Targeting crustal fertility using Magnetotelluric and Seismic data in the Larder Lake area, Abitibi Gold District

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METAL EARTH

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

Presentation Outline

I. Gold endowment of the Southern Abitibi Greenstone Belt

ii. Regional and local geology framework of the Larder Lake area and previous models for the LLCDZ

iii. Part 1: New observations indicative of an early architecture for the LLCDZ

iv. Part 2: Geophysical interpretations and the association with gold deposits along the LLCDZ

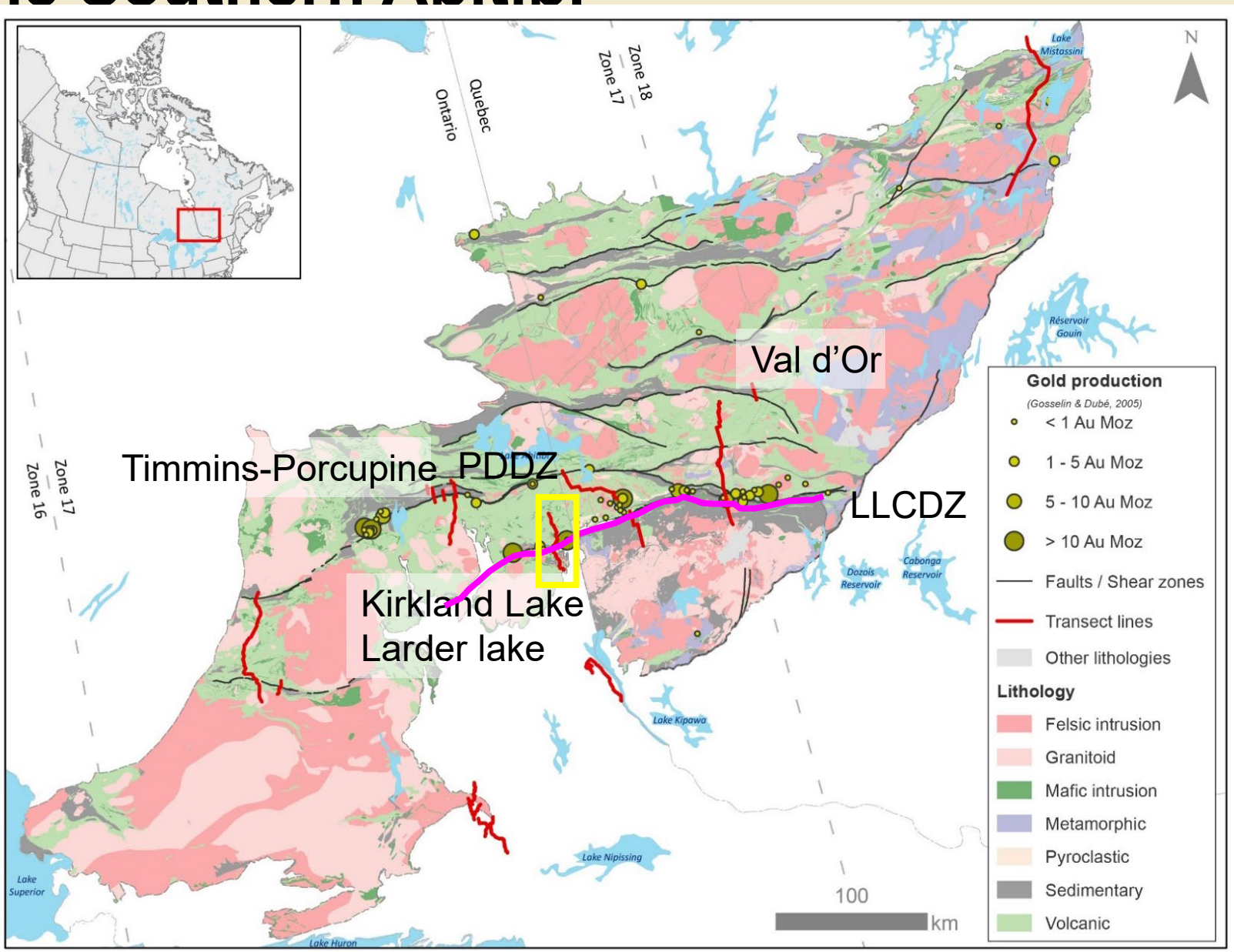
v. Part 3: Application of Seismic and MT to target crustal fertility – case study Australia

vi. Part 4: Implications for the LLCDZ and its gold deposits and metallogenic implications for SAGB

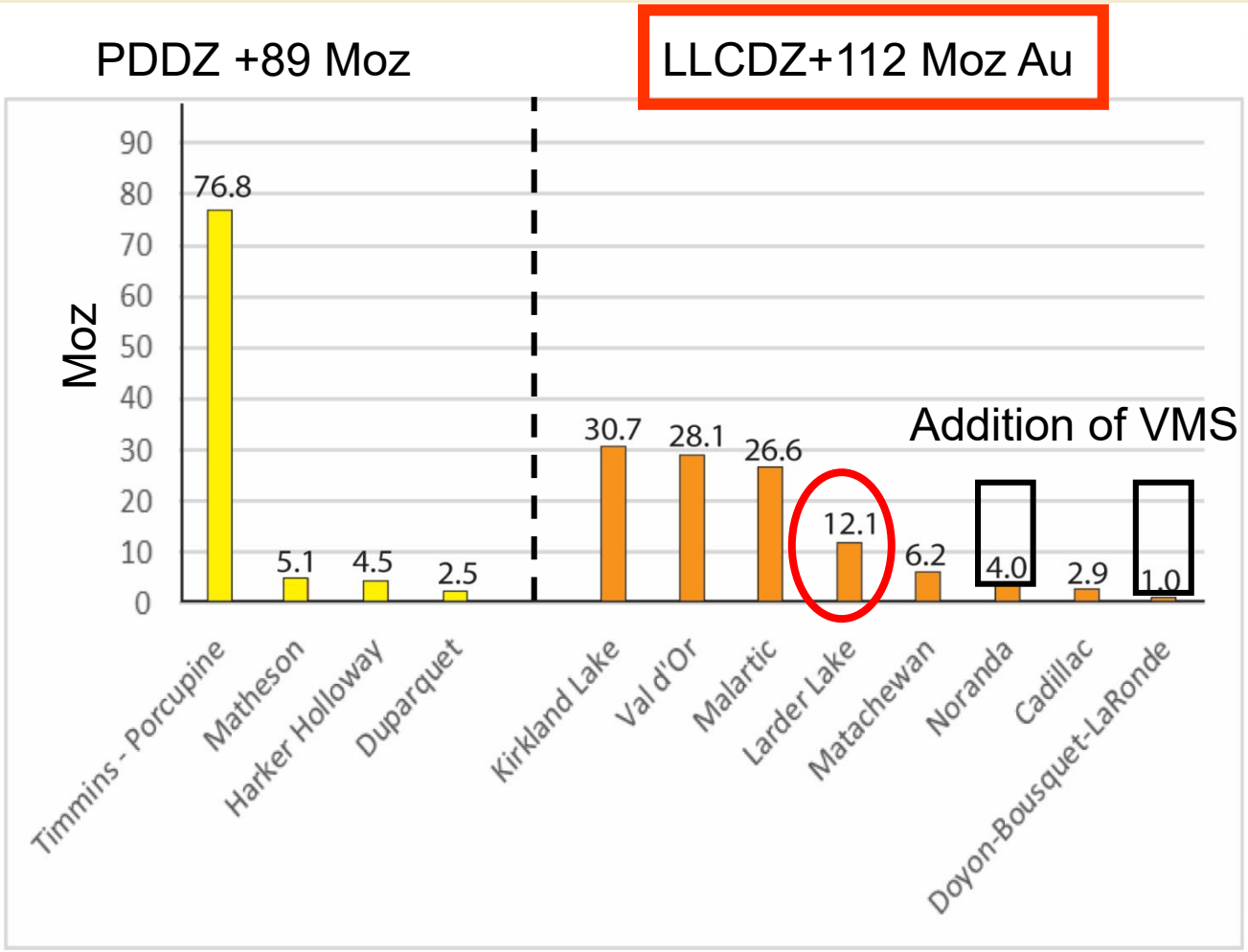
Gold endowment of the Southern Abitibi

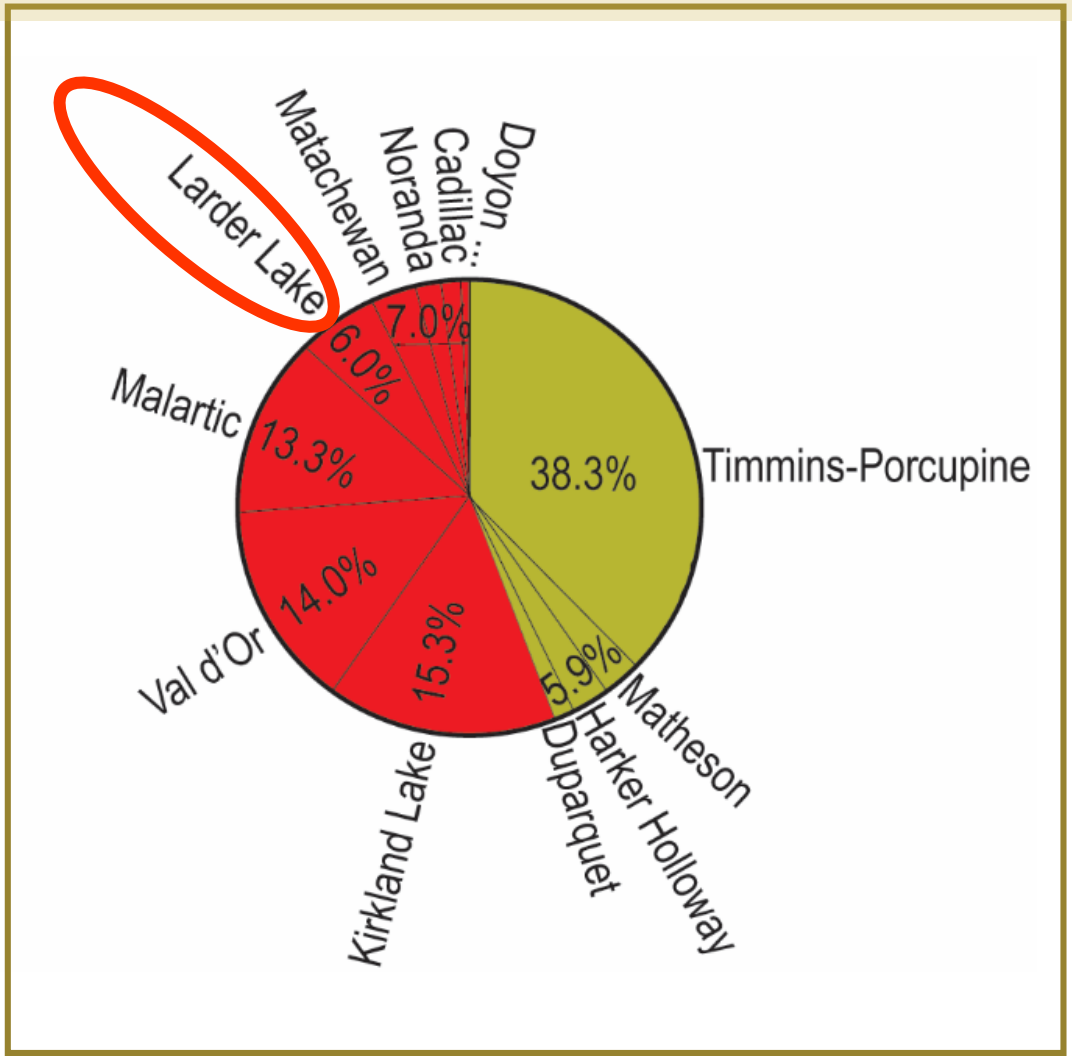
Association of major gold deposits and fault systems

Location of the Larder Lake Cadillac Deformation Zone
- associated with
>112 Moz of Au



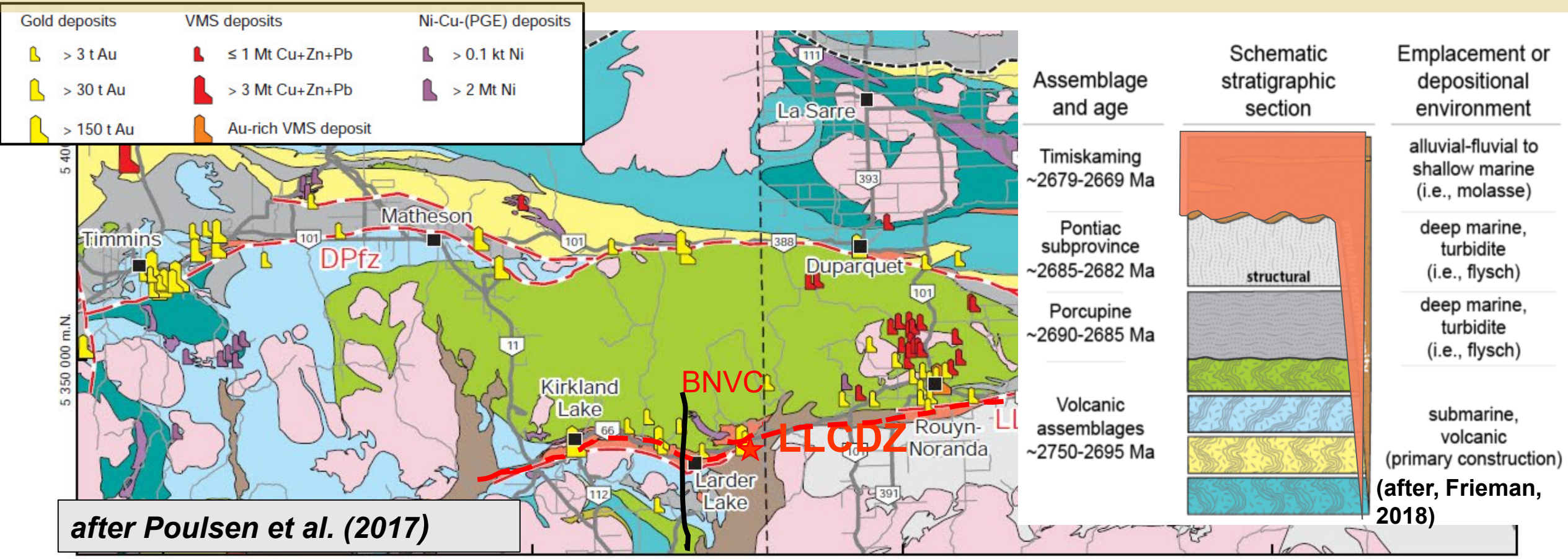
Gold Endowment associated with LLCDZ AND PDDZ





Monecke et al., 2017 Reviews in Economic Geology, v. 19

Part 2: Regional Geology of the Larder Lake area



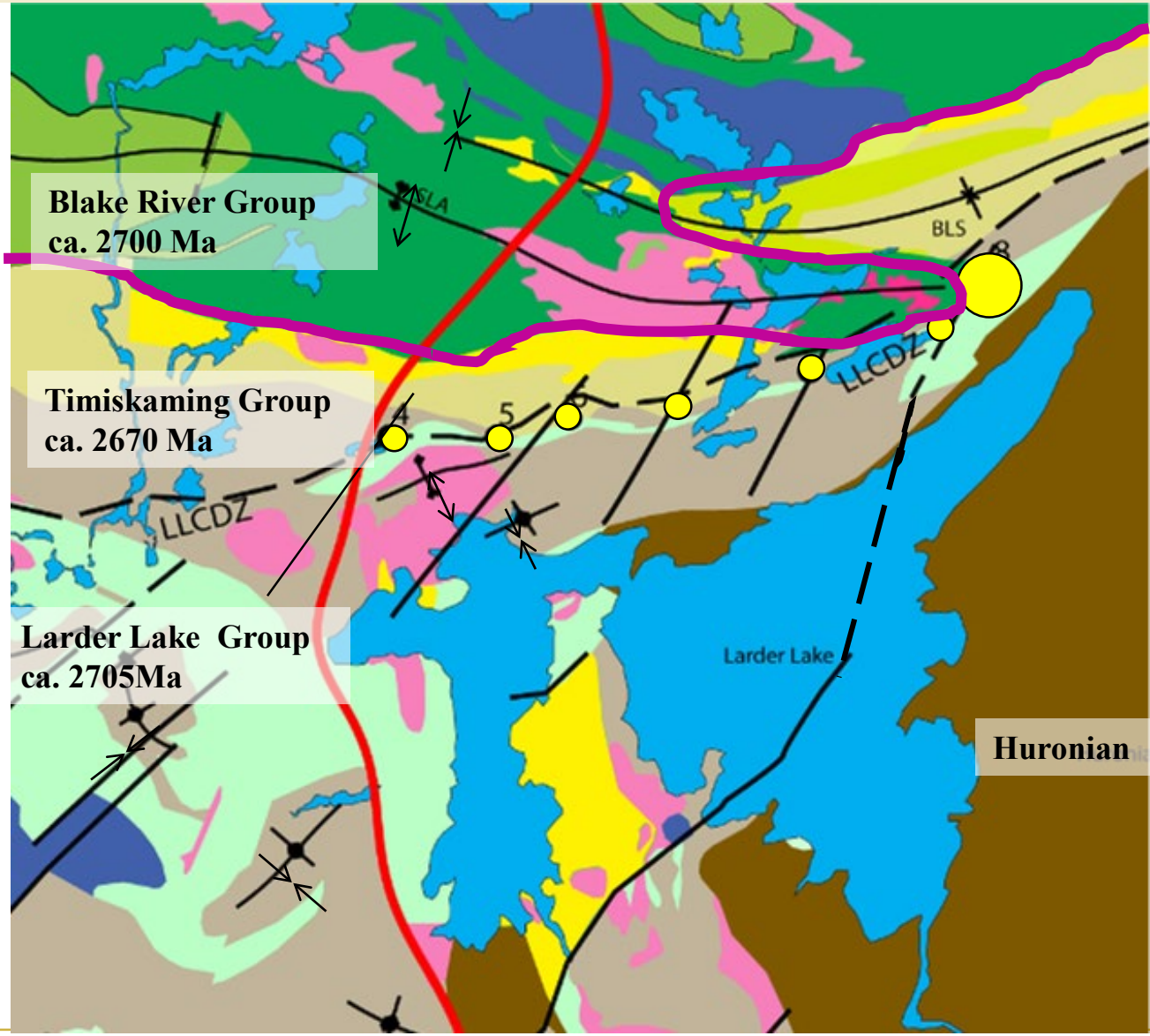
Regional Geology - Sequence of Deformational Events

- Early folding of the volcanic rocks of the Blake River Group pre-Timiskaming deposition
- Regional folding with axial planar foliation – the main regional foliation is intensified within the LLCDZ, where it becomes the foliation marking the deformation zone.
- Late dextral reactivation of the LLCDZ

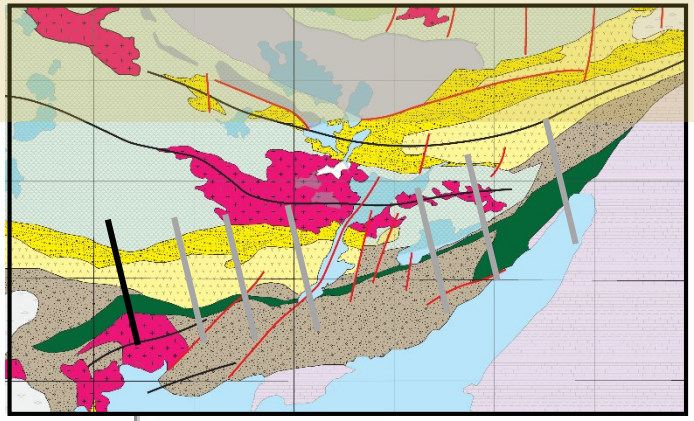
Local Geology of the Larder Lake area

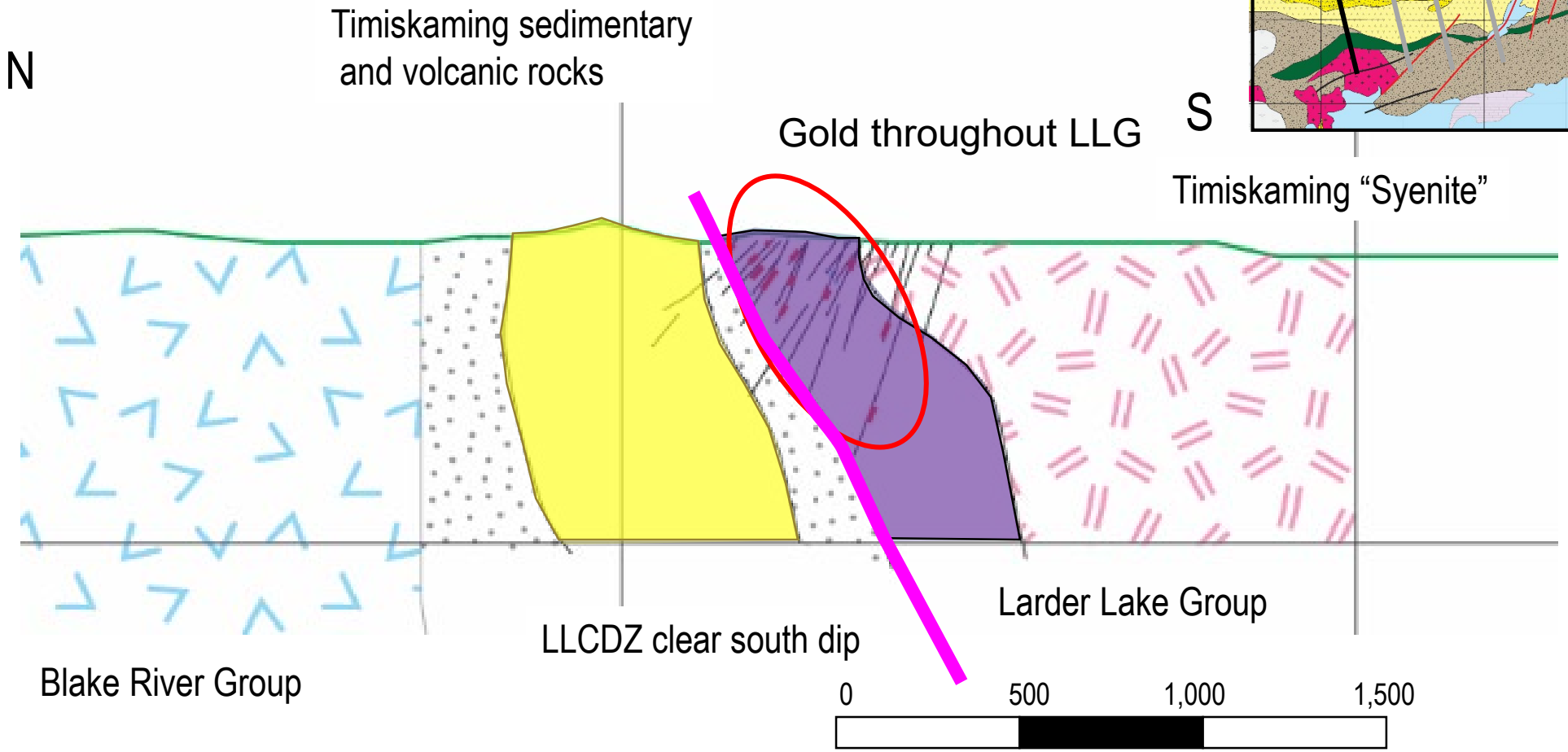
Location of gold deposits along the LLCDZ

- **Omega**
- Fernland
- Cheminis
- Bear Lake
- Barber Larder
- McGarry
- **Kerr Addison**



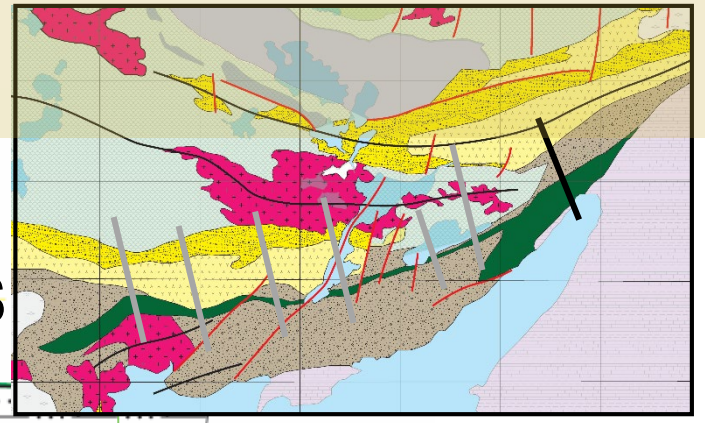
Omega Section Looking East





Ross Sherlock pers. comm 2021

Kerr-Addison Section Looking East



N

S

Gold mainly near contact
Also in FW

Prot. Huronian
Sedimentary Rocks

Timiskaming
sedimentary rocks

Timiskaming
sedimentary rocks

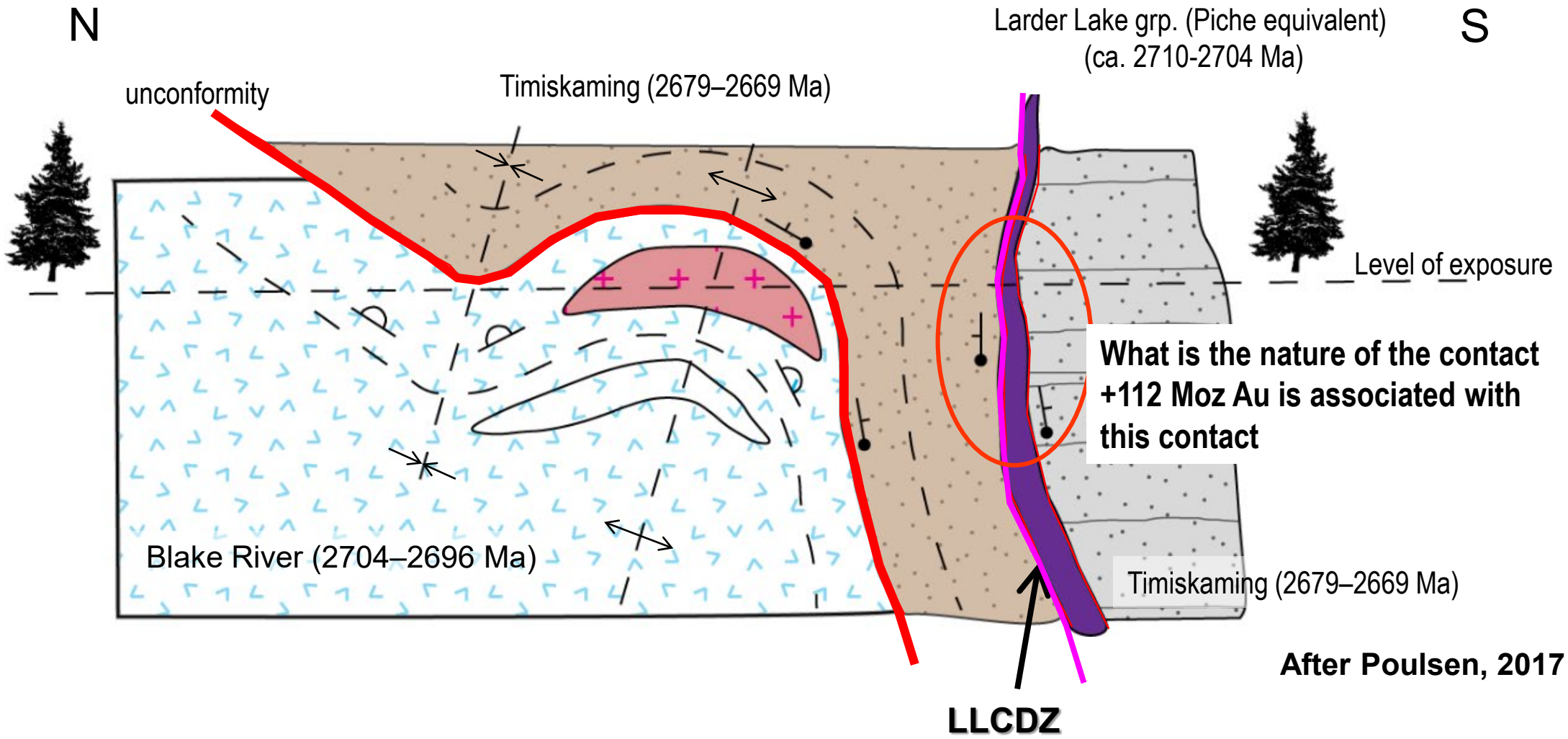
Larder Lake grp.

Ross Sherlock pers. comm 2021

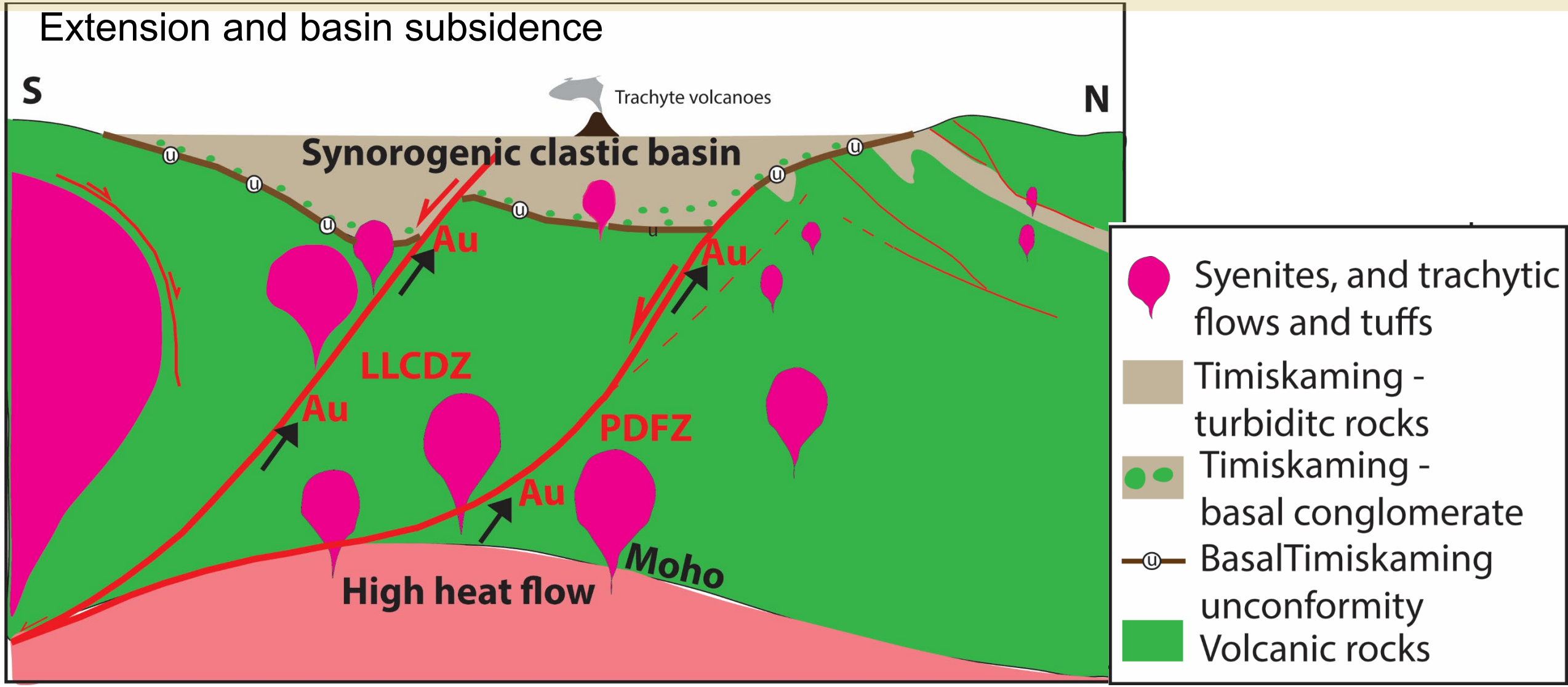
CLLDZ north dip, very planar

0 500 1,000 1,500

Schematic cross section through the LLCDZ



Previous model

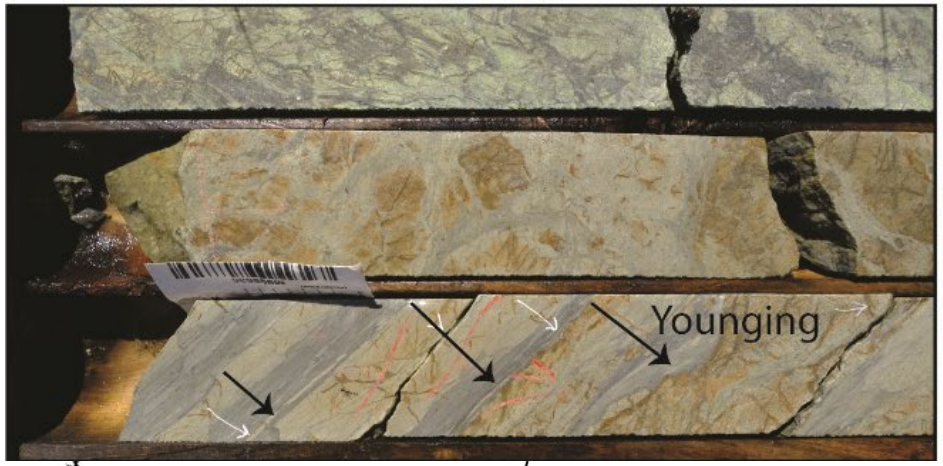


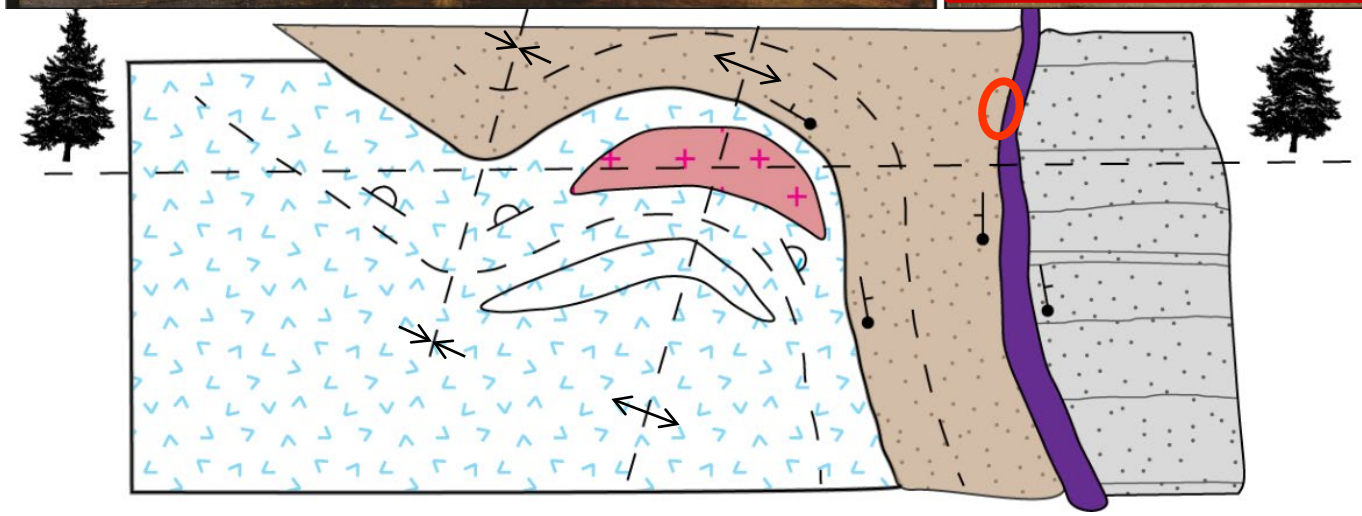
Modified after Cameron 1993, Bleeker, 2012

Part 1: Larder Lake Cadillac deformation Zone

Strongly deformed Timiskaming sedimentary rocks in contact with Larder Lake group ultramafic rocks

Larder Lake group





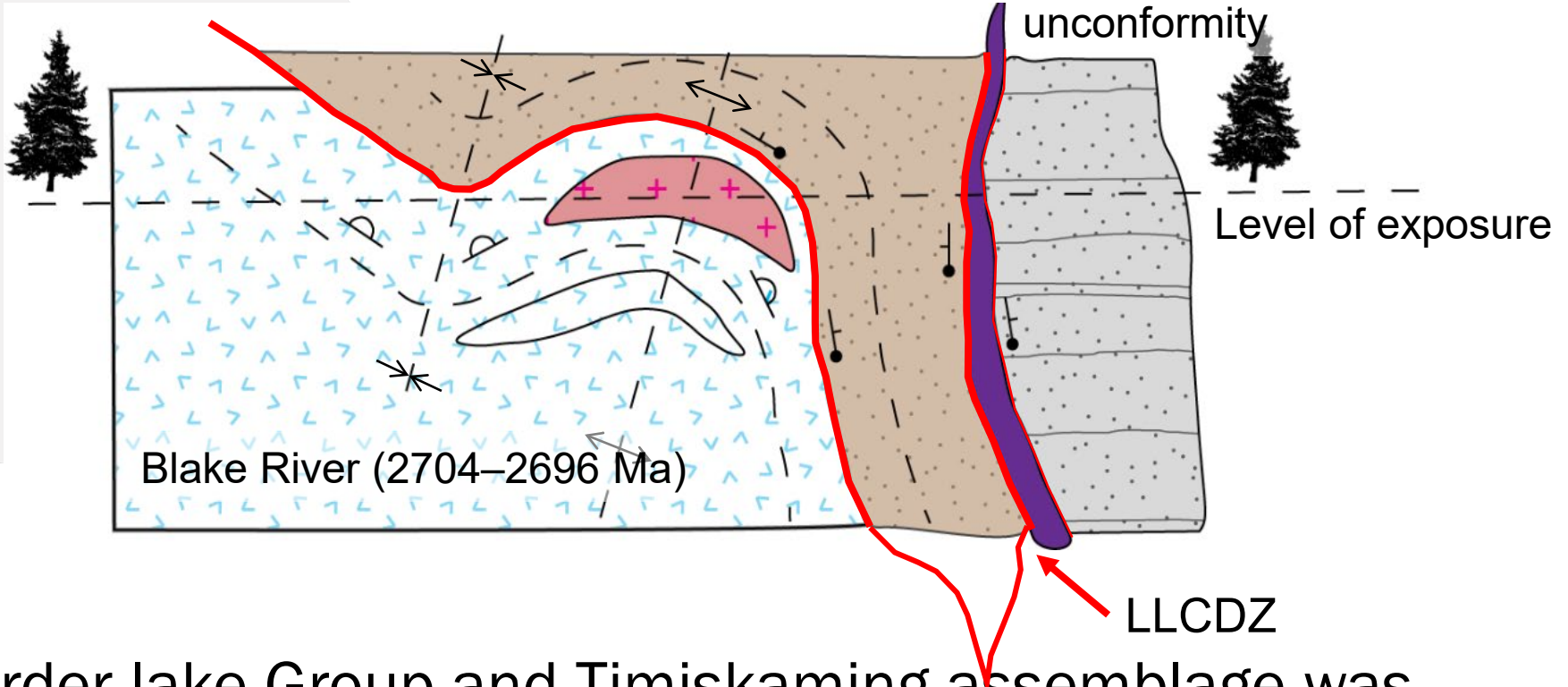
Drill core across the N contact at Cheminis

Presents as an unconformity

Modified by subsequent deformation

Photos from Nadia St-Jean MSc thesis 2020

Conclusions Part 1



- Contact between Larder lake Group and Timiskaming assemblage was initially an unconformity on northern contact.
- LLCDZ – structural juxtaposition between the Blake River and Larder Lake groups.
- Modified by several deformation events.

Nadia St-Jean MSc thesis 2020

Part 2: Metal Earth Geophysical data

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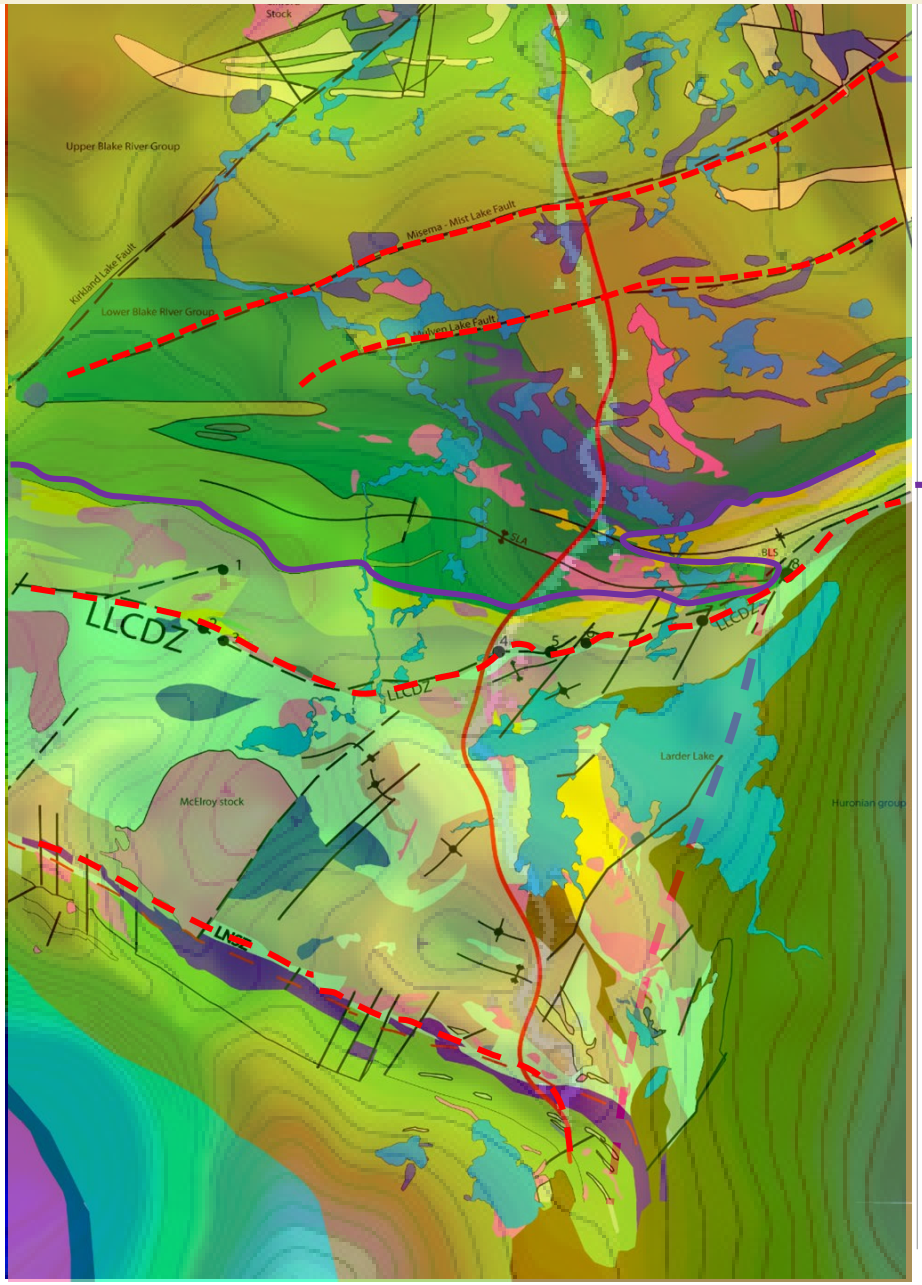
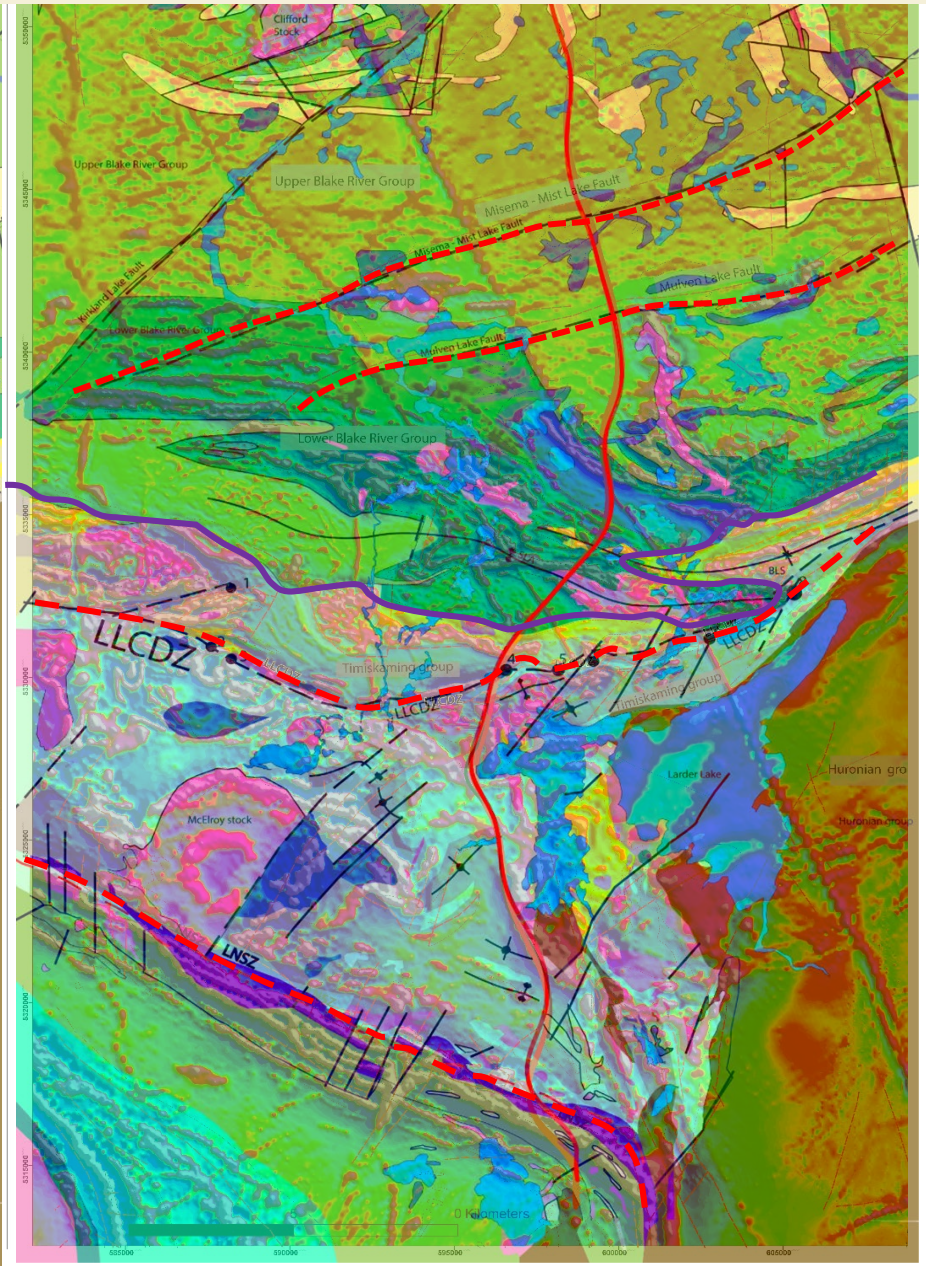
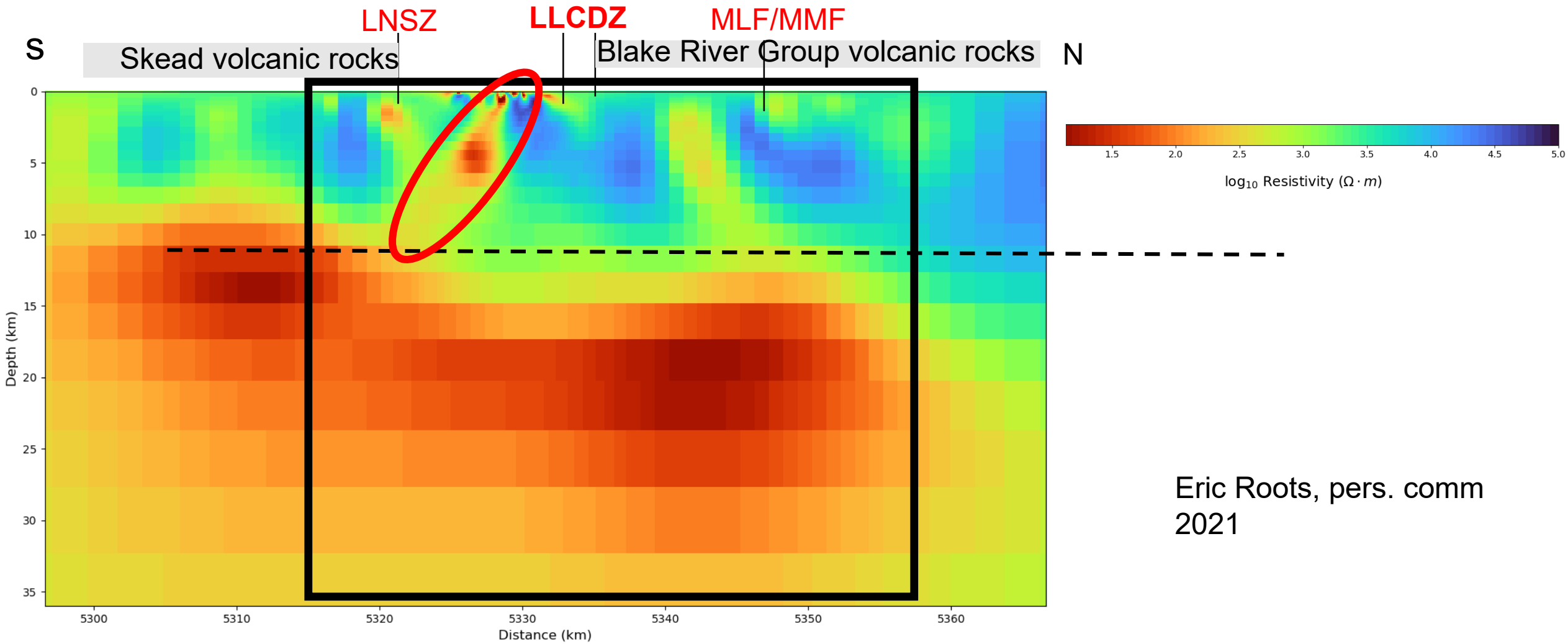
- Timiskaming Assemblage
- Porcupine Assemblage
- Upper Blake River Group
- Lower Blake River Group
- Larder Lake Group(Tisdale
- Stoughton - Roquemaure
- Pacaud



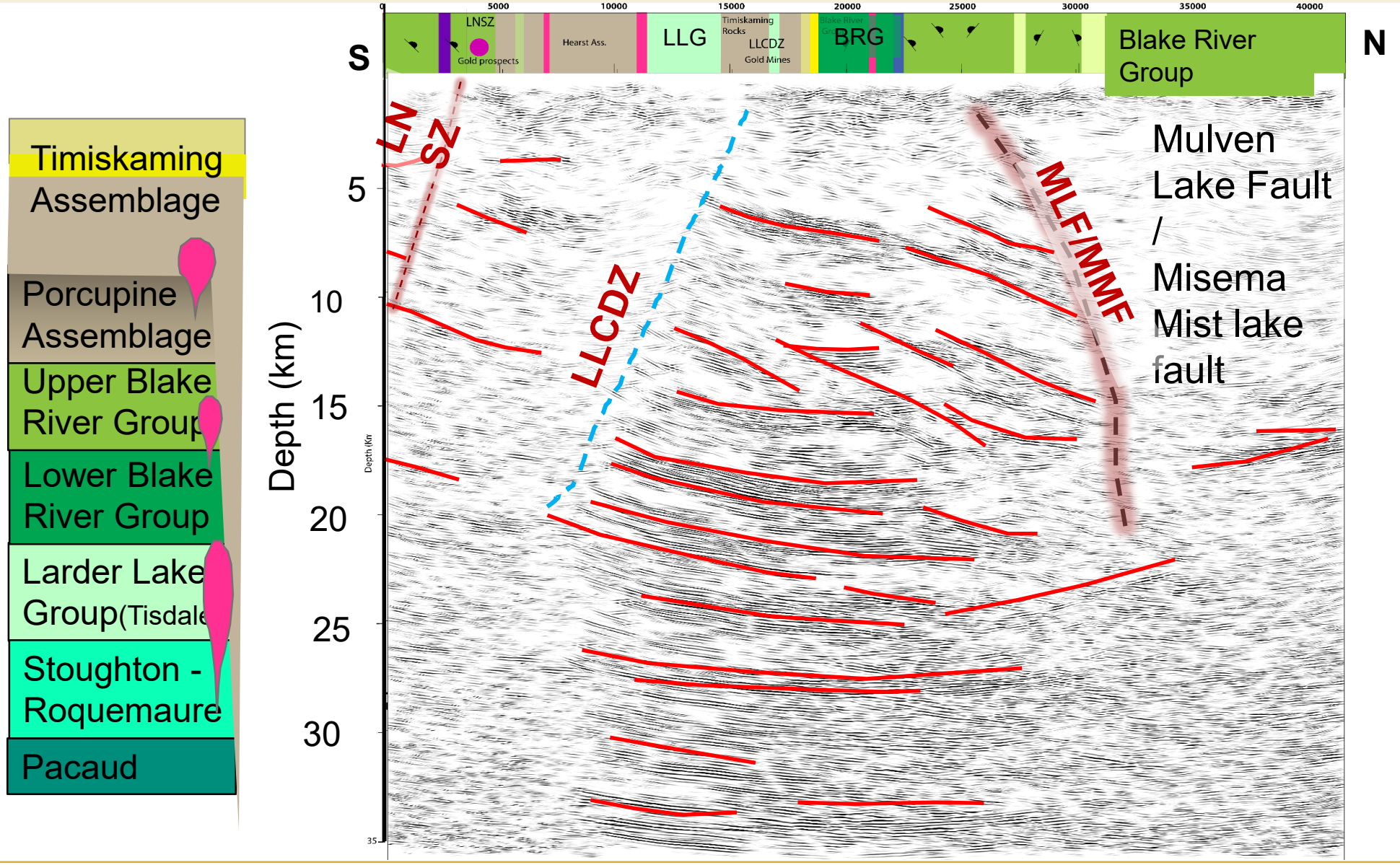


Metal Earth Magnetotelluric (MT) and (AMT) section, 3D inversion

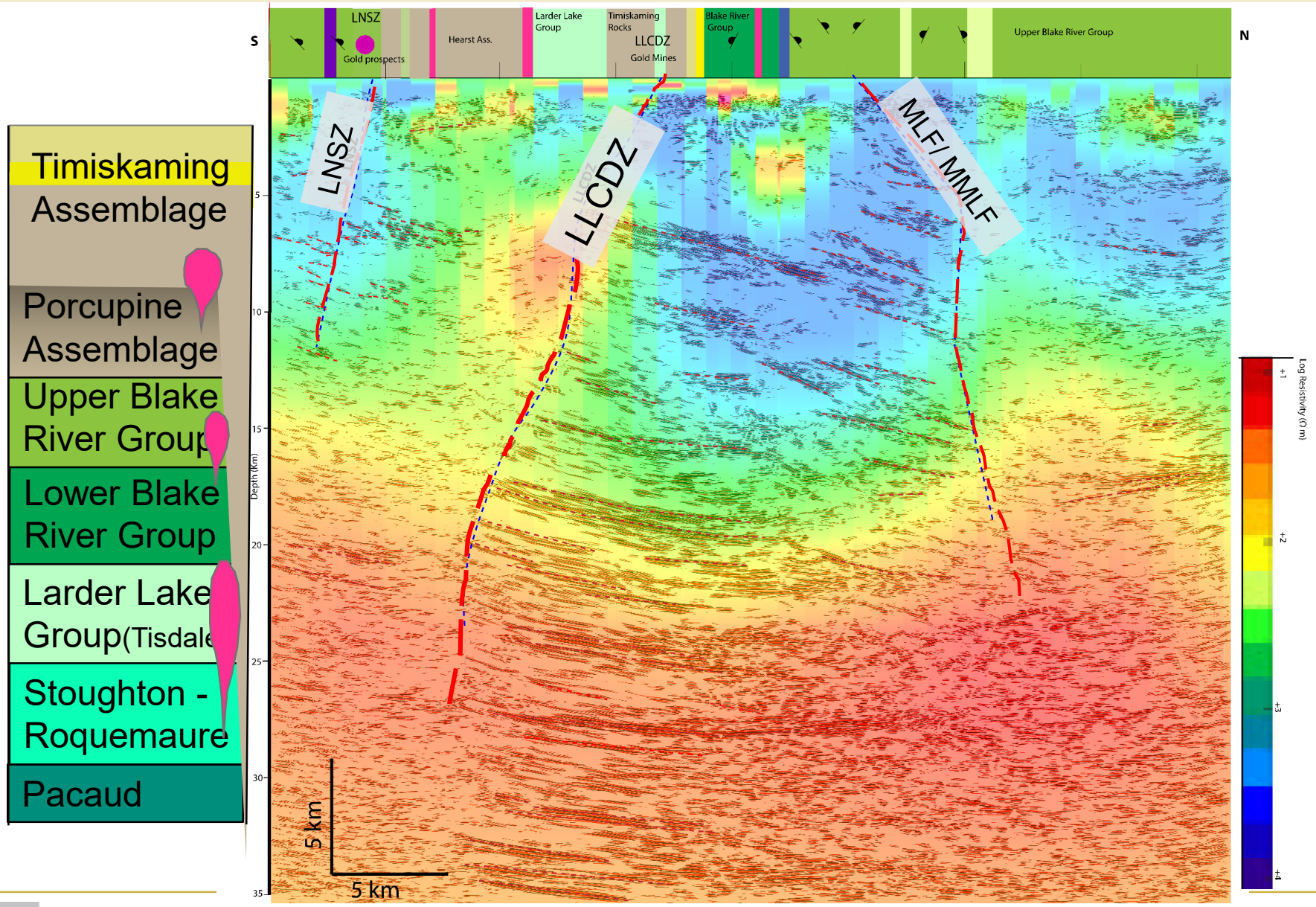


Eric Roots, pers. comm 2021

Metal Earth Seismic data



Metal Earth – Magnetotelluric and Seismic data

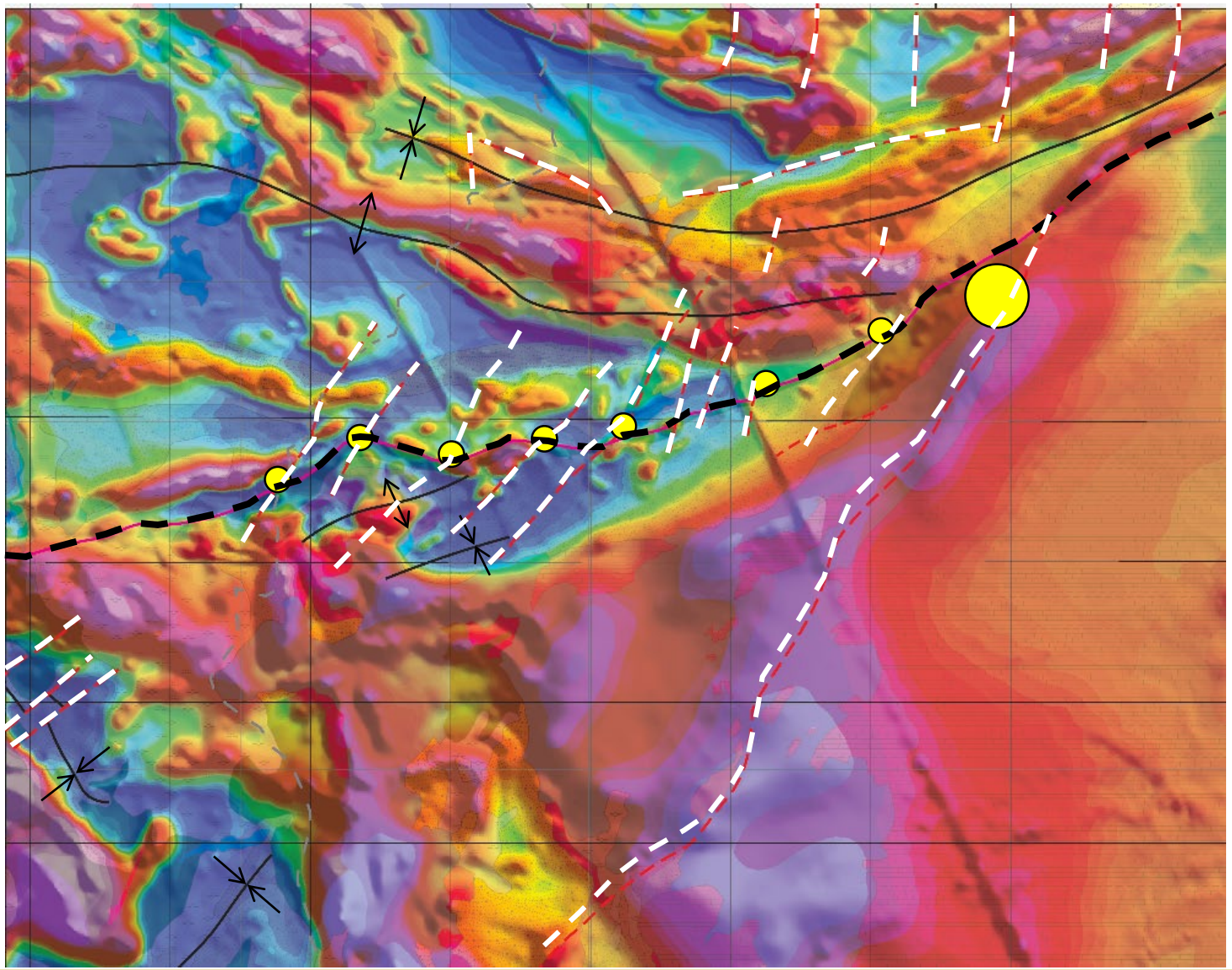


Eric Roots, pers. comm 2020

Comparison of the main faults of the Larder Lake area

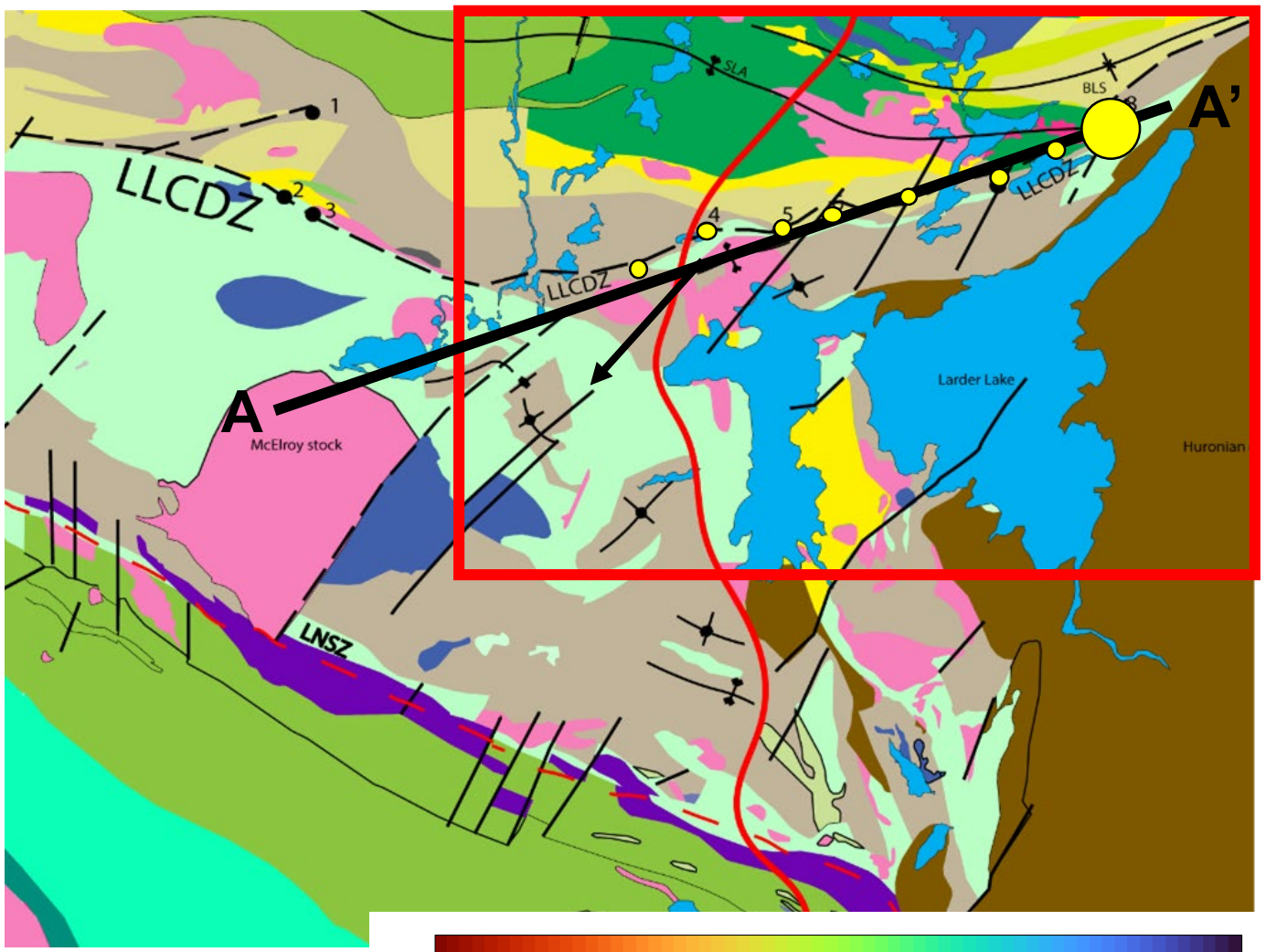
- **LLCDZ –** depth extent + 25km, highest conductivity response extends to surface, and connects into lower crust / mantle.
  - associated with surface expression - strong carbonate alteration, potassic alteration and large gold deposits (11Moz Kerr Addison)
- **LNSZ** depth extent- approx. 12km, weak conductive response
  - similar alteration to main LLCDZ and associated with numerous gold prospects and similar alteration.
- **MLF / MMF -** extension to >20km. Weak conductive response.
  - minimal carbonate alteration, quartz veins, localized mineralized occurrences, and lack of extensive alkaline intrusions

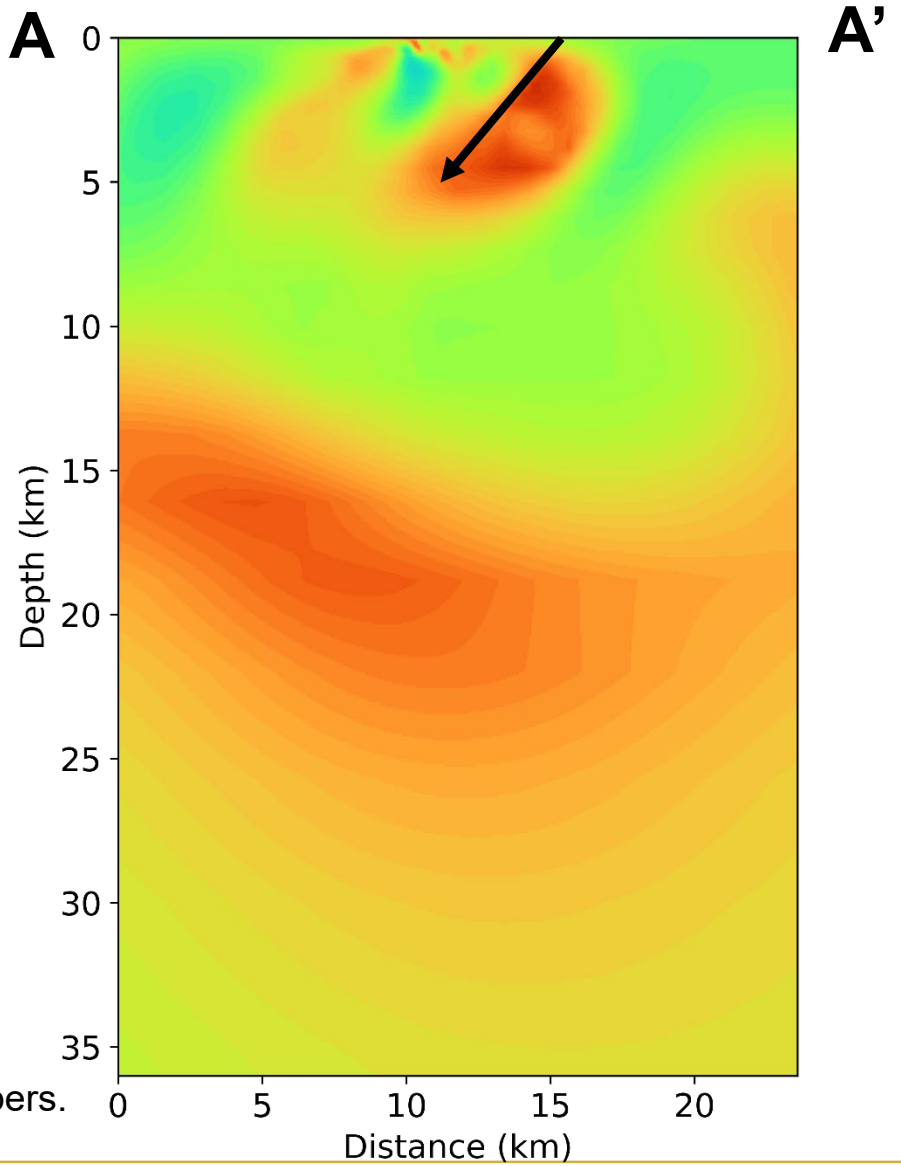
Intersection of LLCDZ and NE faults localizes Au deposits



Intersection of LLCDZ
And NE faults localizes
deposits

MT long section through conductivity anomaly





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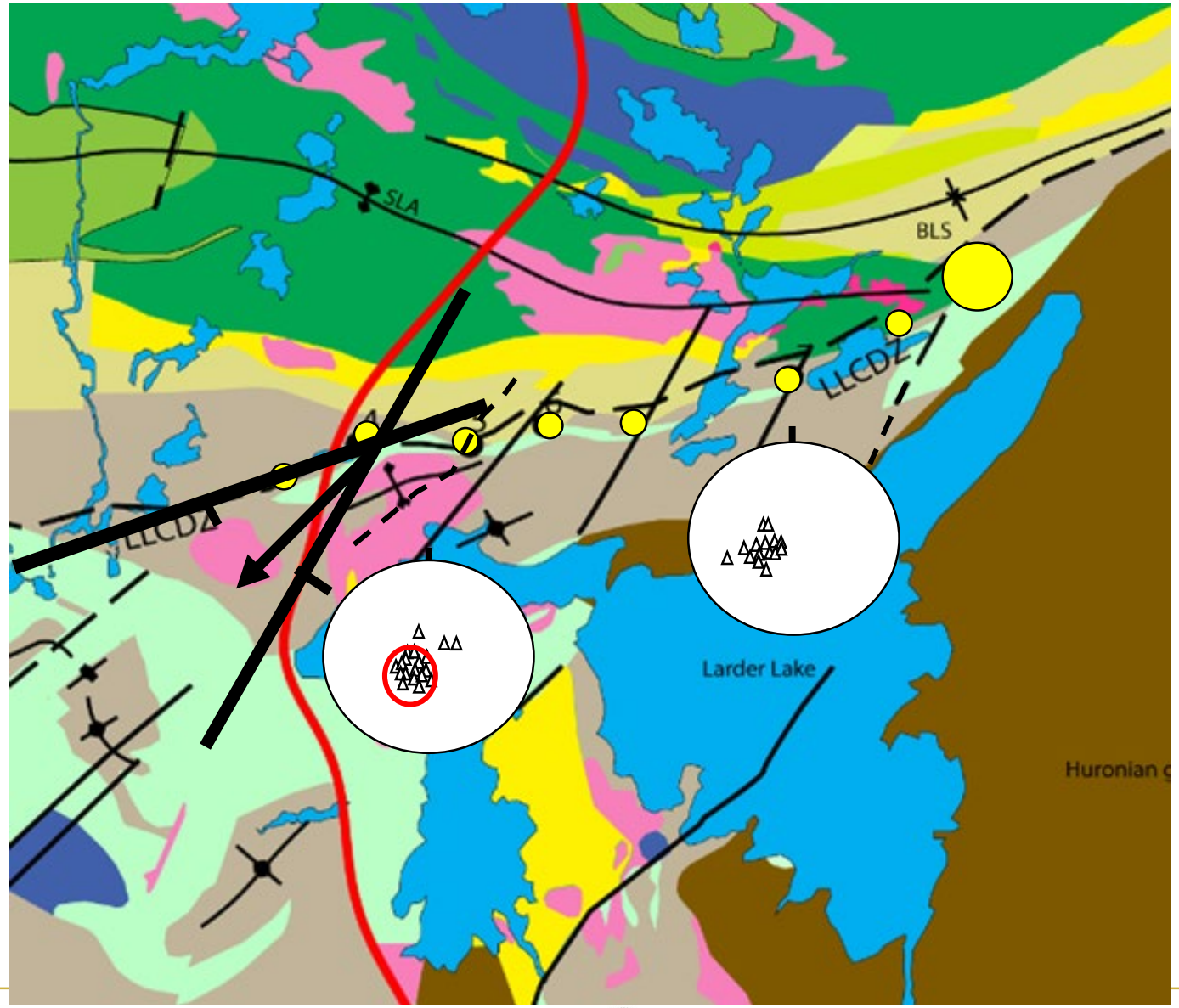
MT anomaly and the intersection of NE faults and the LLCDZ

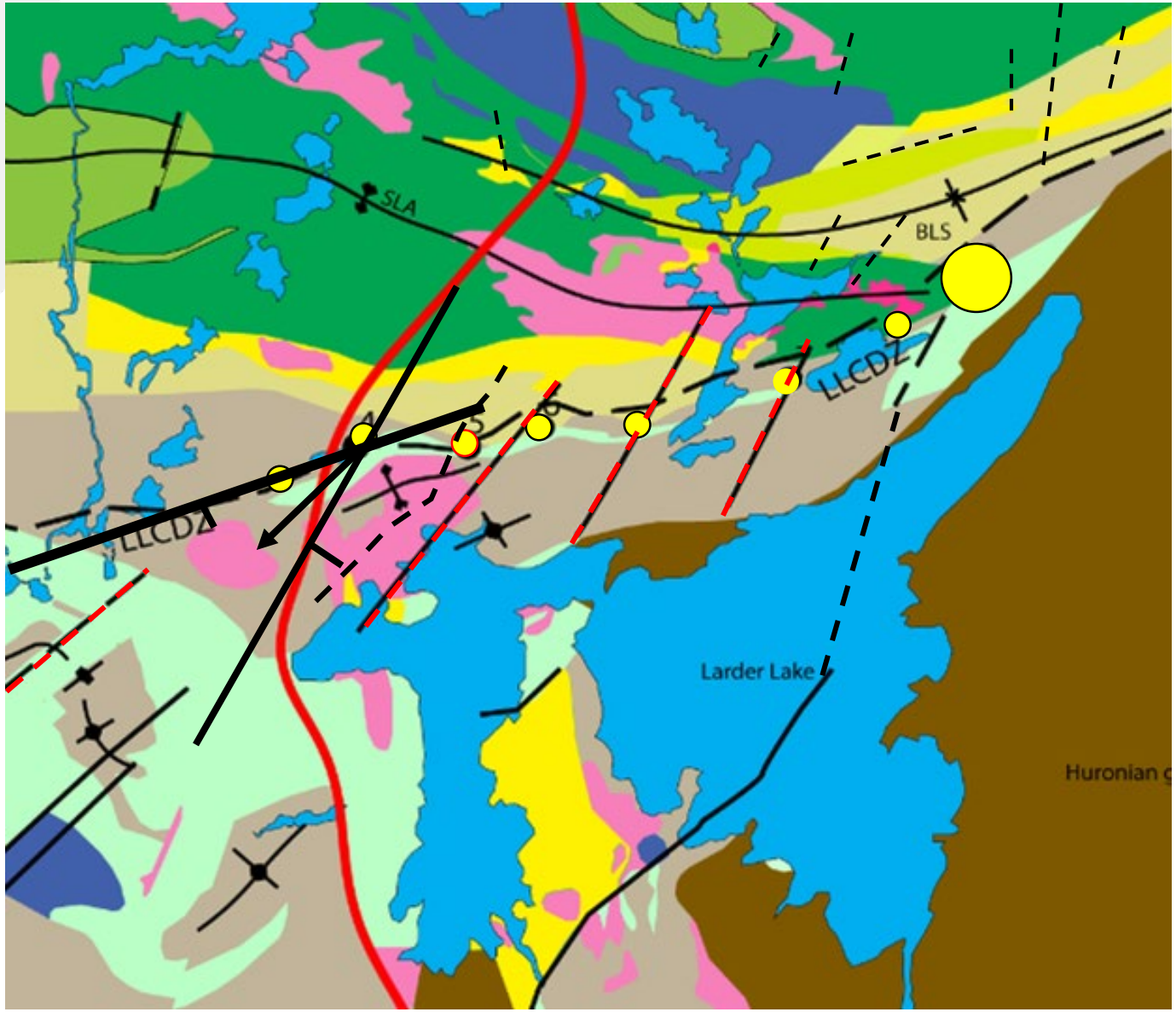


- MT Long section
- Linear MT body
- trends ~220°
- Plunges ~45°
- Intersection of steep S dipping LLCDZ and NE faults with a steep SE dip

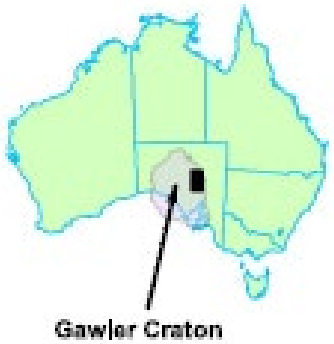
Conclusions
Part 2

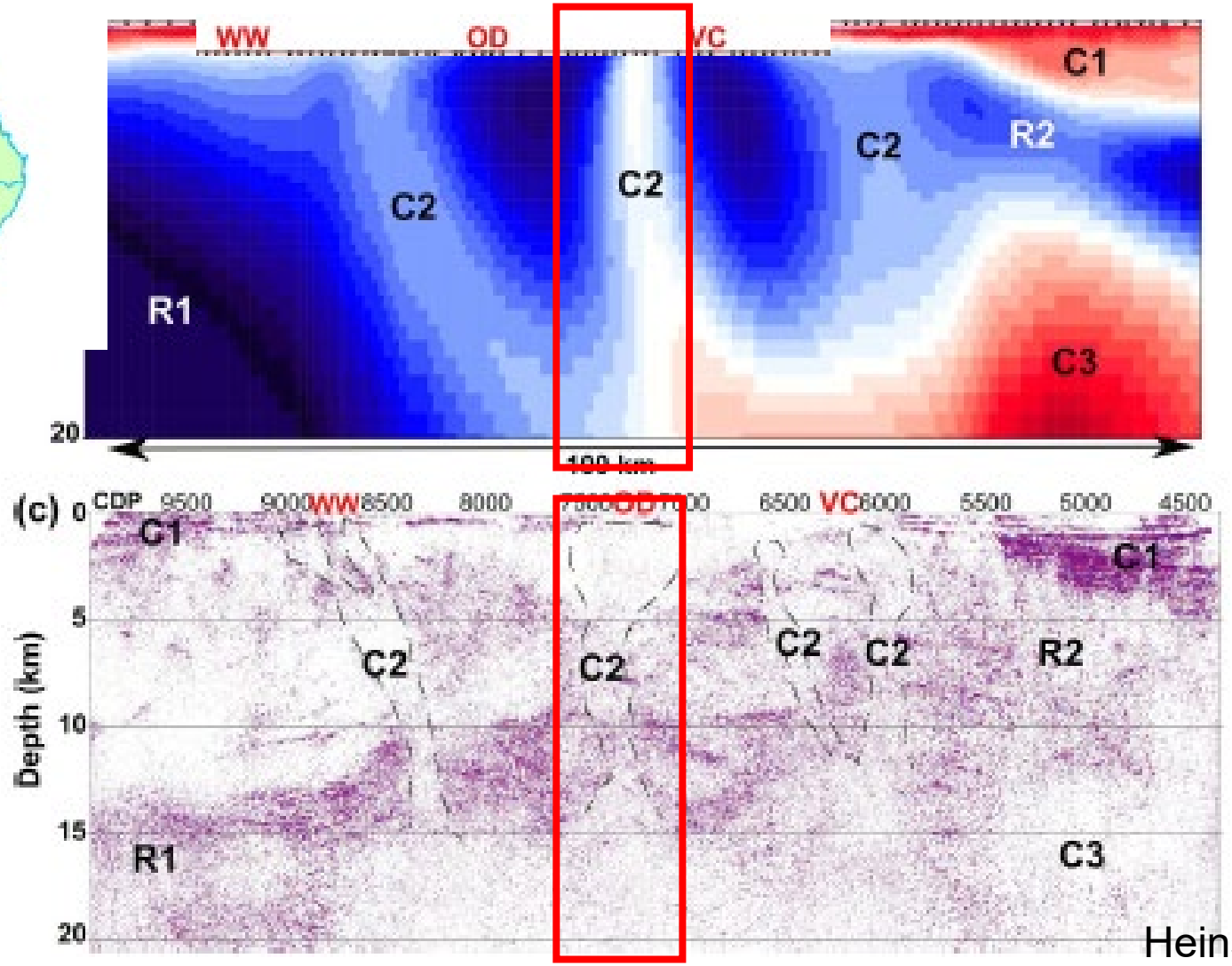
Implications for gold mineralization

- Distinct conductivity contrast
- Interpret as alteration
- Late NE faults are these reactivated early faults?
- These early faults are potentially reactivated extensional faults associated with the Timiskaming basin.



Part 3: Application of Seismic and MT to target crustal fertility – case study Olympic Dam, Australia

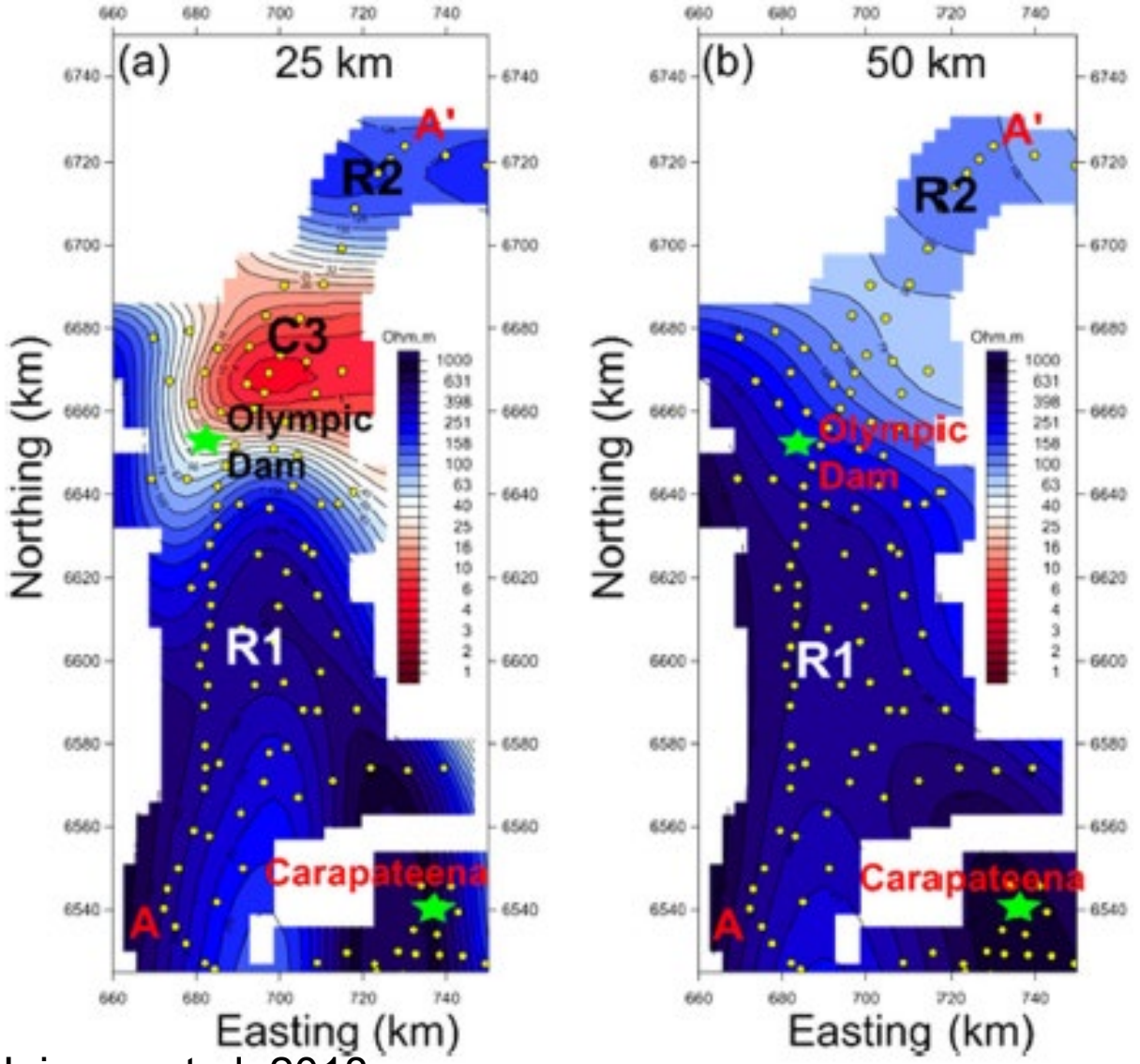




- Combination of MT and Seismic defines metalliferous fluid pathways from mantle to crust.
- Highly conductive domains correlate with significant mineral occurrences.
- Spatially correlates with seismic data and low reflective domains.

Heinson et al. 2018

Application of MT data



Heinson et al. 2018

- Conductive zones correlate with connectivity of fluids with uppermost mantle
- High conductivity zones in other regions also attributed to:-
  - Formation of sulfides along the grain boundaries of minerals
  - Higher iron content
  - Grain boundary graphite films

Conclusions
Part 3

- Application of MT and seismic reflective studies at Olympic Dam delineates subvertical highly conductive conduits which extend continuously throughout the crust to depths > 20km acting as pathways for metalliferous fluids.
- Correlate with known ore deposits at surface.
- Such application can be used to re-evaluate mining camps and target potential fertile domains that are unexplored.

Part 3: Conclusions – and metallogenic implications

Geophysical surveys reflect fault zones of significant alteration and mineralization

- Fertile, highly endowed faults manifest themselves geophysically as large through going features, that separate domains with distinct physical properties.
- Strong conductive response and termination of horizontal seismic reflectivity is correlative with the LLCDZ.
- MT models show a distinct contrast in the structural hanging wall of the fertile systems and demonstrate the importance of NE structures along the fault.
- LLCDZ is a planar late fault that likely rotates on a horizontal axis.

Part 3: Conclusions – and metallogenic implications

Nature of the LLCDZ

LLCDZ acted as a plane of anisotropy, that localized the development of the fault, the migration of hydrothermal fluids and gold mineralization. However new field and geophysical data implies an early ancestral fault and a series of NE faults which control the distribution of gold mineralization along the LLCDZ.

- Implications of this new model interprets the ancestral LLCDZ as the structural juxtaposition between the Blake River and the Larder Lake group.
- This ancestral fault acted as the basement for the development of the Timiskaming basin.
- Implied early history of NE faults that intersect the LLCDZ and control the localization of the deposits, which is reflected in the geophysical expression.

Thank you!

Special thanks to

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