Large-Scale Geology and Fault Geometry of Gold-Endowed Archean Crust: Insight from the Matheson Transect of the Abitibi Greenstone Belt

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SEG

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METAL EARTH

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CANADA FIRST RESEARCH EXCELLENCE FUND

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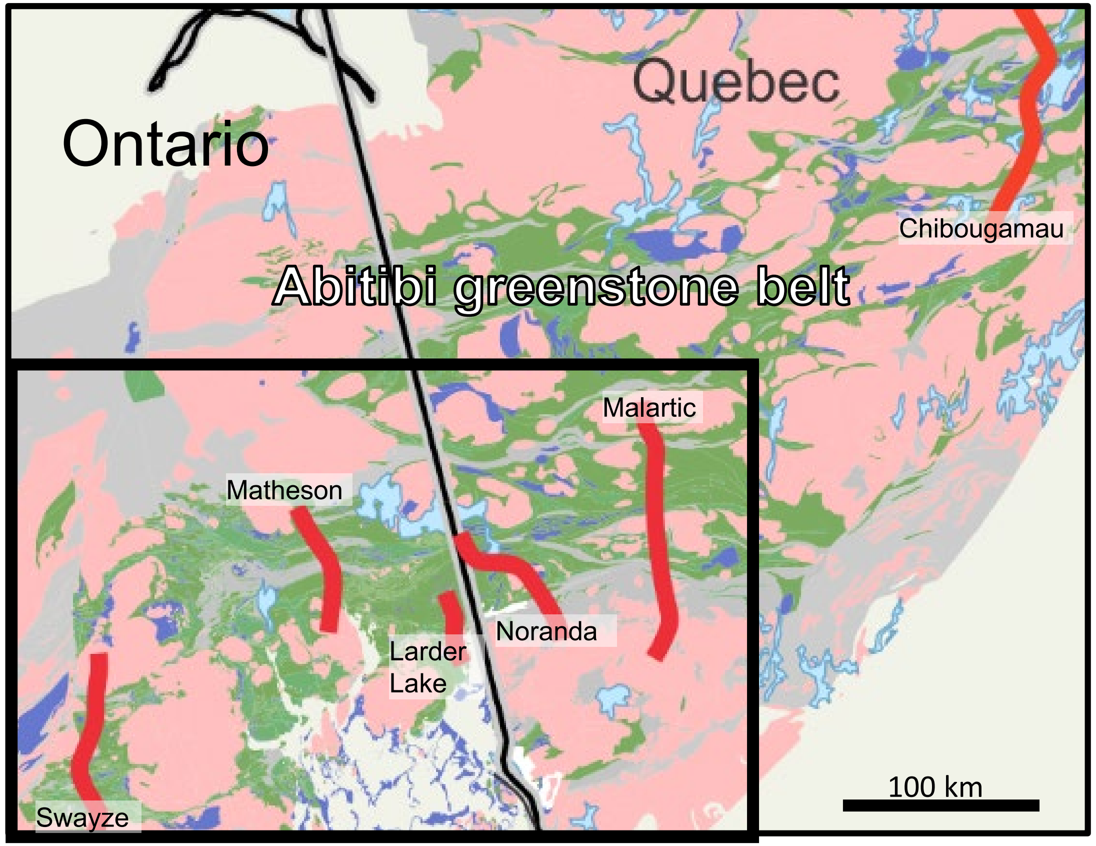
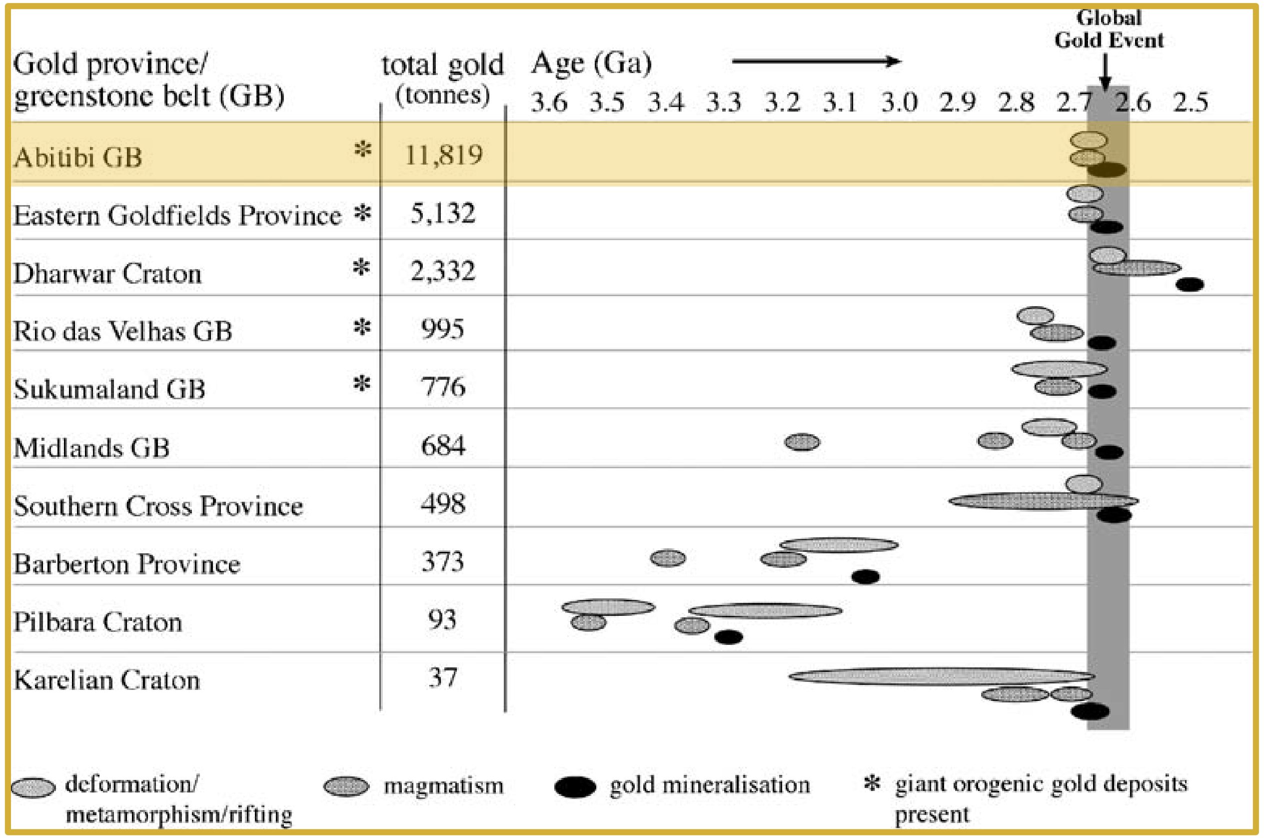
Transect-scale research – Abitibi greenstone belt and orogenic gold



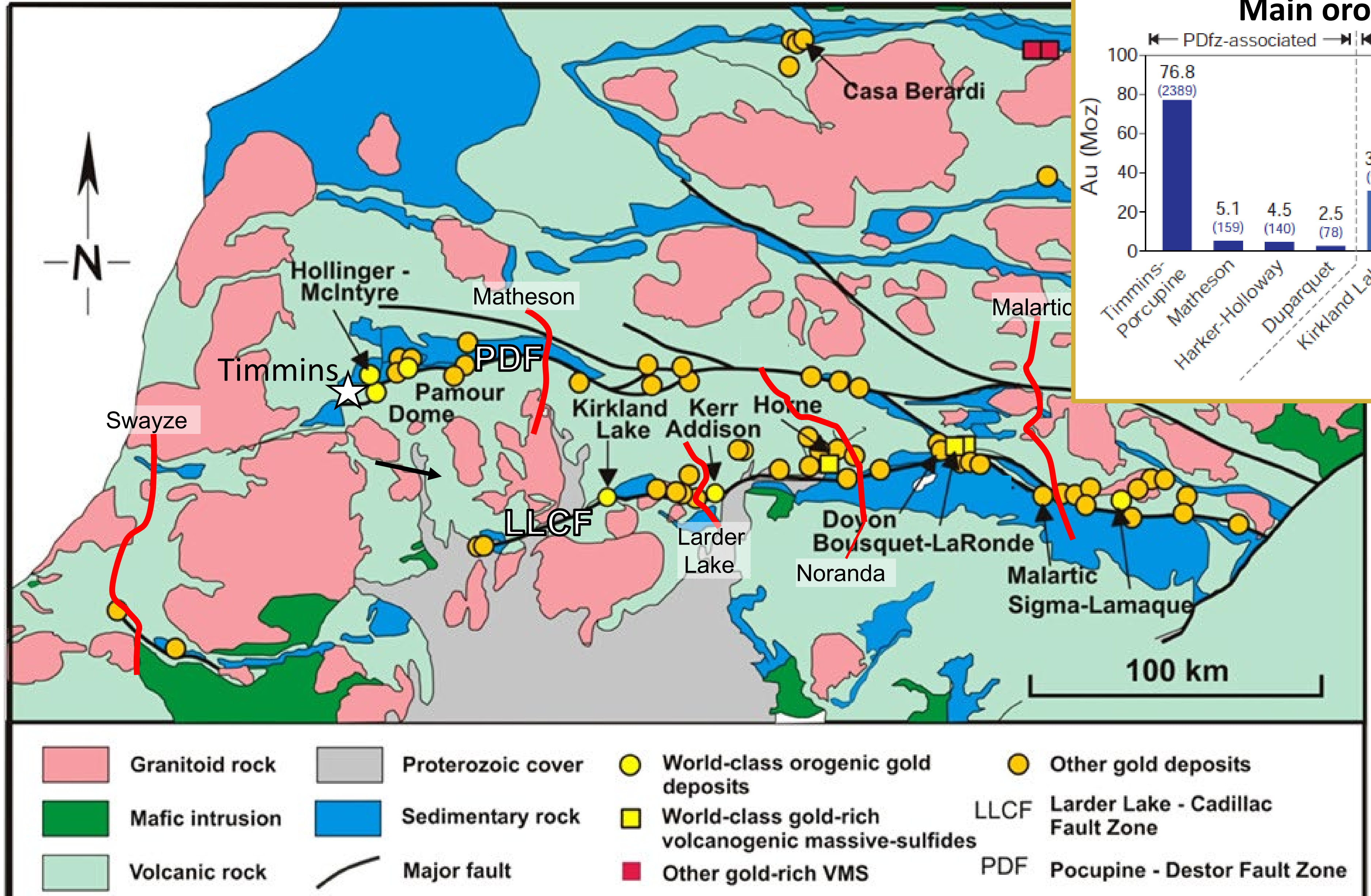
Legend
- Proterozoic to Phanerozoic rocks
- Sedimentary rocks
- Volcanic rocks
- Mafic to ultramafic intrusive rocks
- Felsic to intermediate intrusive rocks
- Metal Earth geophysical survey

Largest orogenic gold provinces

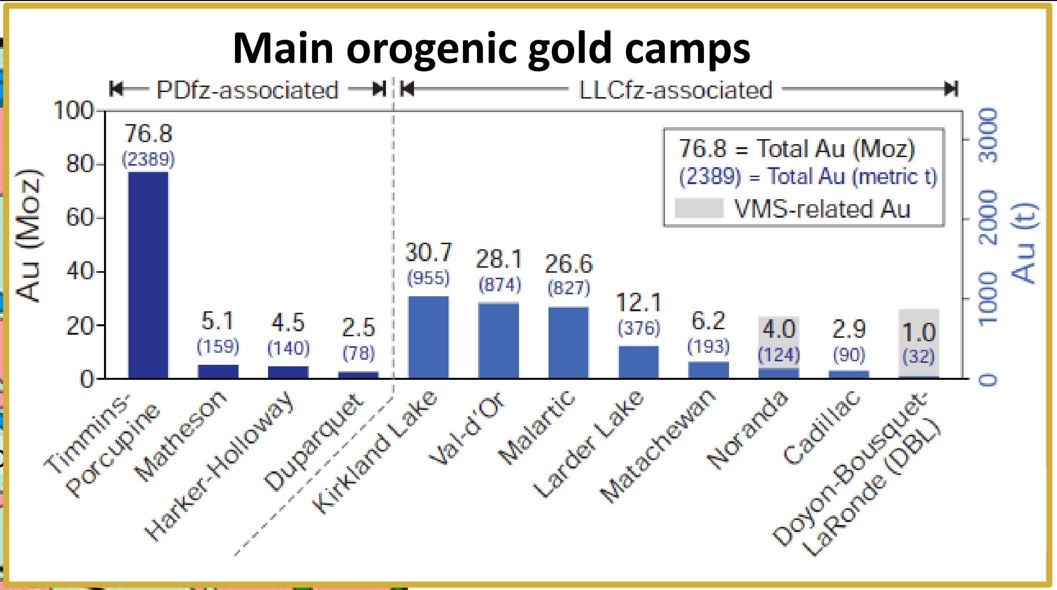


Bierlein et al (2006)

Transect scale research – Abitibi greenstone belt and orogenic gold

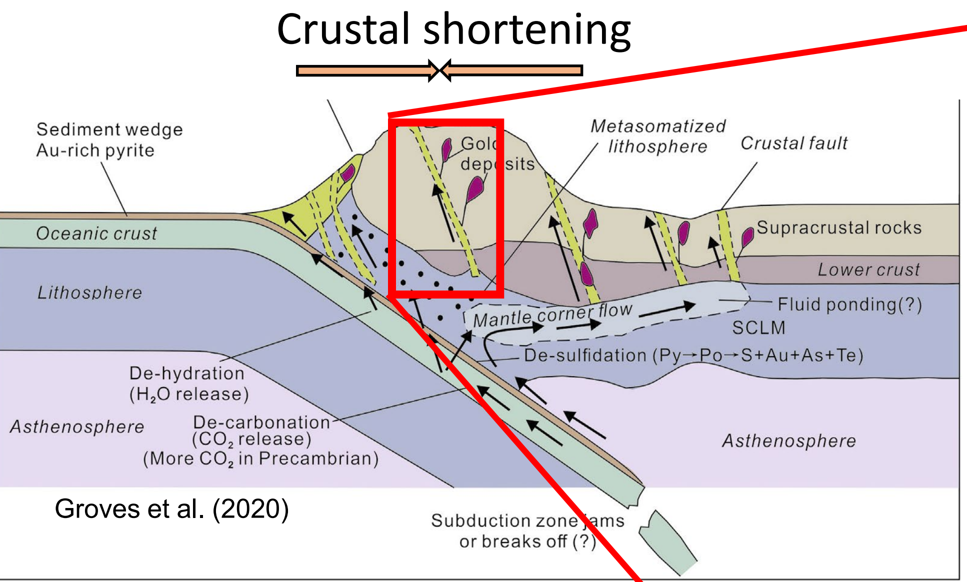


Poulsen et al. (2000)

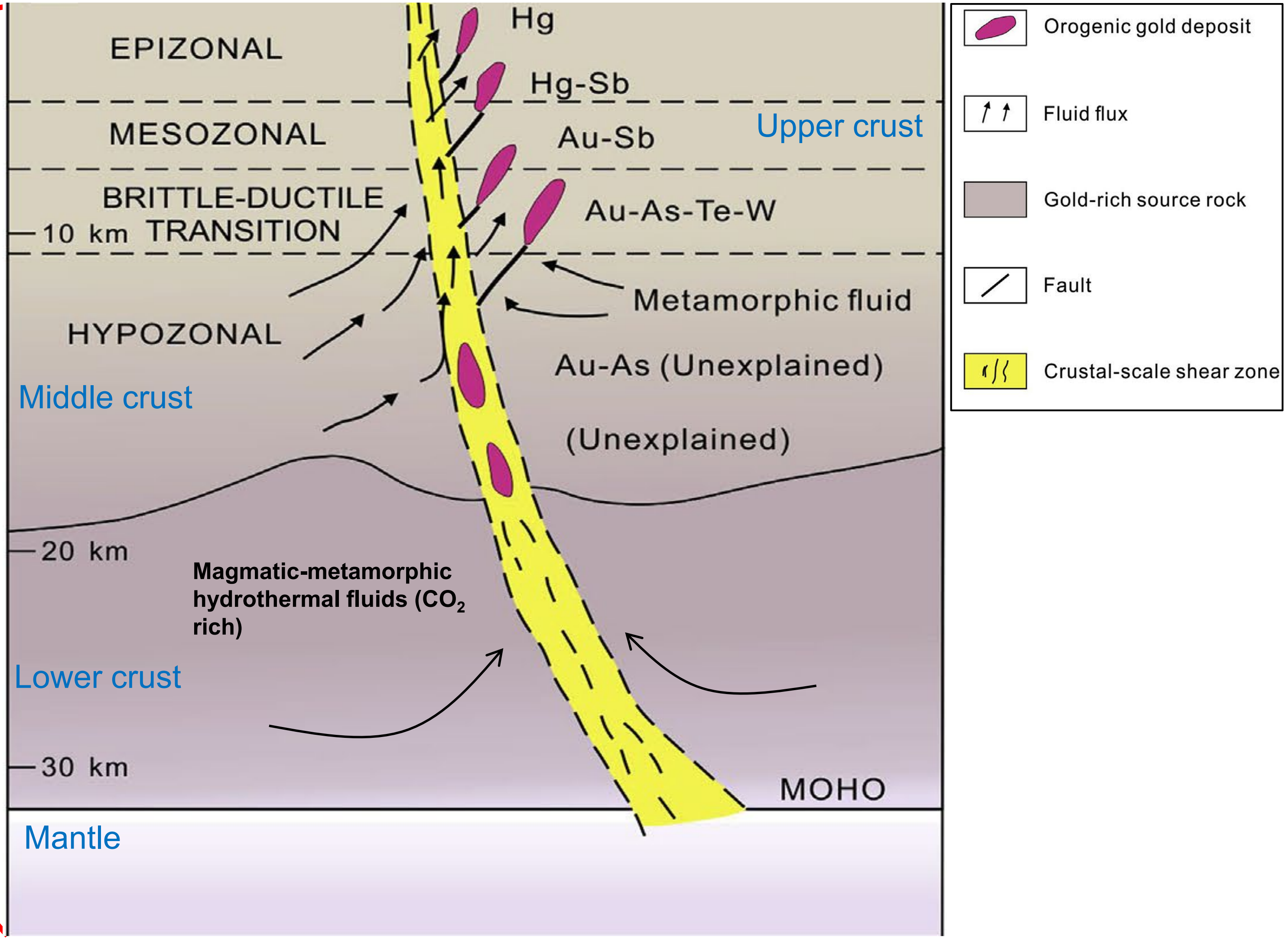


Monecke et al. (2017)

General orogenic Au model – Crustal shortening



Groves et al. (2020)



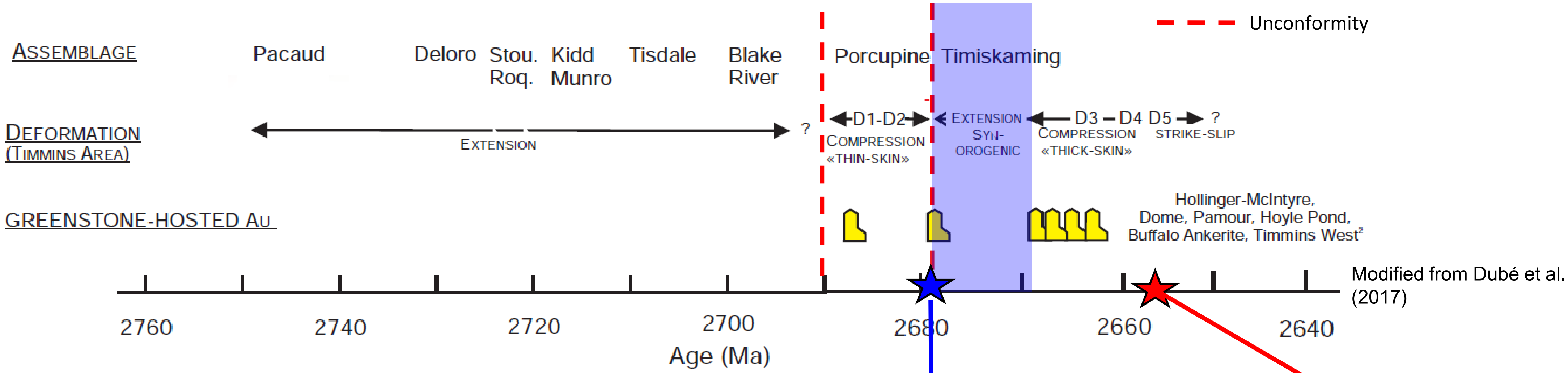
Modified from Groves et al. (2020)

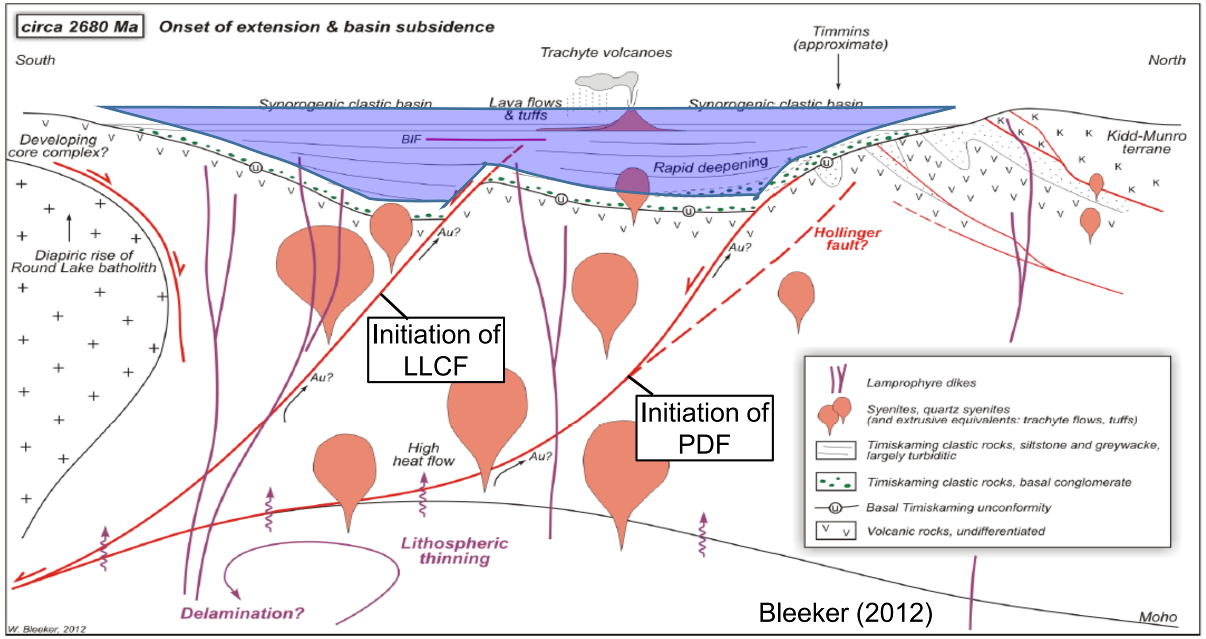
1. Regional metamorphism and deformation during crustal shortening events → **elevated heat and fluid flux**
2. Large scale conduits/shear zones was originally terrane sutures/boundaries

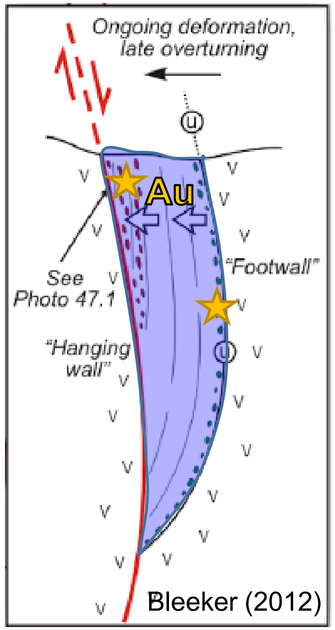
3. Crustal-scale shear zones (1st order) tapping, focusing and transporting the fluids

4. Au source region (lower crust/upper mantle?)

Abitibi model – Extension?



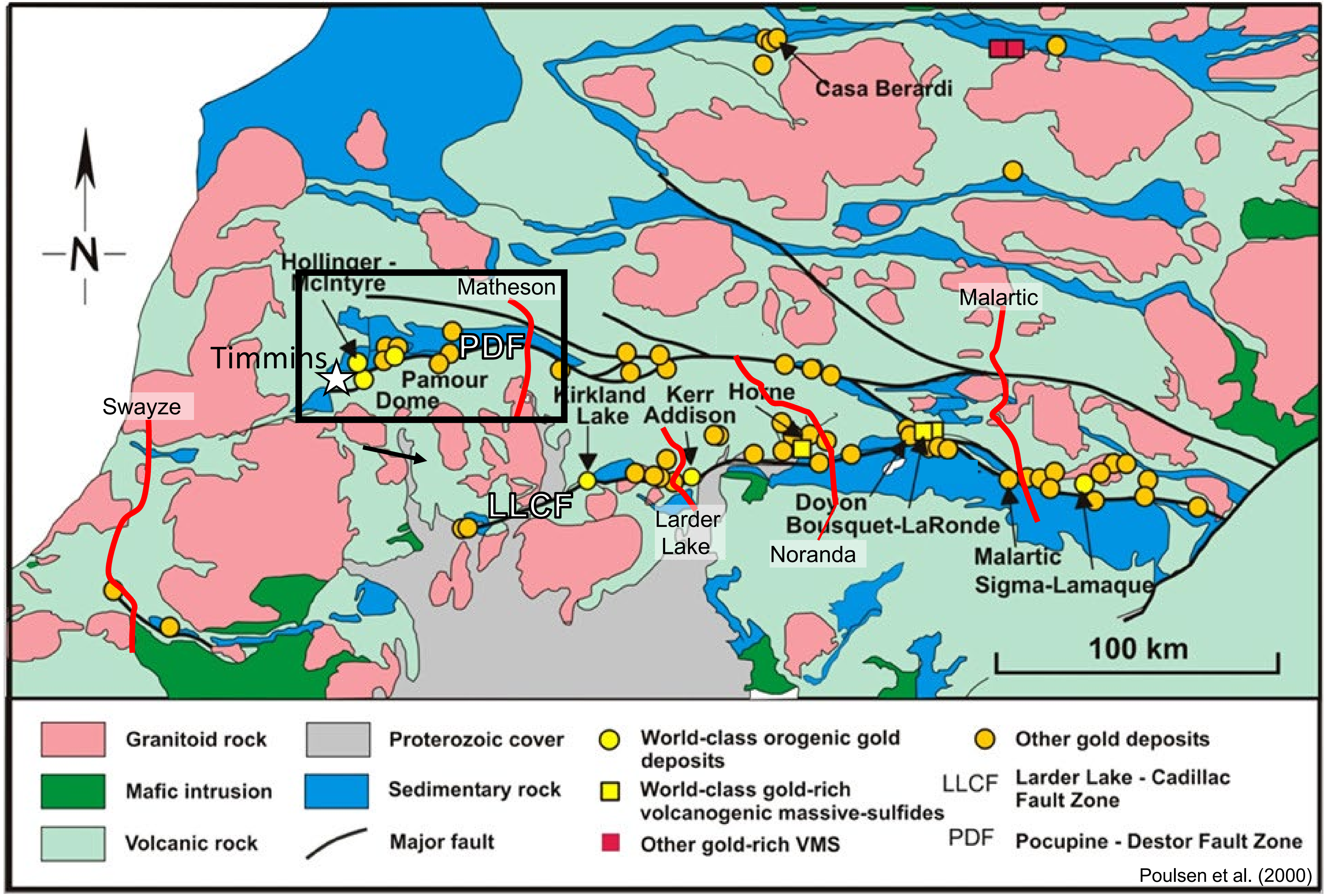




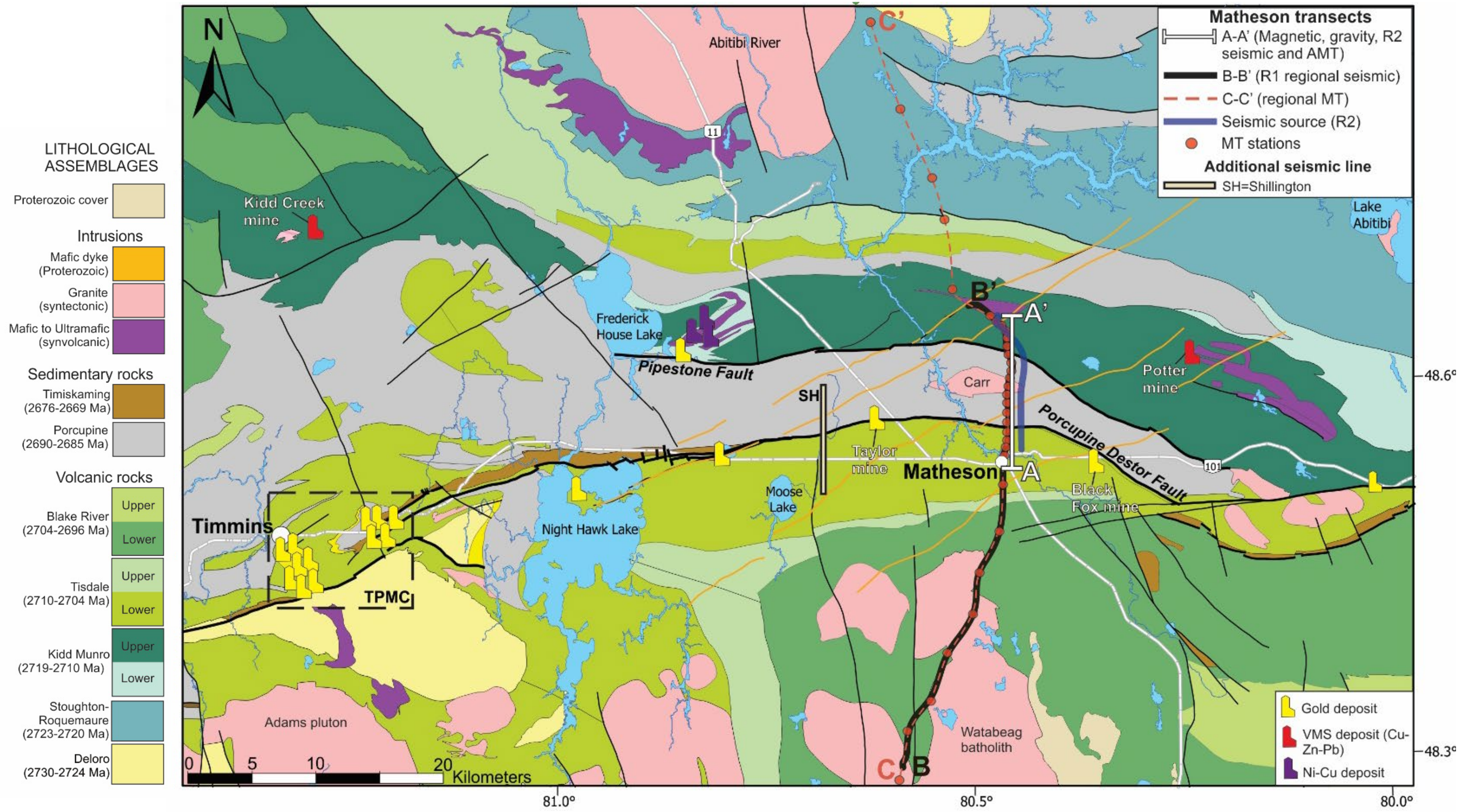
Syn-orogenic extensional fault?

- PDF truncates earlier fold-thrust structures (D2)
- Formation of syn-orogenic clastic-dominated basins (Timiskaming)
- Synchronous alkaline magmatism (syenite and trachyte + lamprophyre dykes) → lithospheric thinning

The Matheson Transect



The Matheson Transect



The Matheson Transect - Goals

Economic Geology

BULLETIN OF THE SOCIETY OF ECONOMIC GEOLOGISTS

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Crustal-Scale Geology and Fault Geometry Along the Gold-Endowed Matheson Transect of the Abitibi Greenstone Belt

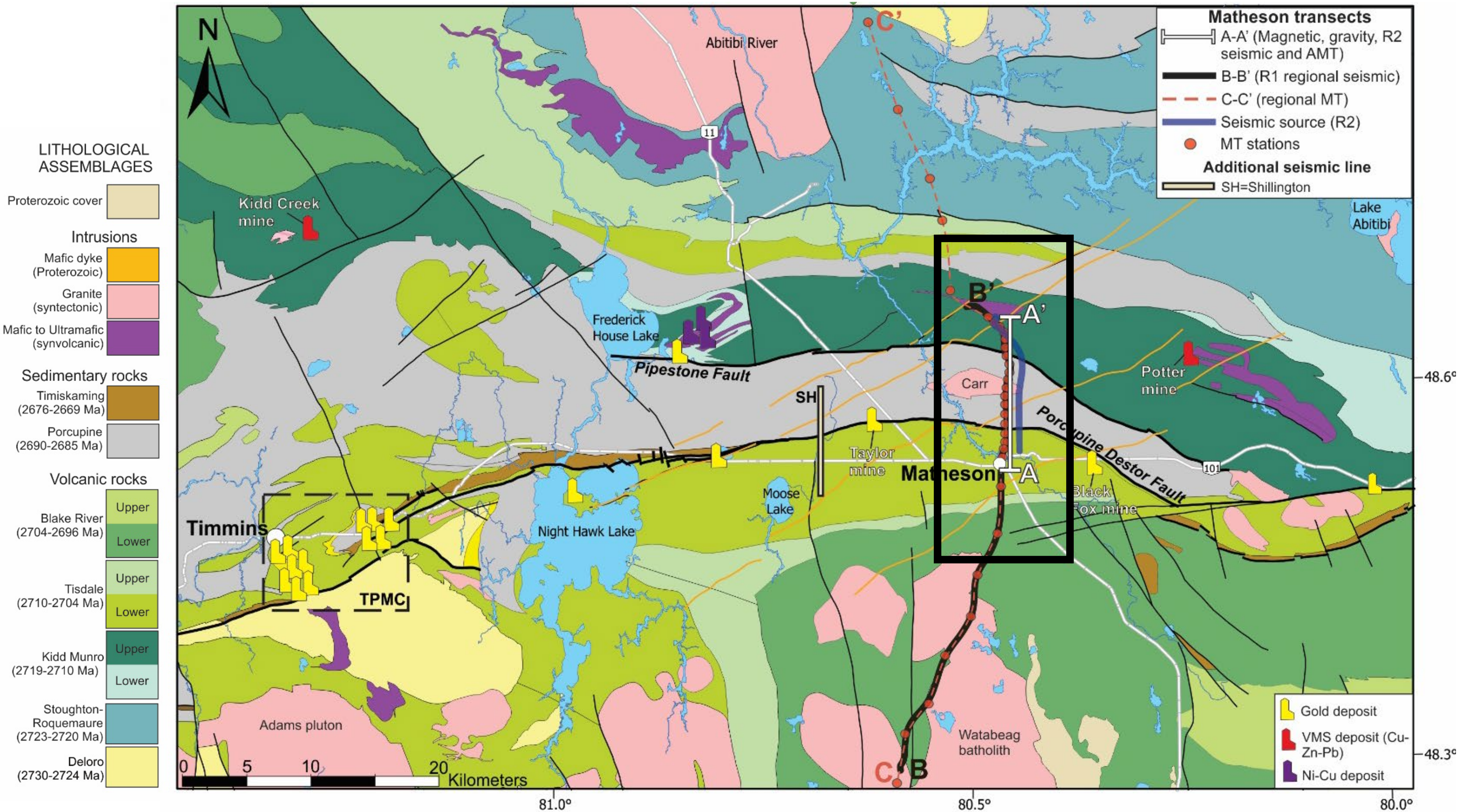
Rasmus Haugaard,[1,†] Fabiano Della Justina,[1] Eric Roots,[1,2] Saeid Cheraghi,[1] Rajesh Vayavur,[1] Graham Hill,[3] David Snyder,[1] John Ayer,[1] Mostafa Naghizadeh,[1] and Richard Smith[1]

- **Upper crustal geology** – Modelling key greenstone belt assemblages and fault geometry (integrating surface geology, gravity, MT and high resolution seismic)

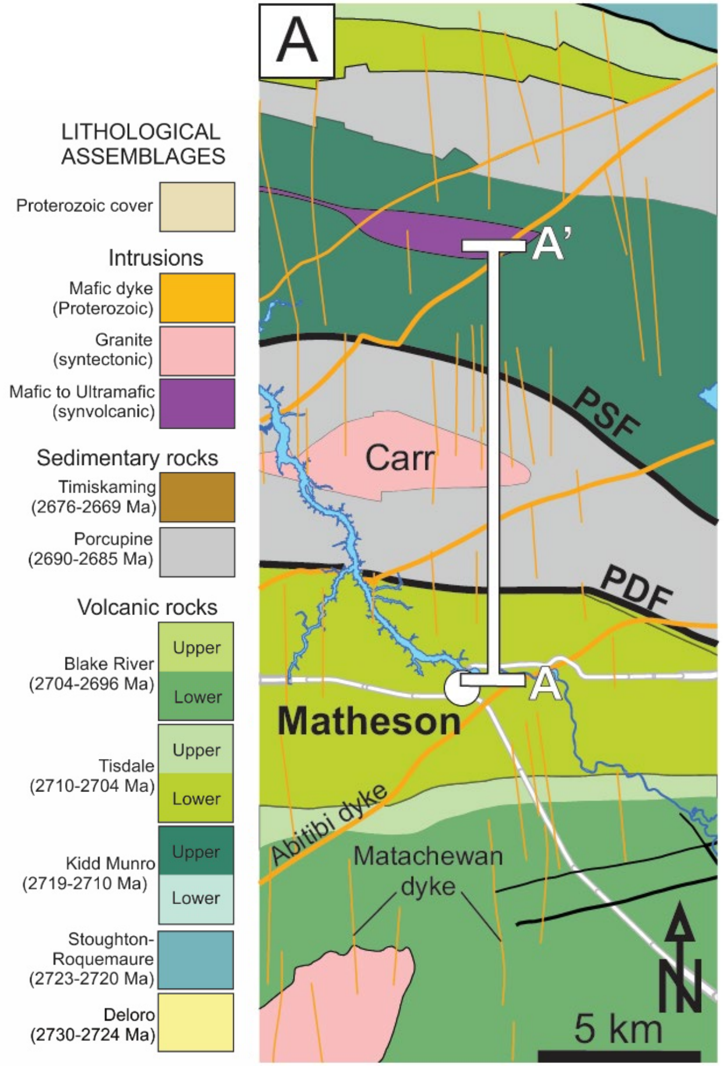
- **Full crustal geology** – Modelling the geology based on the physical properties of the crust (integrating surface geology, MT and deep seismic imaging)

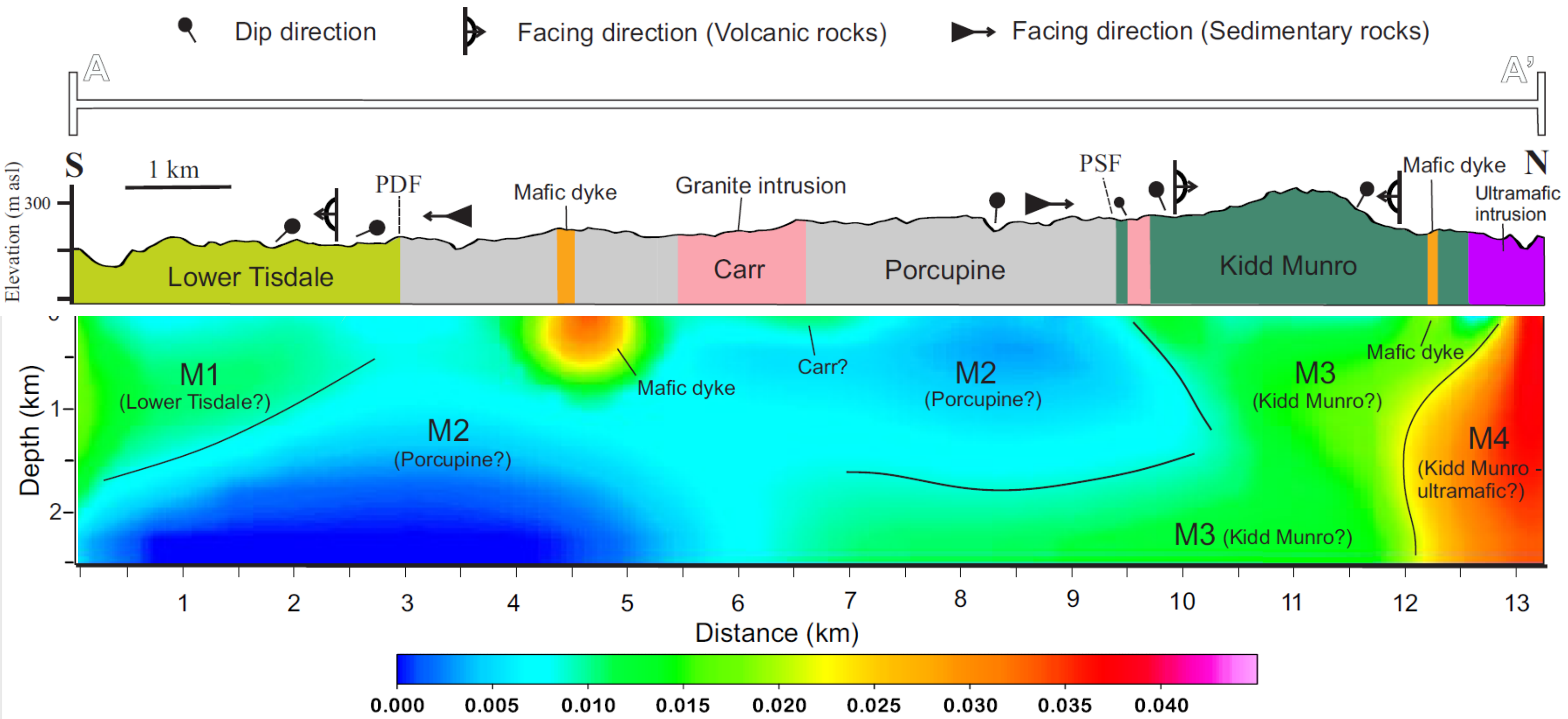
Assess the **metallogenic fingerprints** of the Matheson transect including characterizing potential deep-seated mineralizing fault systems

The Matheson Transect

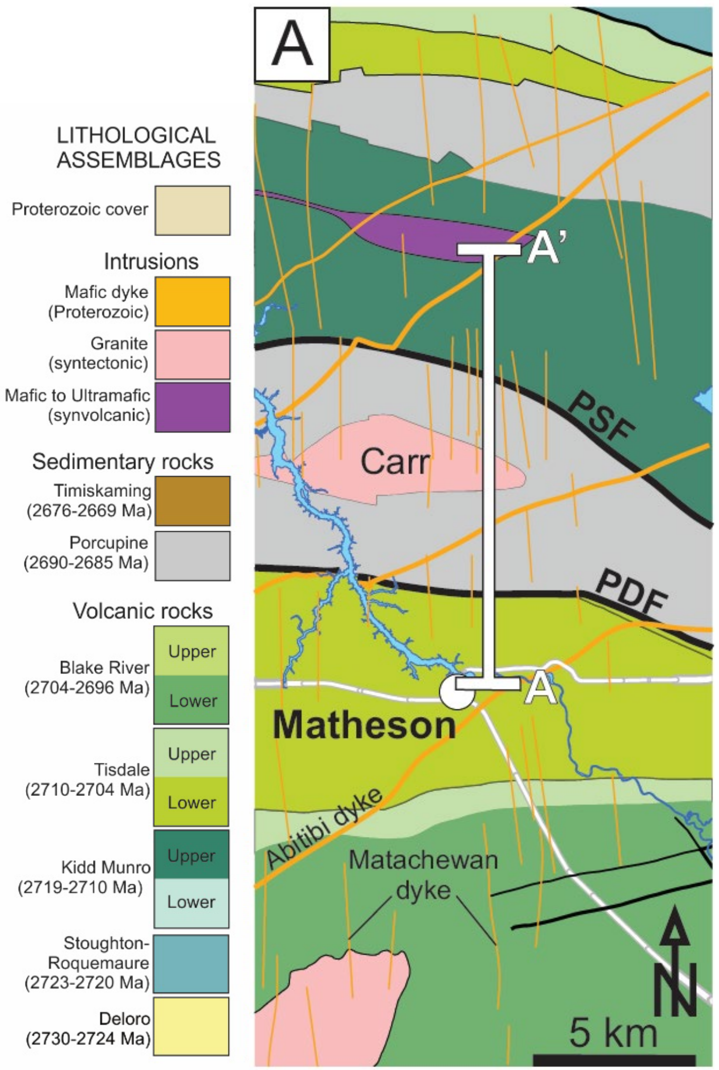


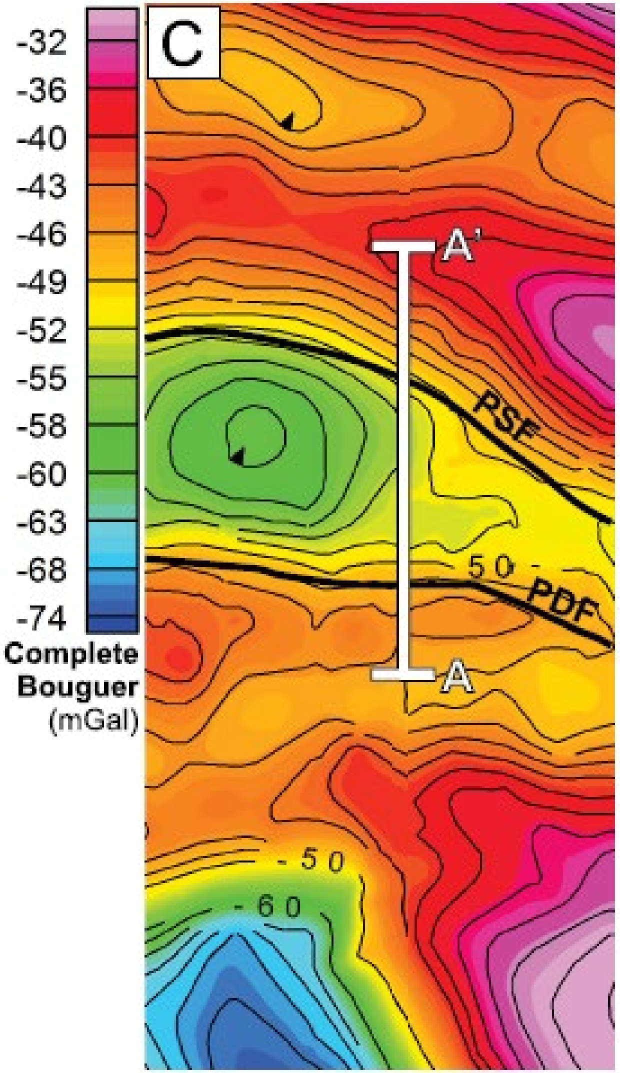
Matheson – surface geology and 3D magnetic inversion

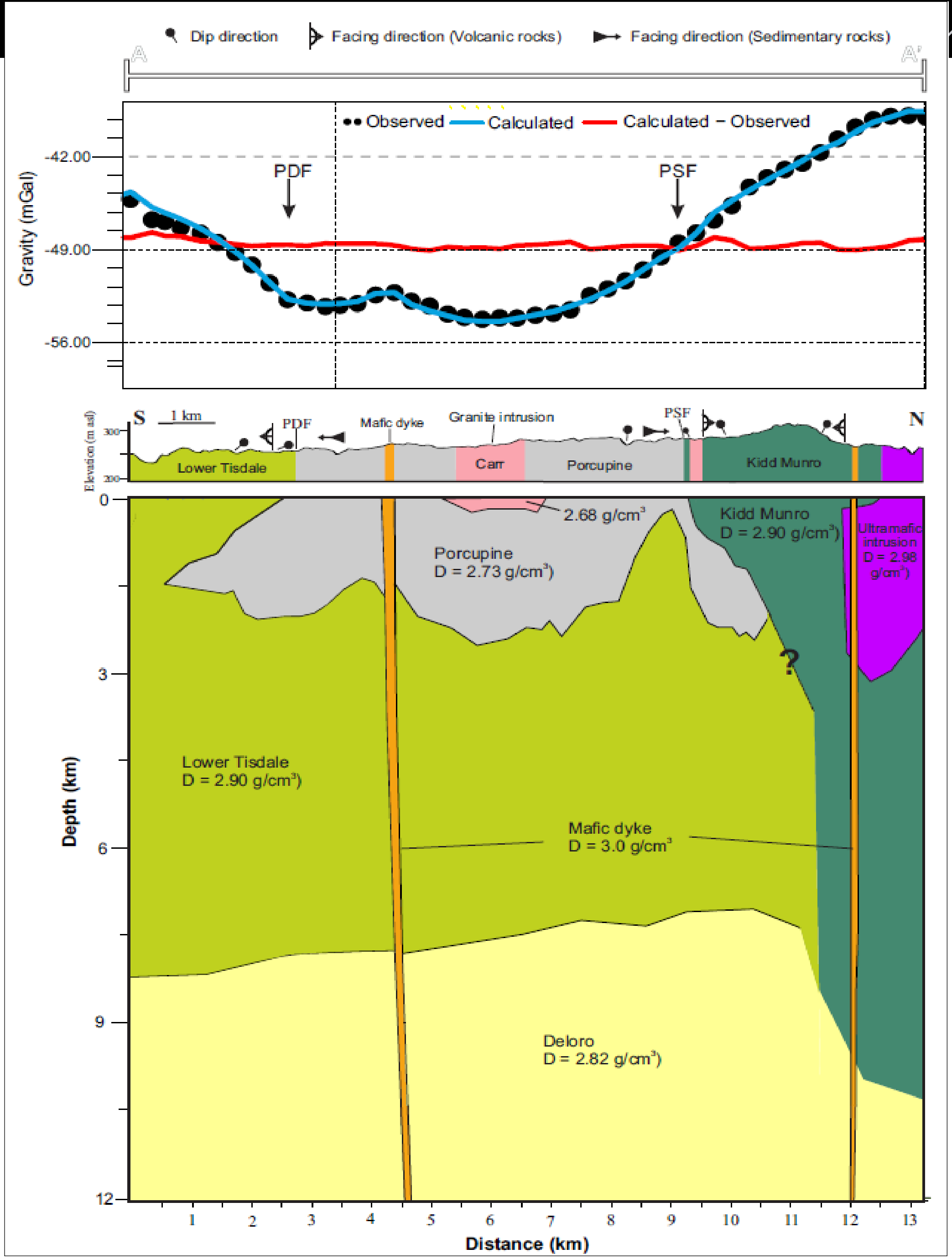




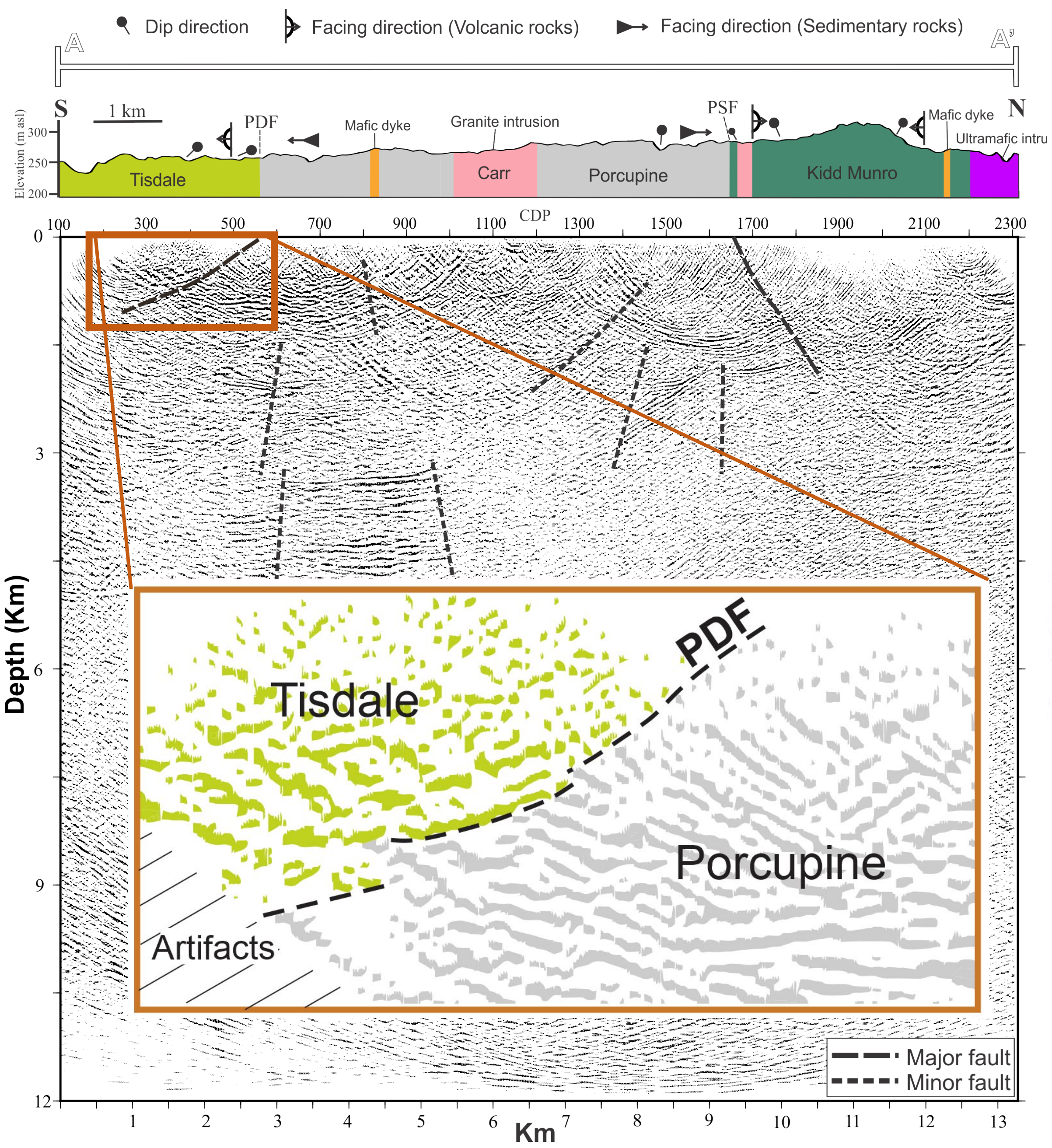
Matheson – 2.5D forward gravity modelling

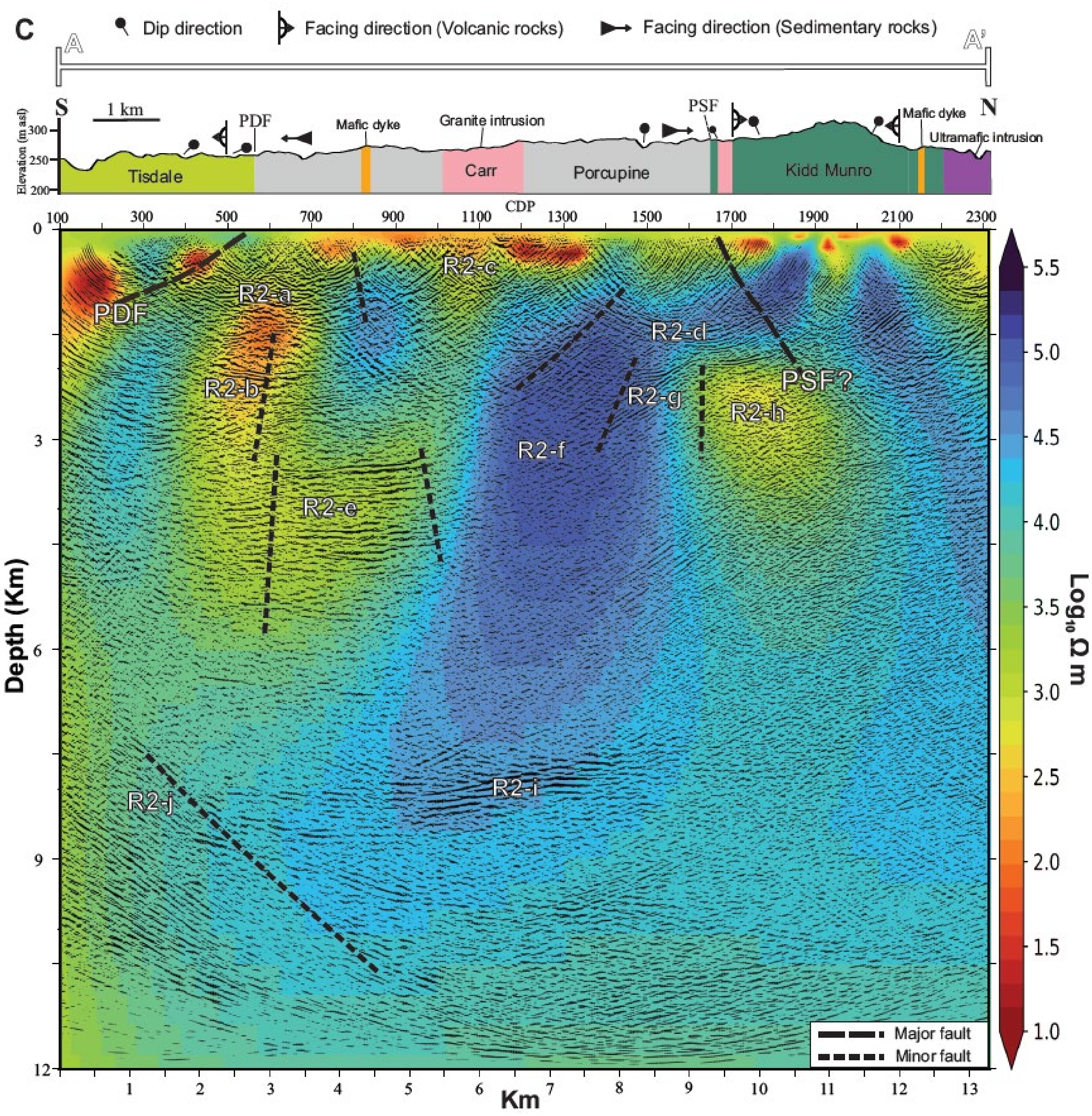




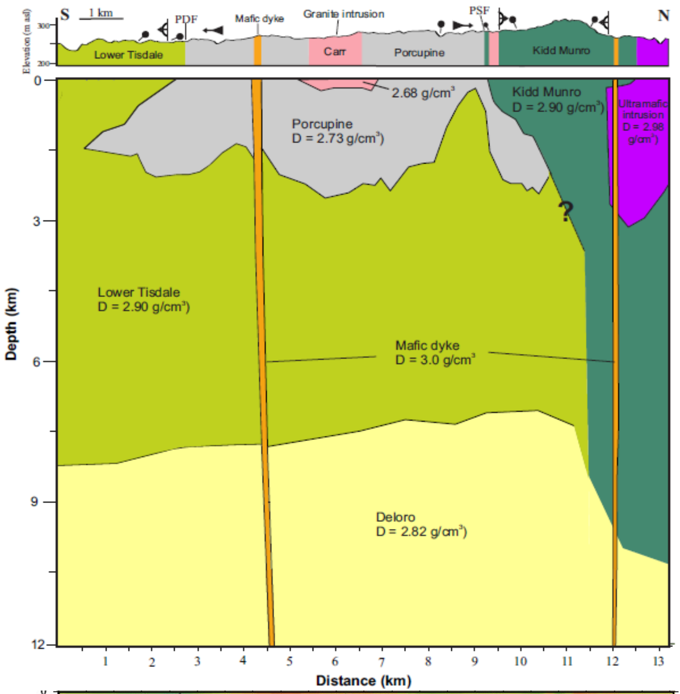


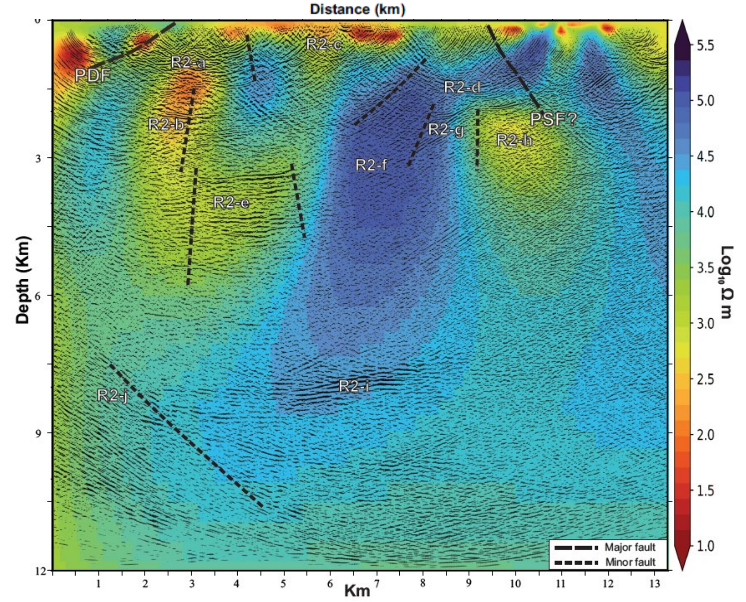
Matheson – High resolution seismic and AMT

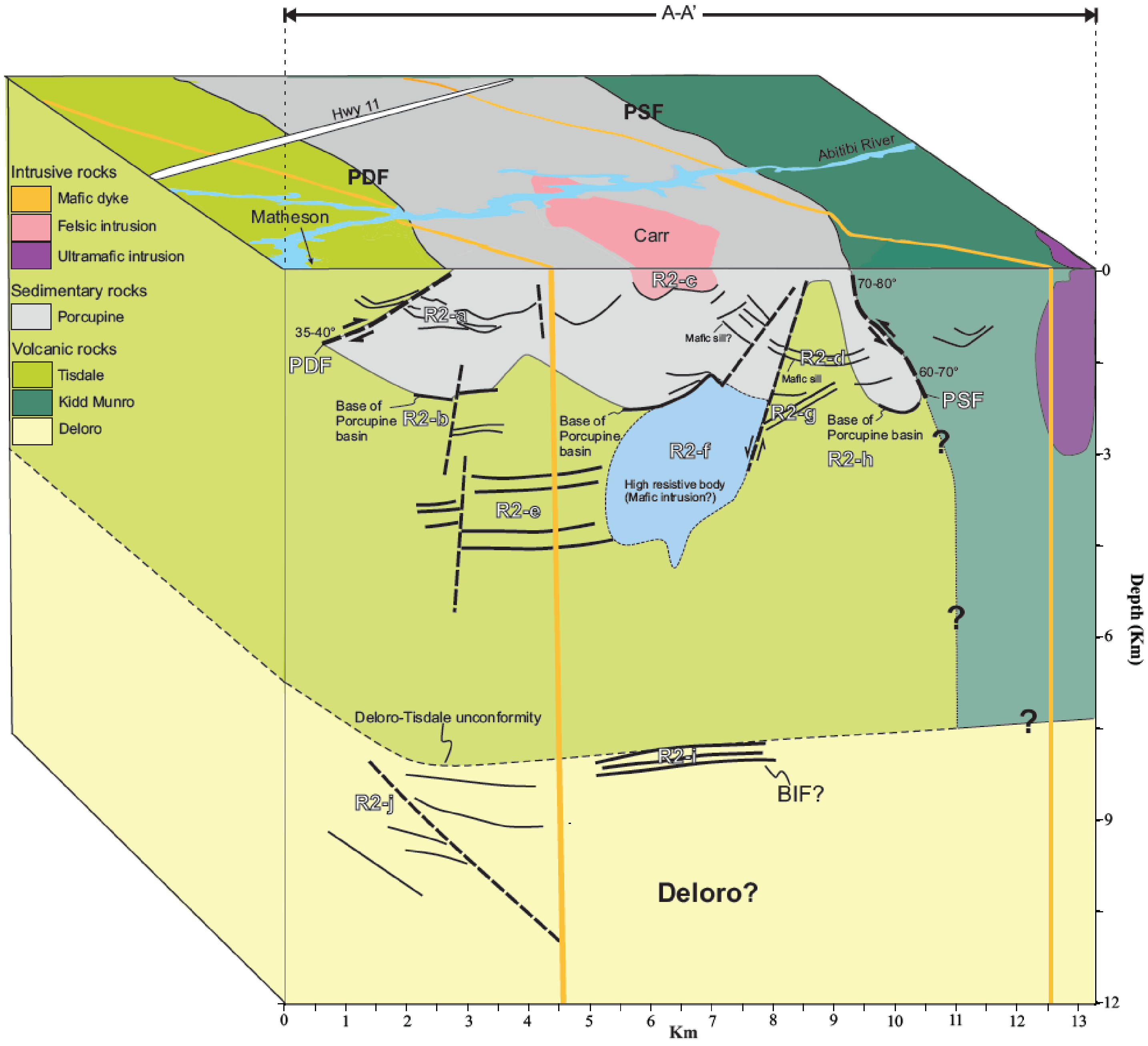




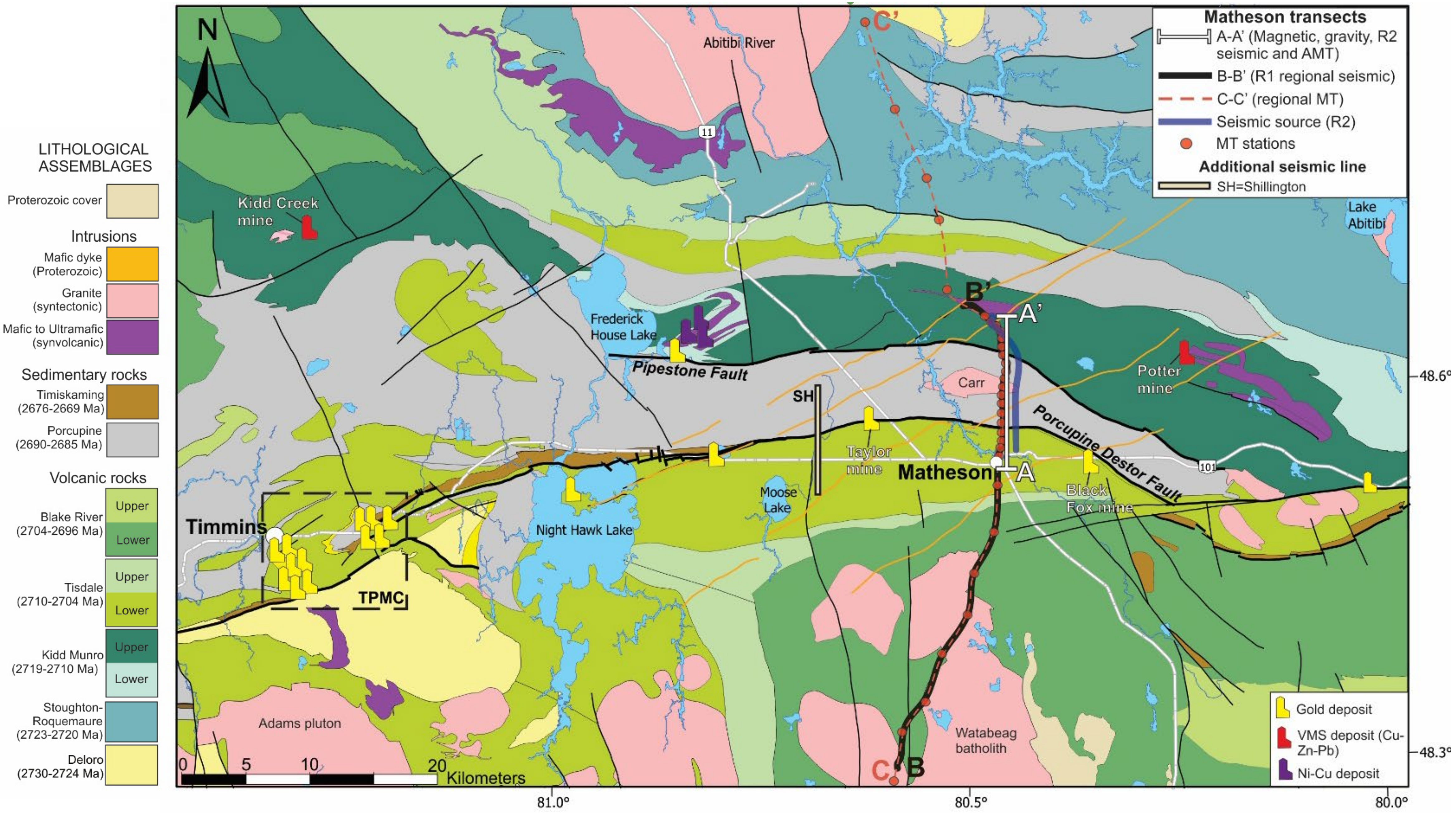
Matheson – Upper crustal geology model



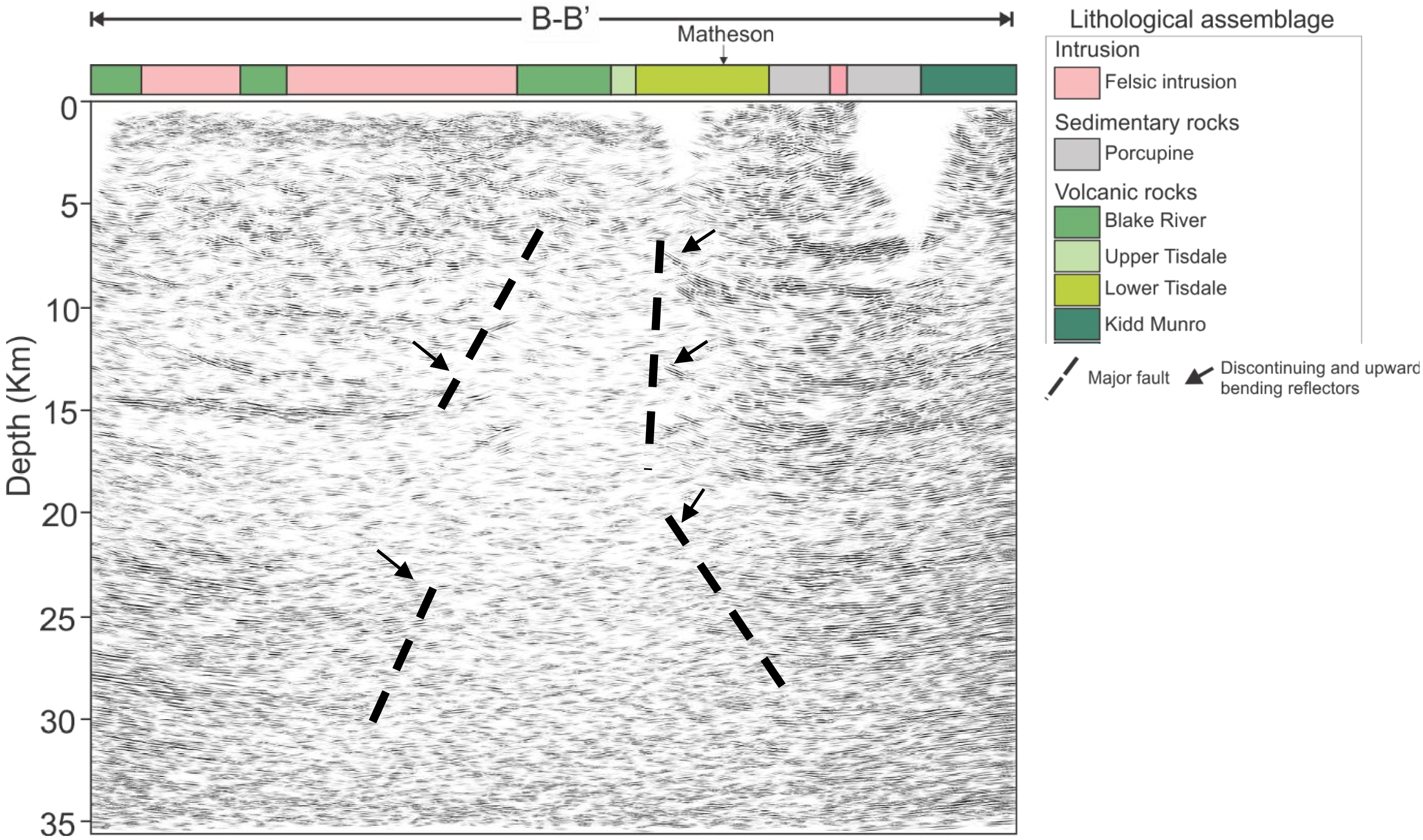




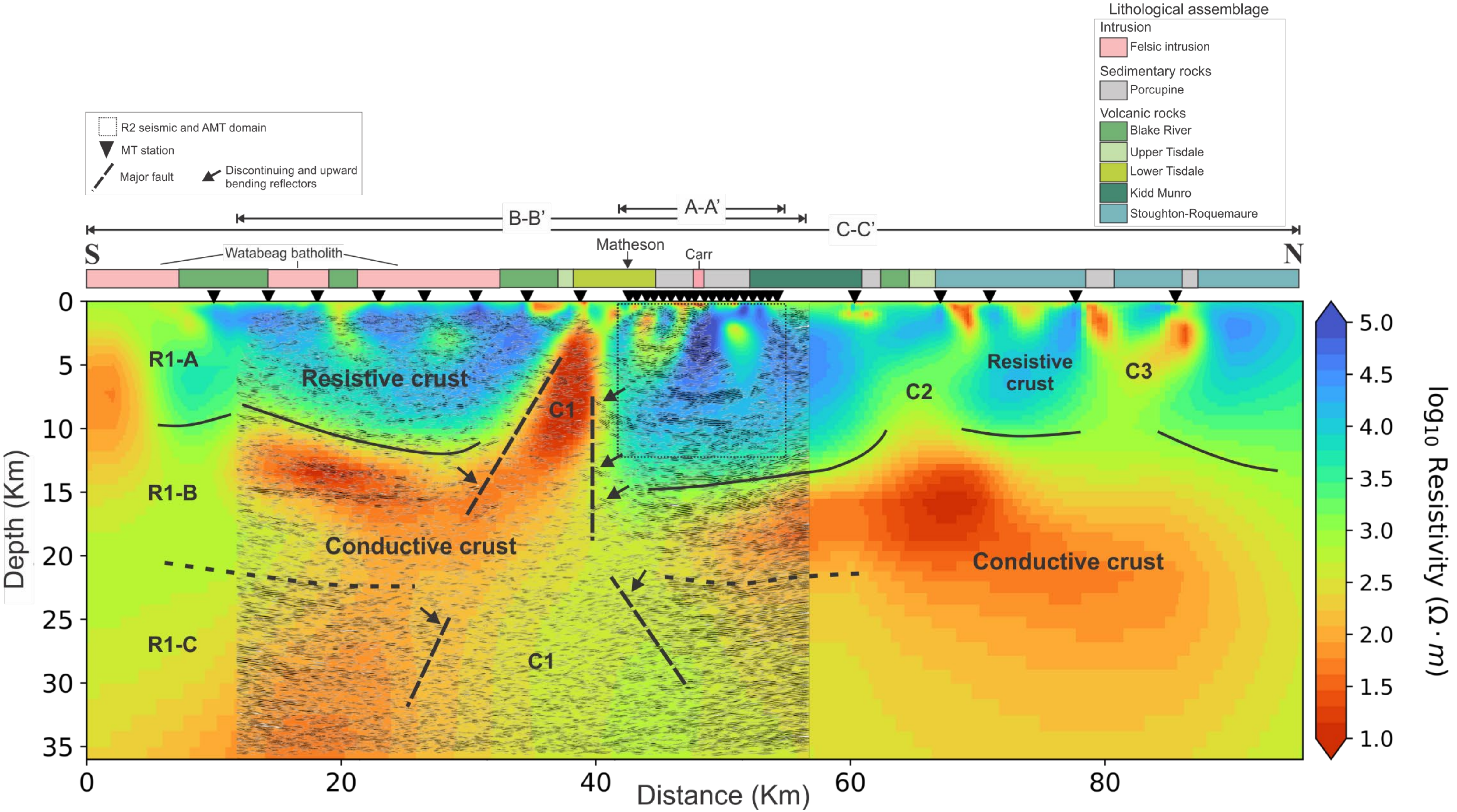
The Matheson Transect



Matheson - Full crustal seismic

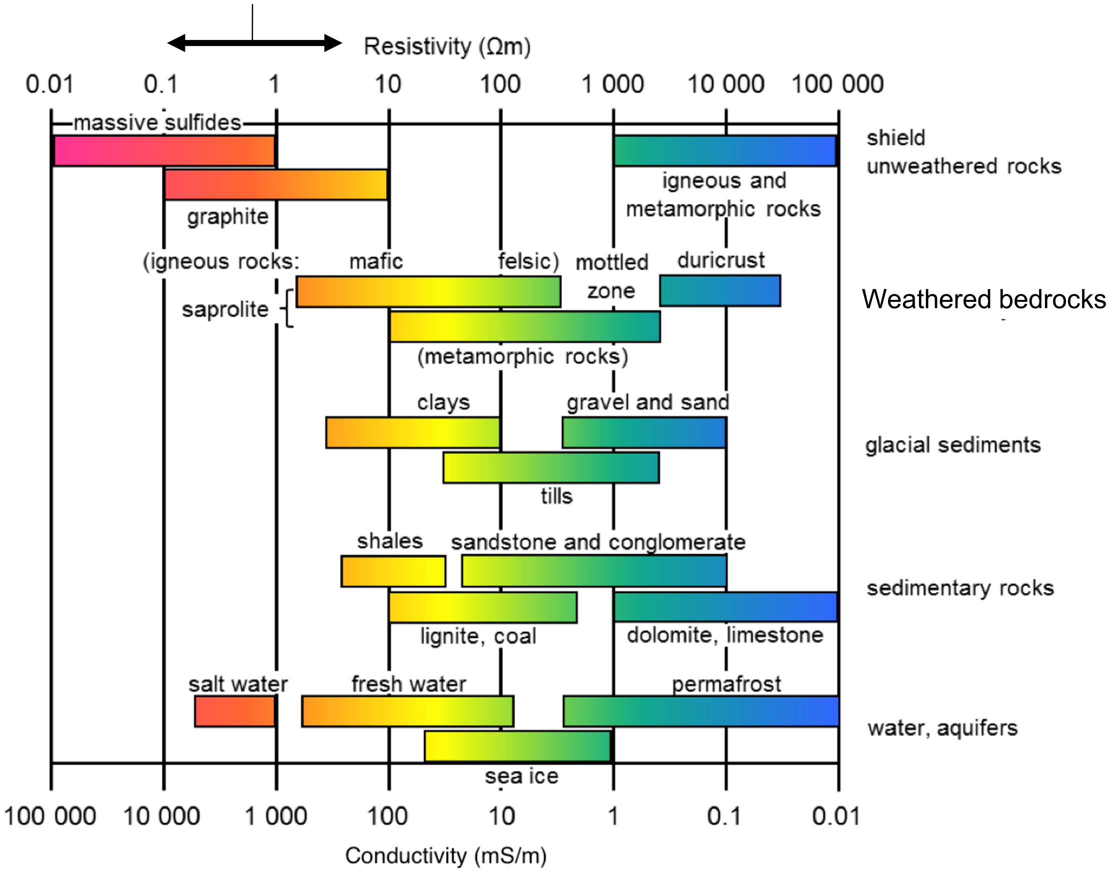


Matheson - Full crustal seismic and MT



Source of low resistivity in Archean crust

C1 feature (Matheson)

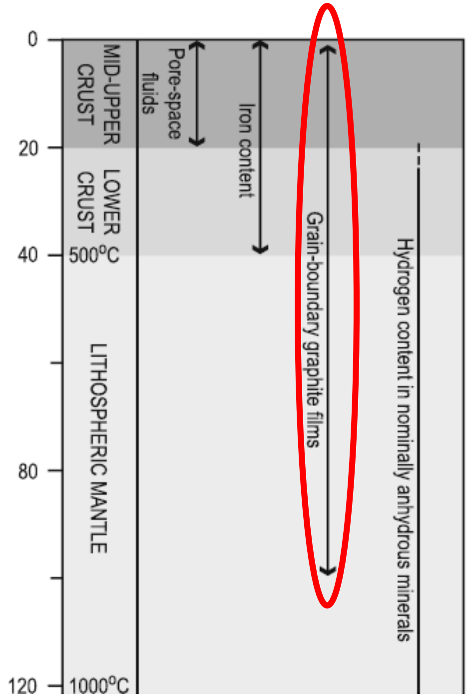


- Water/brines/melts?
- Sulfides?
- Graphite?

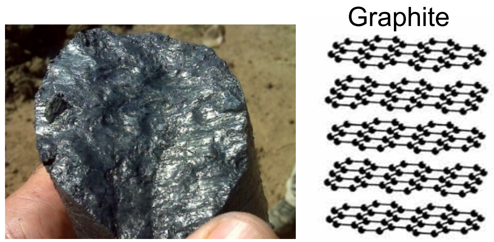
<u>Metamorphic graphite formation:</u>
Fluid-deposited graphite from carbon-bearing fluids such as CO_2, CH_4, and CO or mixtures of these. (*Mantle derived magmas + metamorphic derived fluids are CO_2-rich)

Stable to mantle depths

Grain boundary graphite films (5-50 nm) → **<u>solid</u>** and **<u>interconnected</u>** conductive phase (Mareschal et al. (1992).



(Selway, 2014)

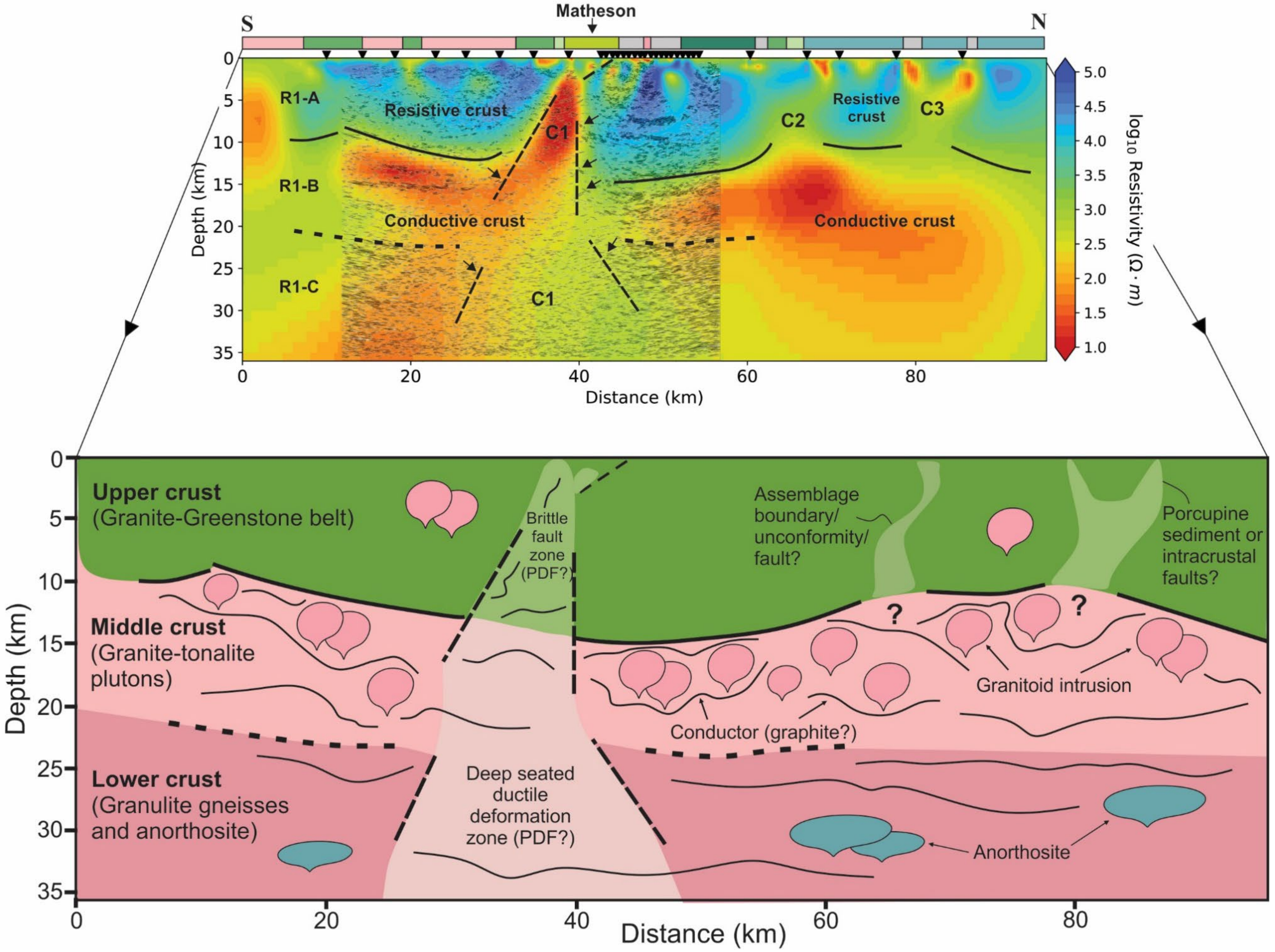


Grain-boundary graphite in Kapuskasing gneisses and implications for lower-crustal conductivity

Marianne Mareschal*, William S. Fyfe†, John Percival‡ & Tammy Chan†

NATURE · VOL 357 · 25 JUNE 1992

Matheson - Full crustal geology



- Does the C1 feature represent a regional first order crustal-scale fault?
- Is it part of the PDF and how are the PDF in Matheson linked to the C1 feature?
- Did the deep-rooted C1 feature focused and transported hydrothermal fluids into the PDF in Matheson?

Graphitization: a by-product of late-stage thermal events following craton stabilization?

Matheson - Summary

Upper crustal geology
- A ca. 30-40° southern dip of the Porcupine Destor Fault zone
- A steep northern dip of the Pipestone Fault
- A depth of the Porcupine basin of up to 2.2-2.6 km

Full crustal geology
- Conductive middle-to-lower crust and a resistive upper crust corresponding to the greenstone belt
- A deep-crustal conductive corridor connects the lower crust with the surface geology at the Upper Tisdale-Blake River boundary. This could indicate the existence of a deep-seated mineralizing system – Porcupine Destor Fault zone?
- The PSF have no crustal conductive corridor developed at the Porcupine/Kidd Munro contact, suggesting this fault are a less endowed crustal structure than the PDF

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