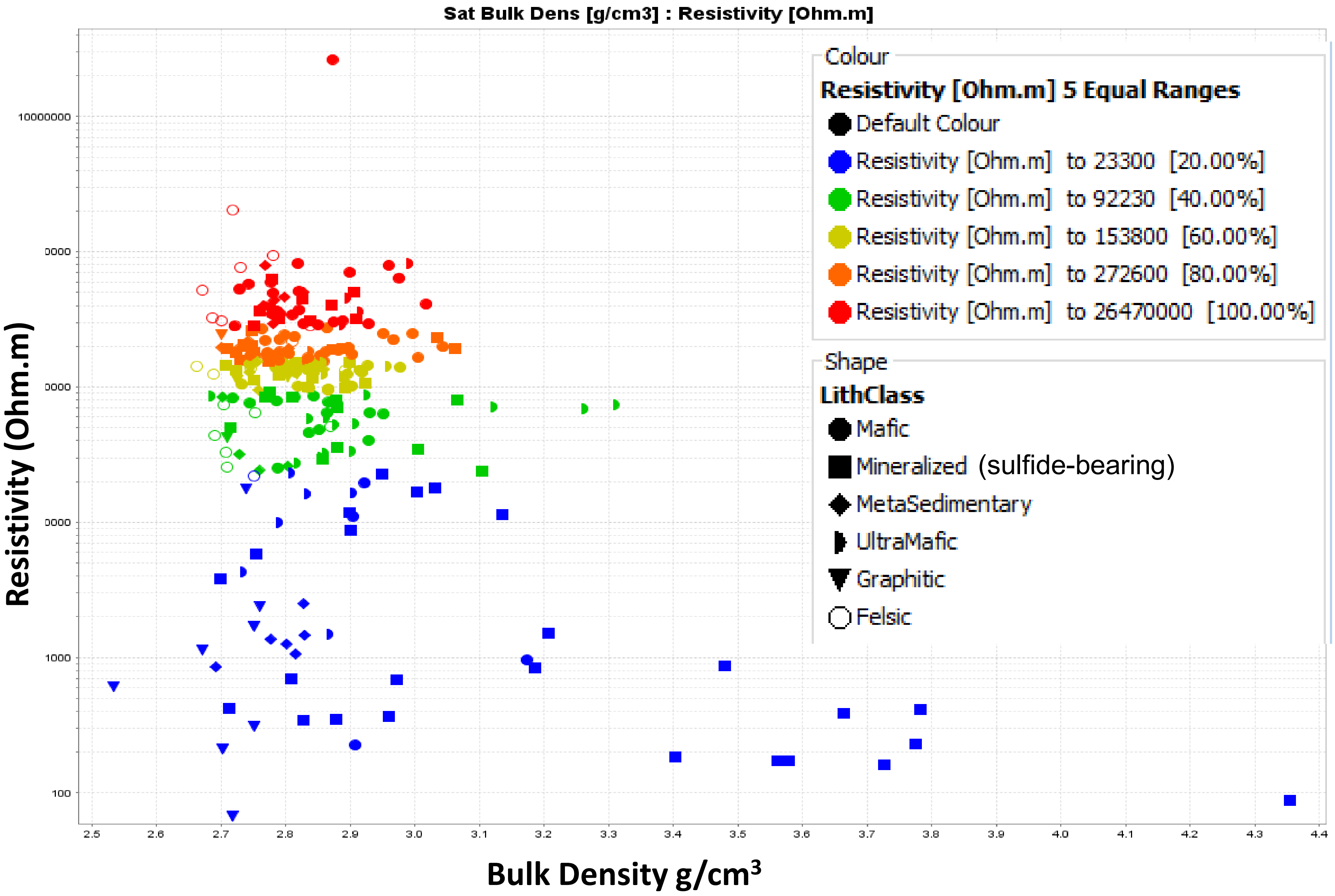


Variation of Resistivity Vs. Density

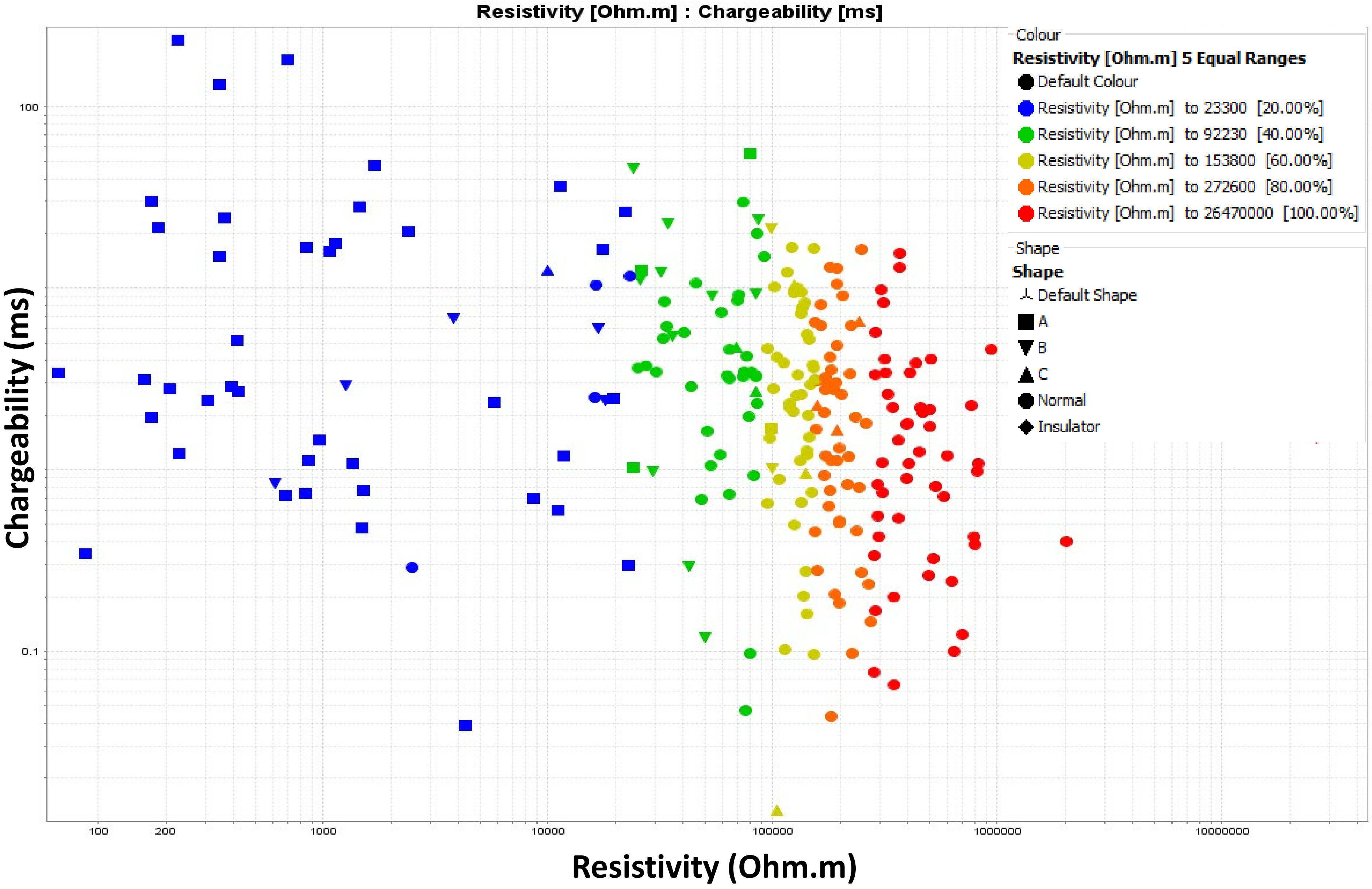
Lab resistivities are typically 1 to 2 orders of magnitude higher than measured by MT due to fractures & large-scale connectivity.
Resistivity <1000 Ohm.m is considered conductive.

Most conductors are mineralized or graphitic. Often metasedimentary rocks are relatively conductive.

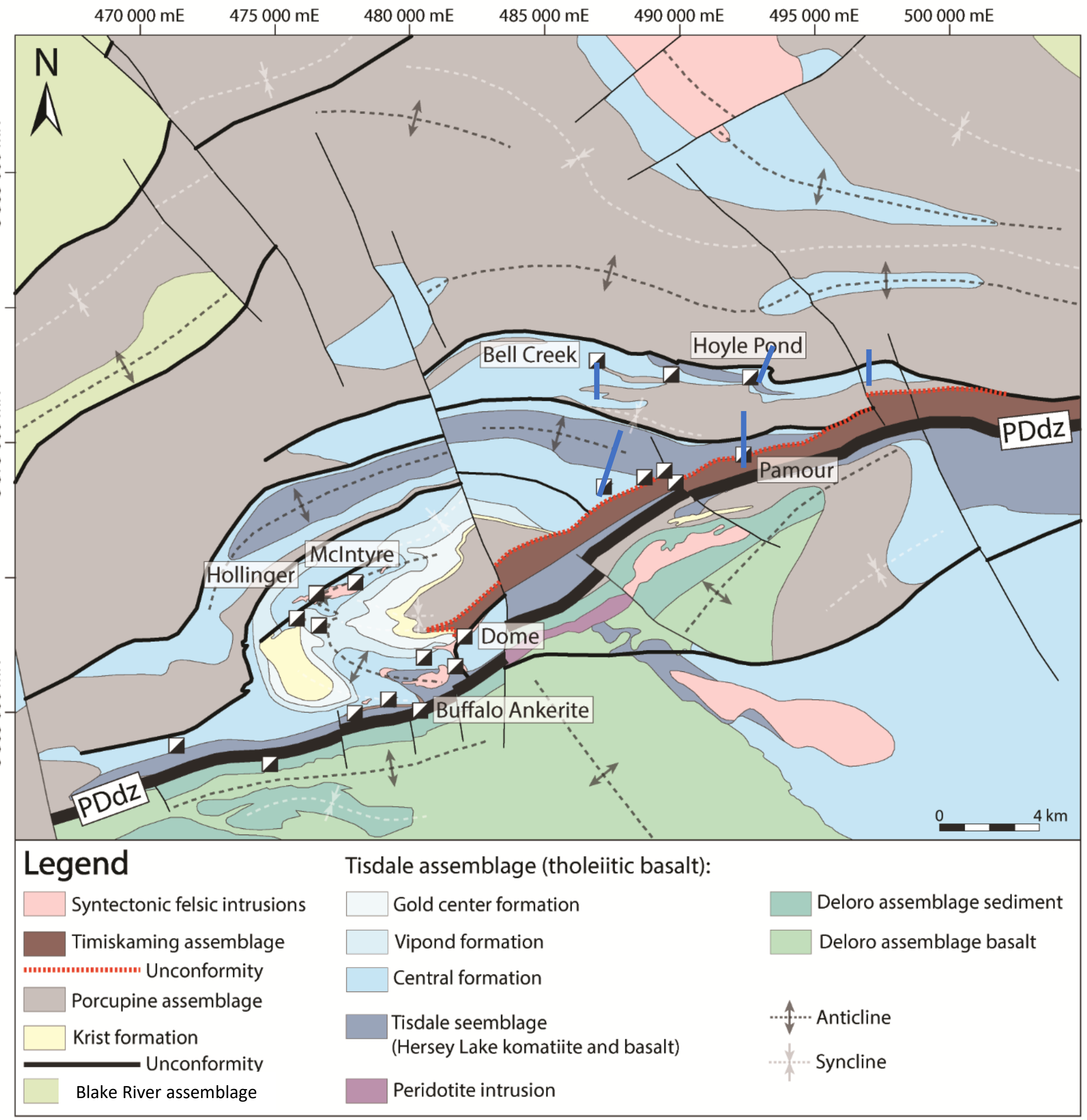
Igneous rocks tend to be insulative.

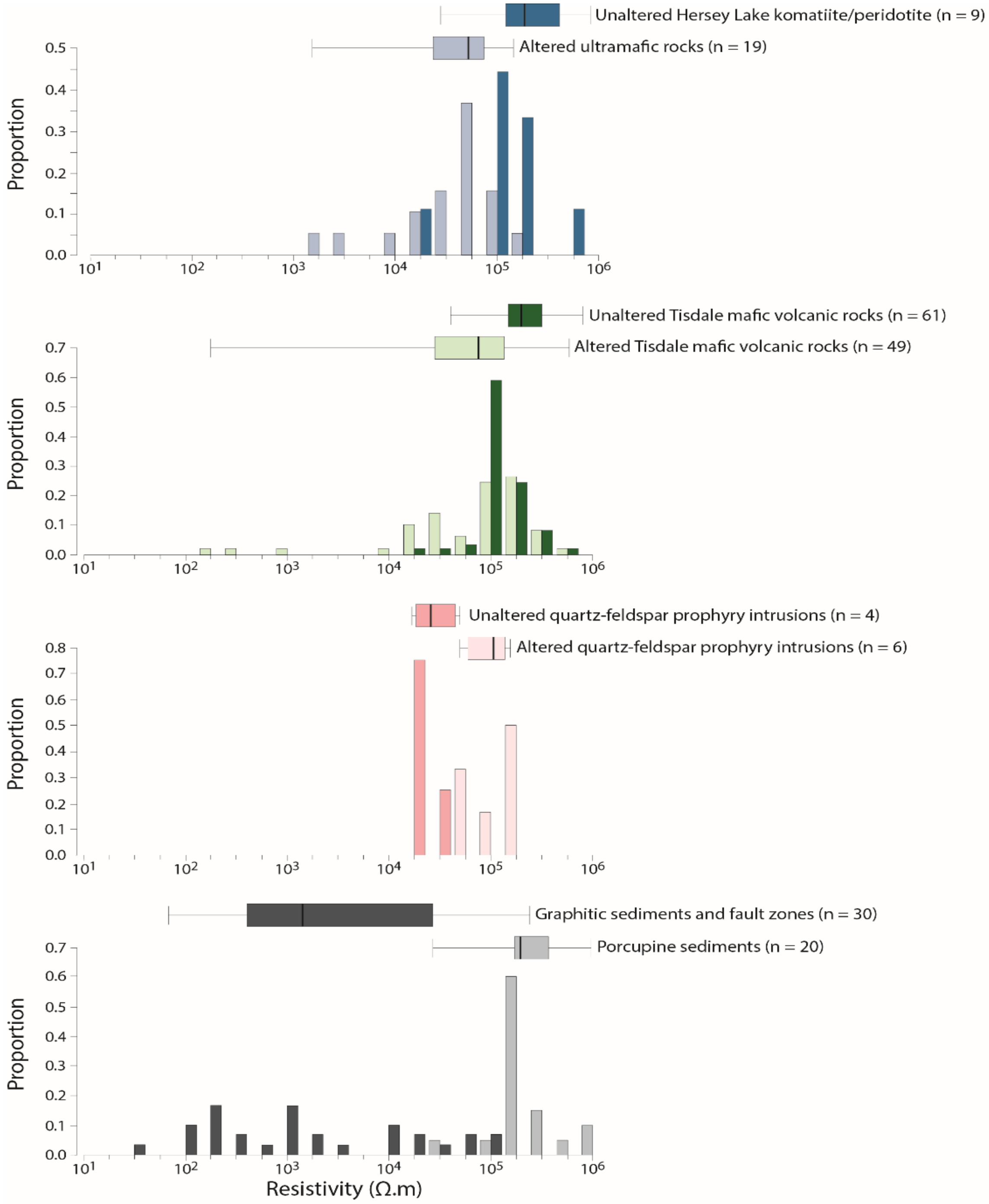


The highest chargeabilities are found in the conductive samples.



Timmins – petrophysical properties





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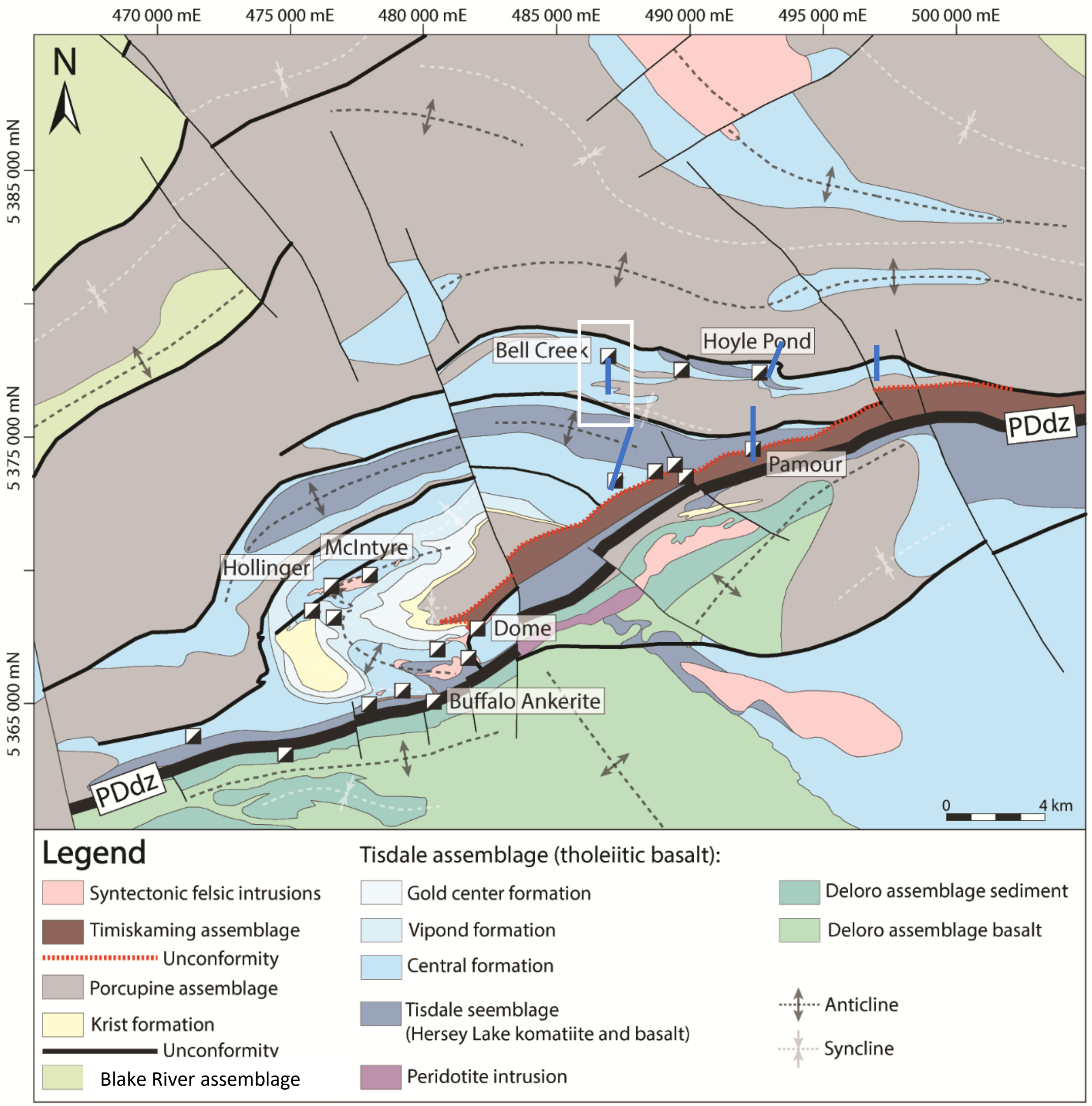
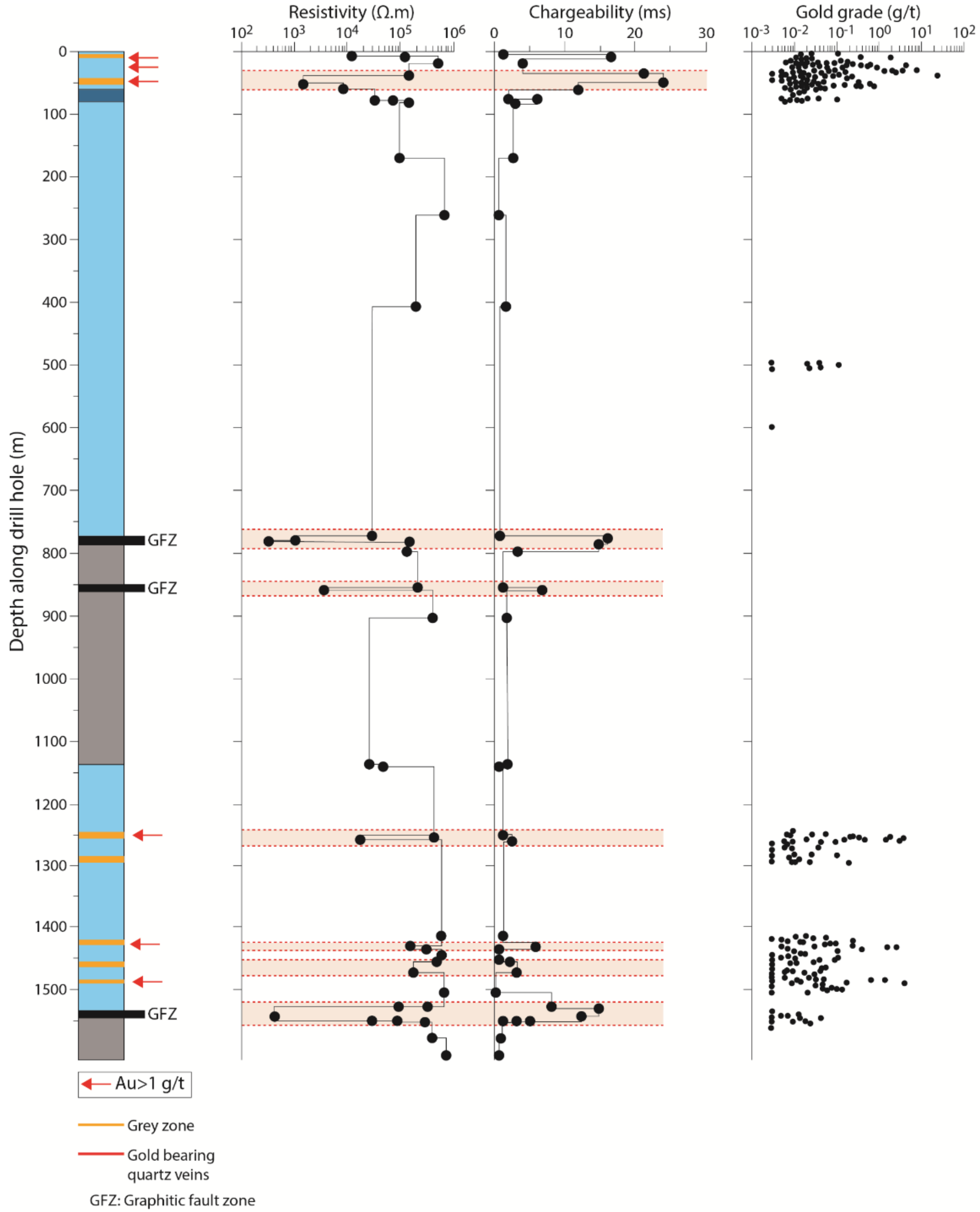
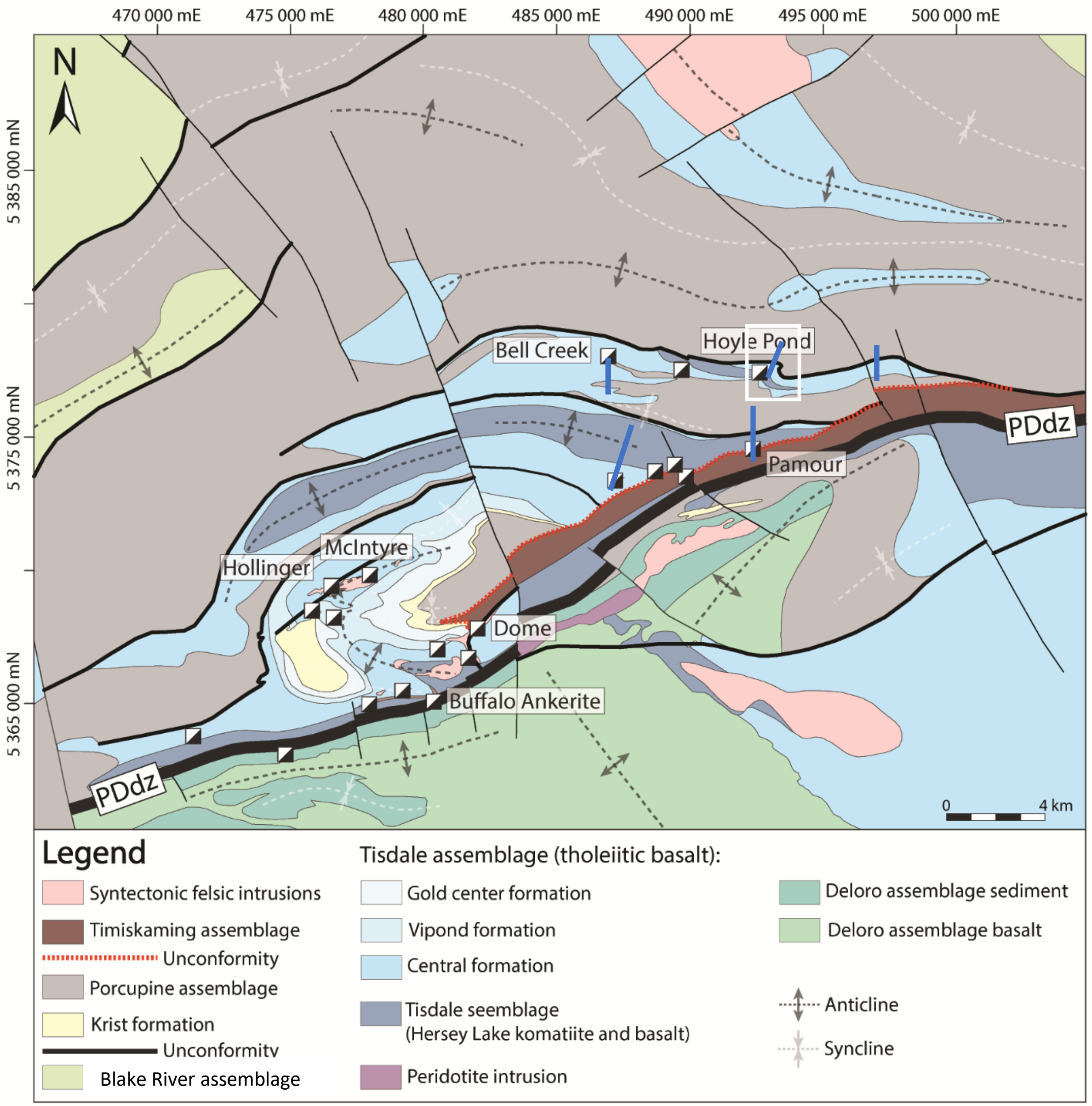


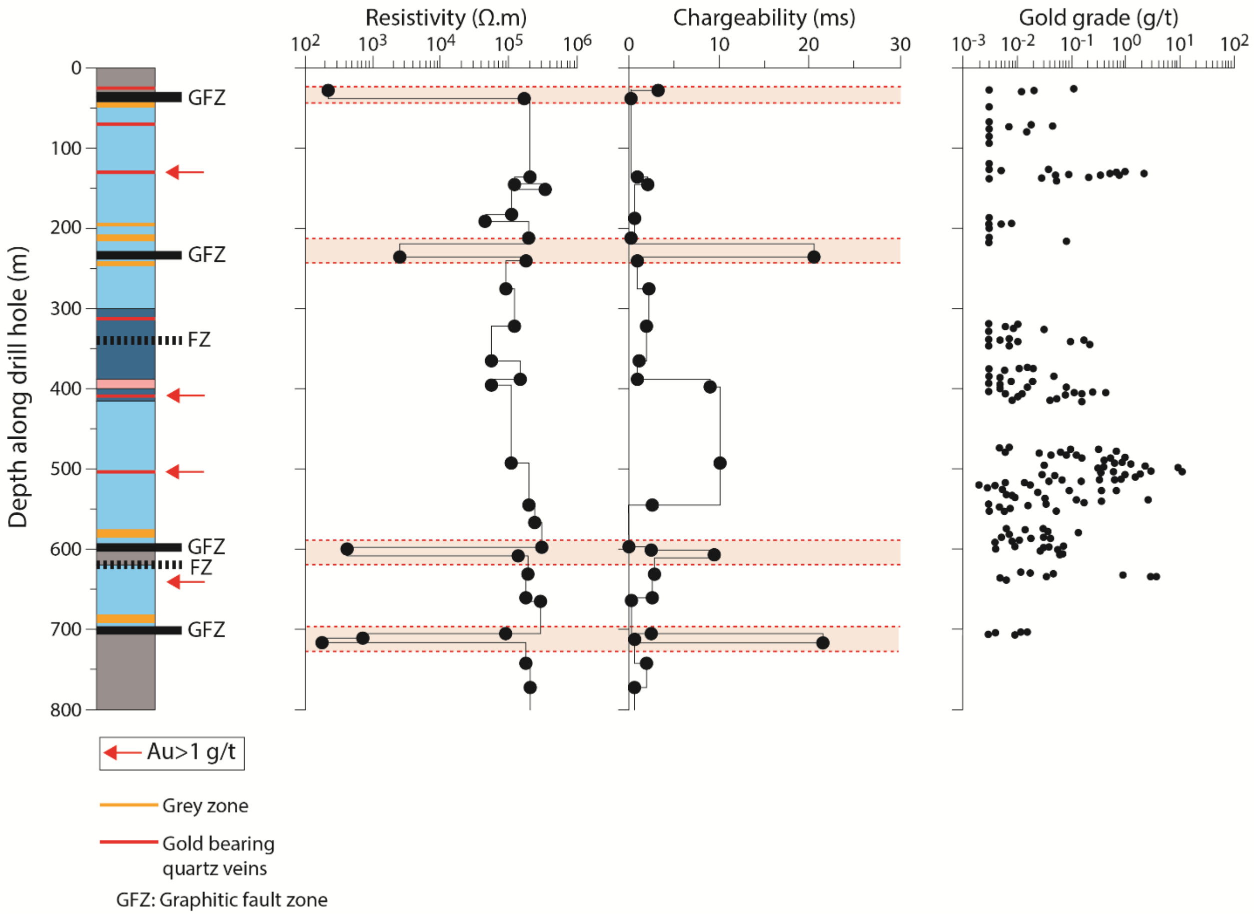
Bell Creek Area: 49 Samples



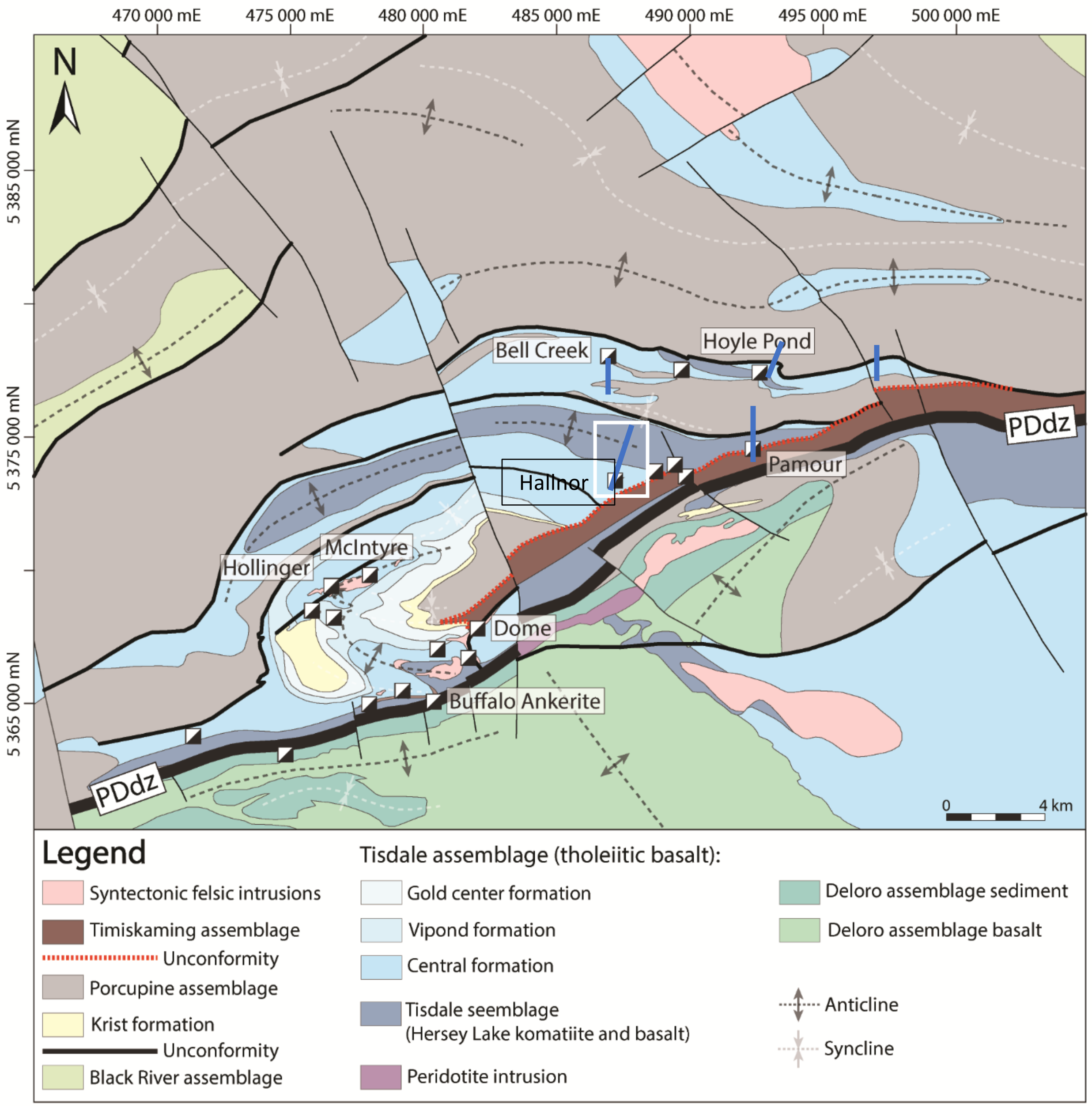
Timmins – petrophysical properties

Hoyle Pond Area: 33 Samples

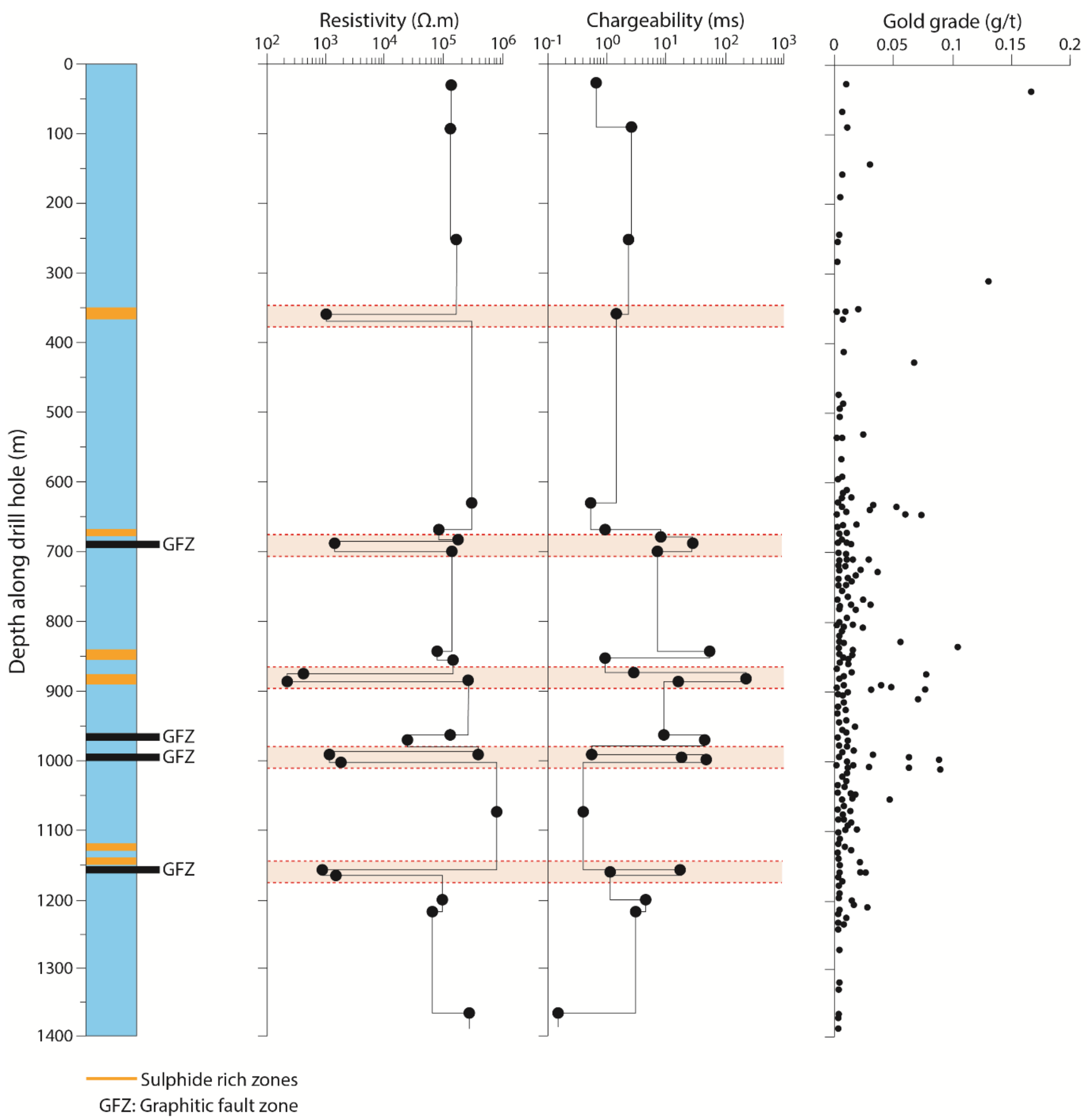




Timmins – petrophysical properties

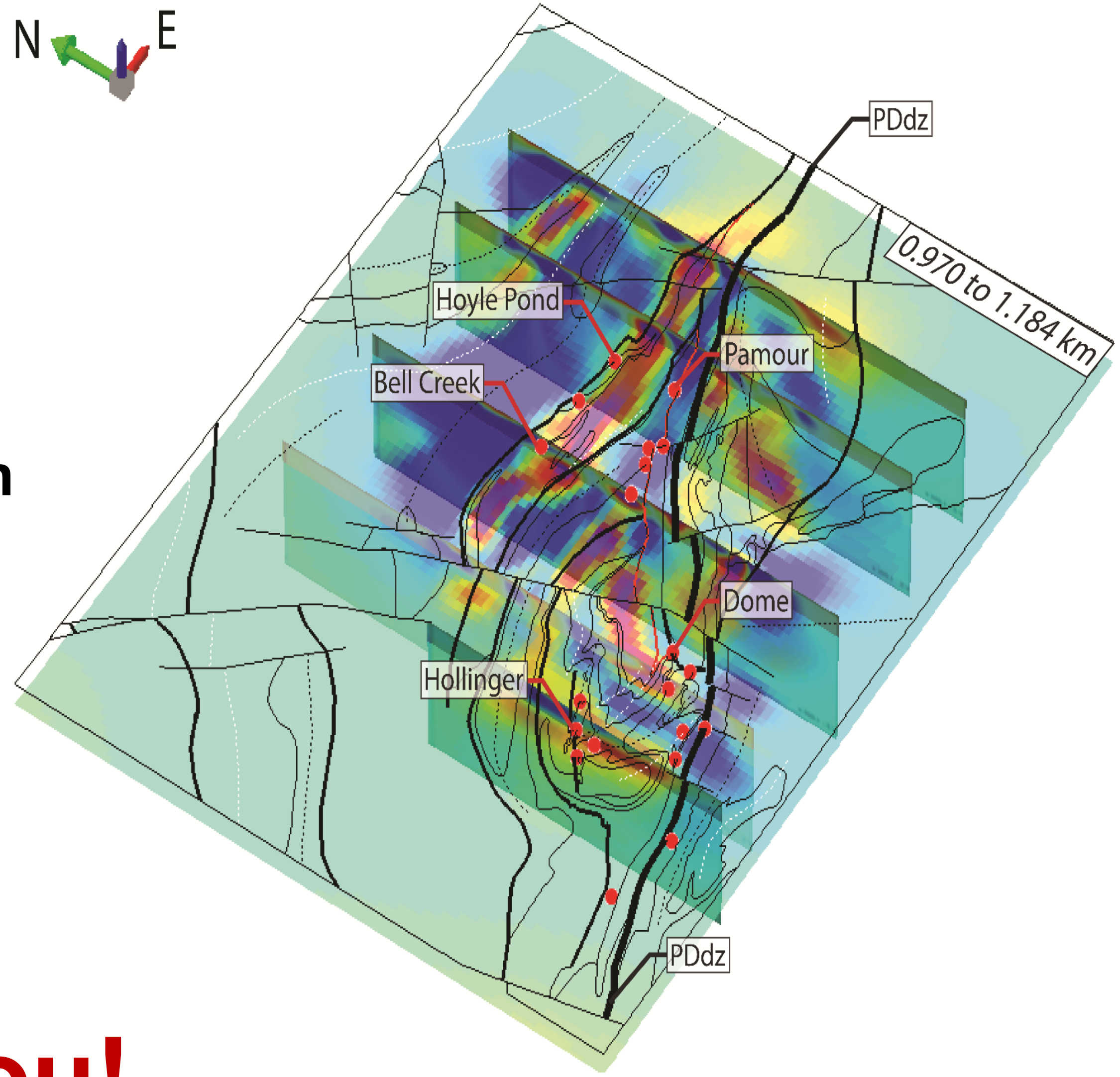


Hallnor Area: 49 Samples



Timmins Camp AMT Summary

- **Conductive anomalies are spatially associated with known gold deposits:**
  - **Large scale >20 km east-west conductive anomaly thru. Hoyle Pond-Bell Creek.**
  - **Dome and Hollinger related to folded conductive anomalies at graphitic units within the Porcupine**
- **Timmins camp anomalies related to graphitic faults spatially associated with high grades of gold**
- **Altered and mineralized mafic volcanic rocks ("Grey zones") are also characterized by lower values of electrical resistivities**



Thank You!

MERC
Mineral Exploration Research Centre

Laurentian University
Université Laurentienne
HARQUAIL SCHOOL OF EARTH SCIENCES
ÉCOLE DES SCIENCES DE LA TERRE

METAL EARTH

Thank You

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