

Crustal architecture of the Larder Lake area, controls on gold mineralization along the Cadillac Larder Lake deformation zone.



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



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MERC
Mineral Exploration Research Centre

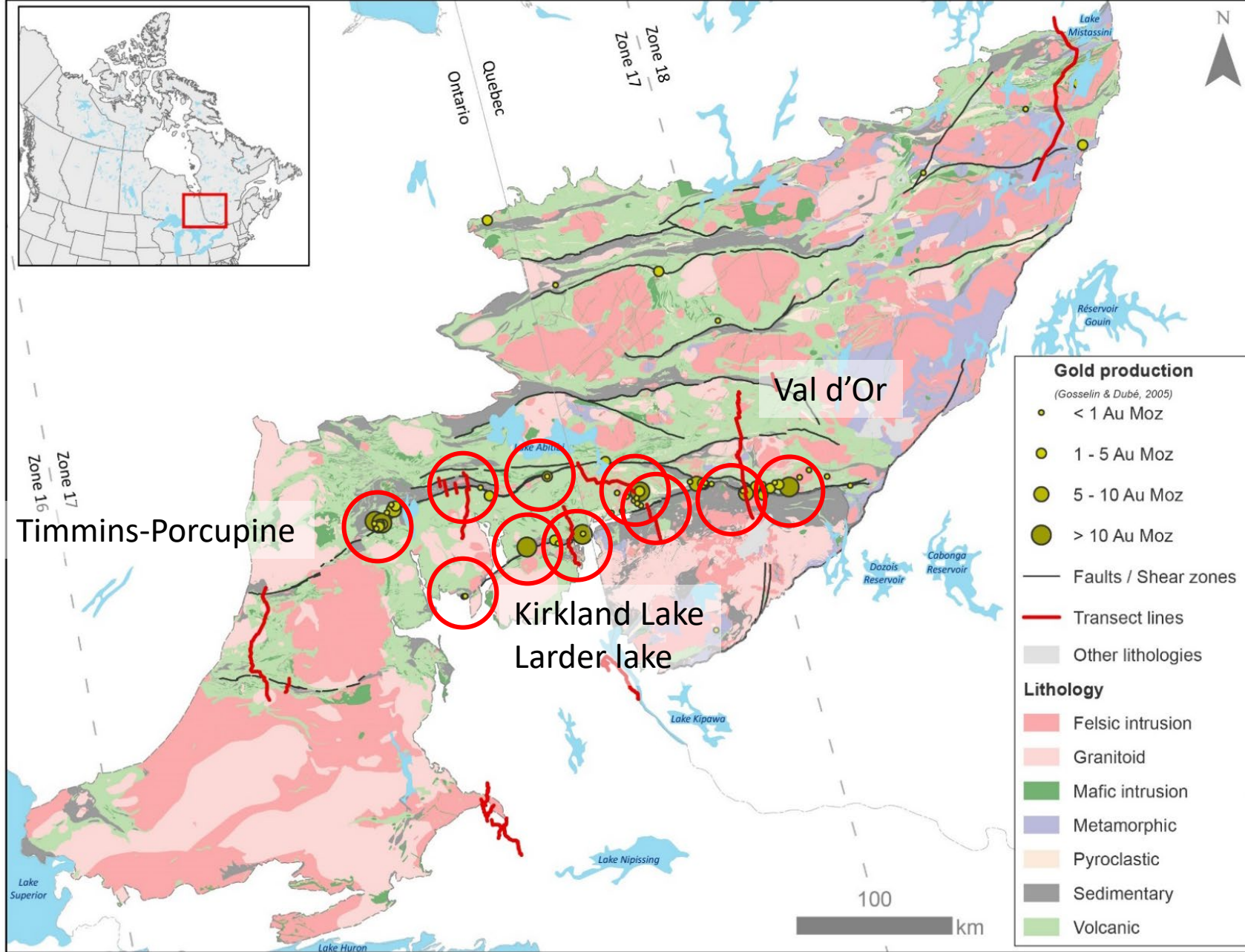
Outline

- Metal Endowment in the Abitibi
- Larder Lake Geology
- Examination of the Cadillac-Larder Lake Deformation Zone
- Kerr Addison, geology, alteration and styles of mineralization
- Lincoln Nipissing zone geology / similarities with the Cadillac-Larder Lake Deformation Zone
- Geophysical surveys, seismic and MT/AMT
- Expressions of various fault systems geophysically and mapping of fertile structures.
- Application to other regions

Gold Endowment

Southern Abitibi

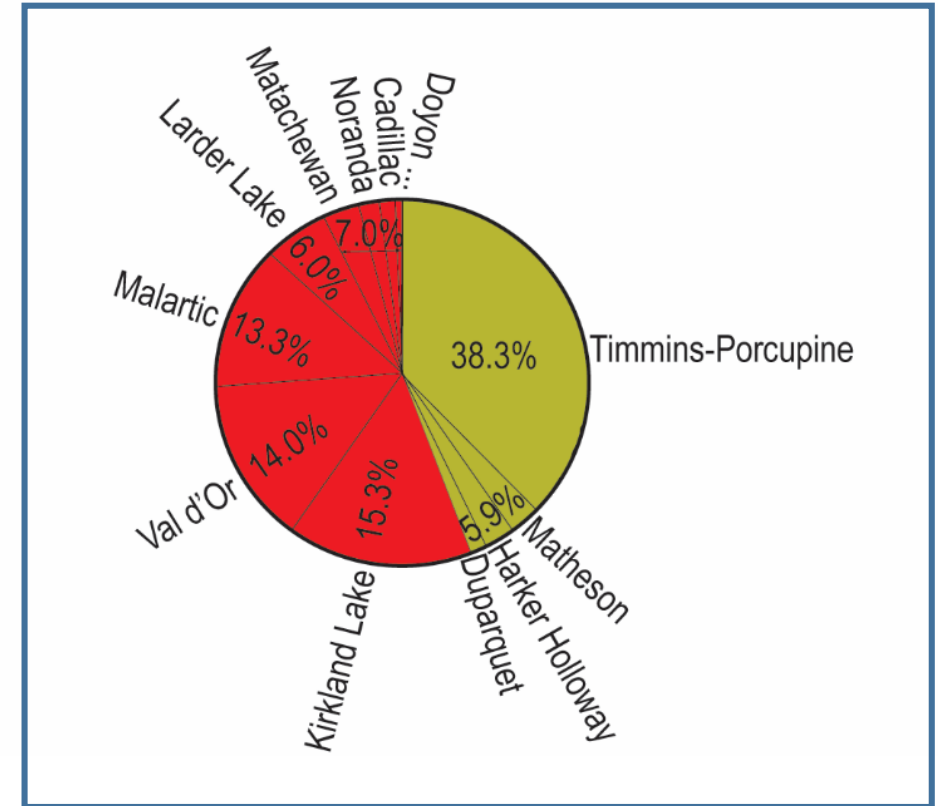
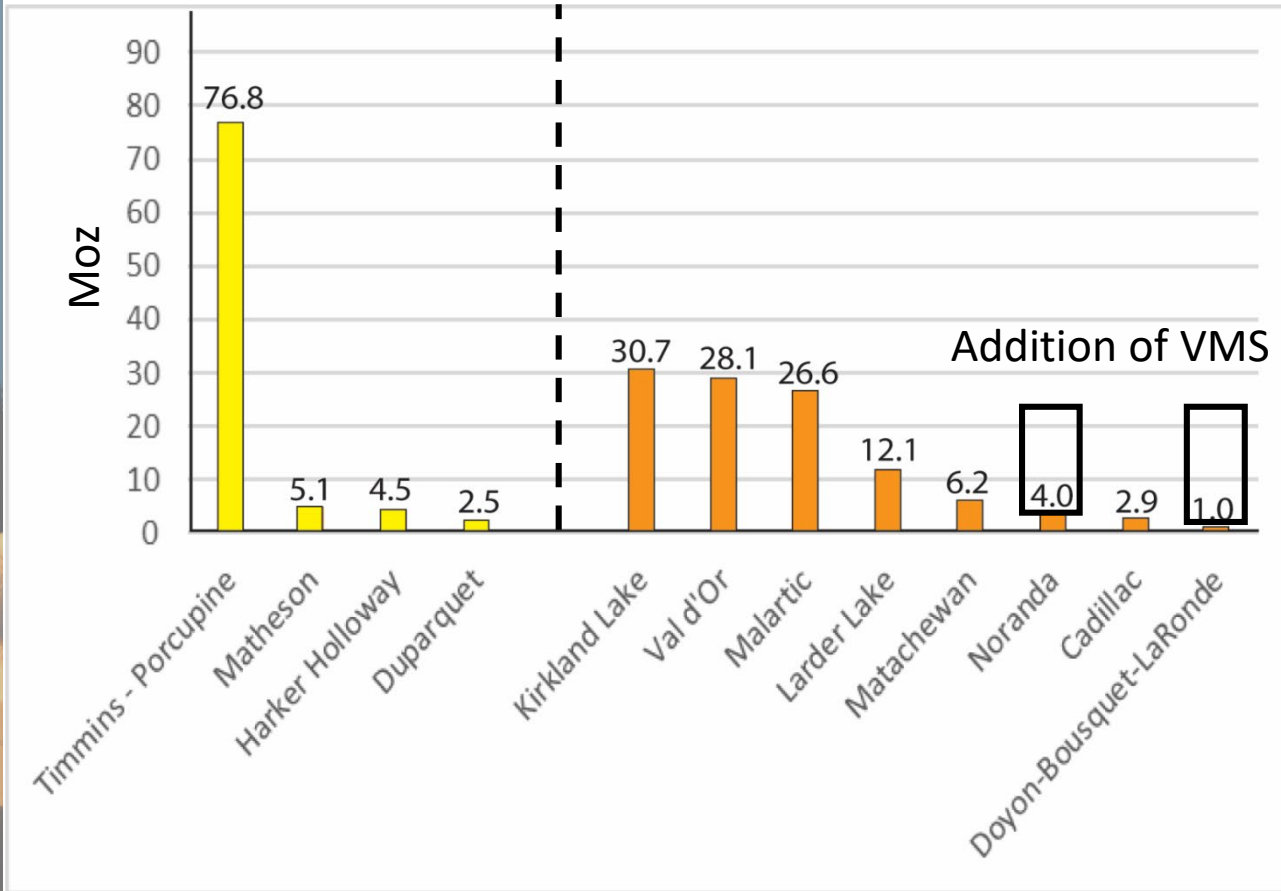
Deposits aligned along the Destor Porcupine fault and the Cadillac Larder Lake



Gold Endowment

Destor Porcupine +89 Moz

Cadillac-Larder Lake +112 Moz Au



Monecke et al., 2017 Reviews in Economic Geology, v. 19 pp 7-49

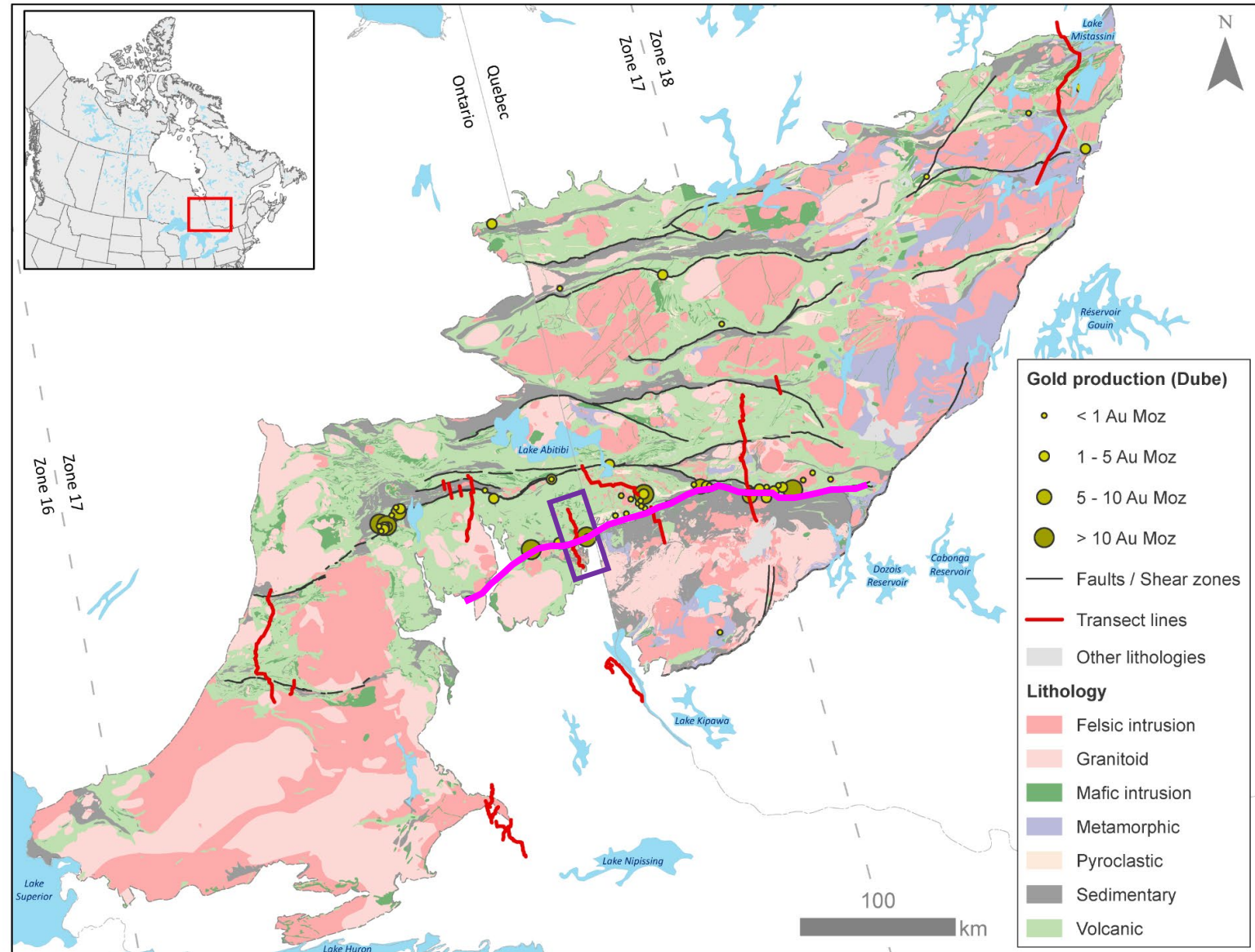
Abitibi Transects

Larder Lake

Along the Cadillac
Larder Lake
deformation zone

+112 Moz of Au

Area of relatively good
exposure and
extensive drilling



Larder Lake area

CLL deformation zone

Lincoln Nipissing fault

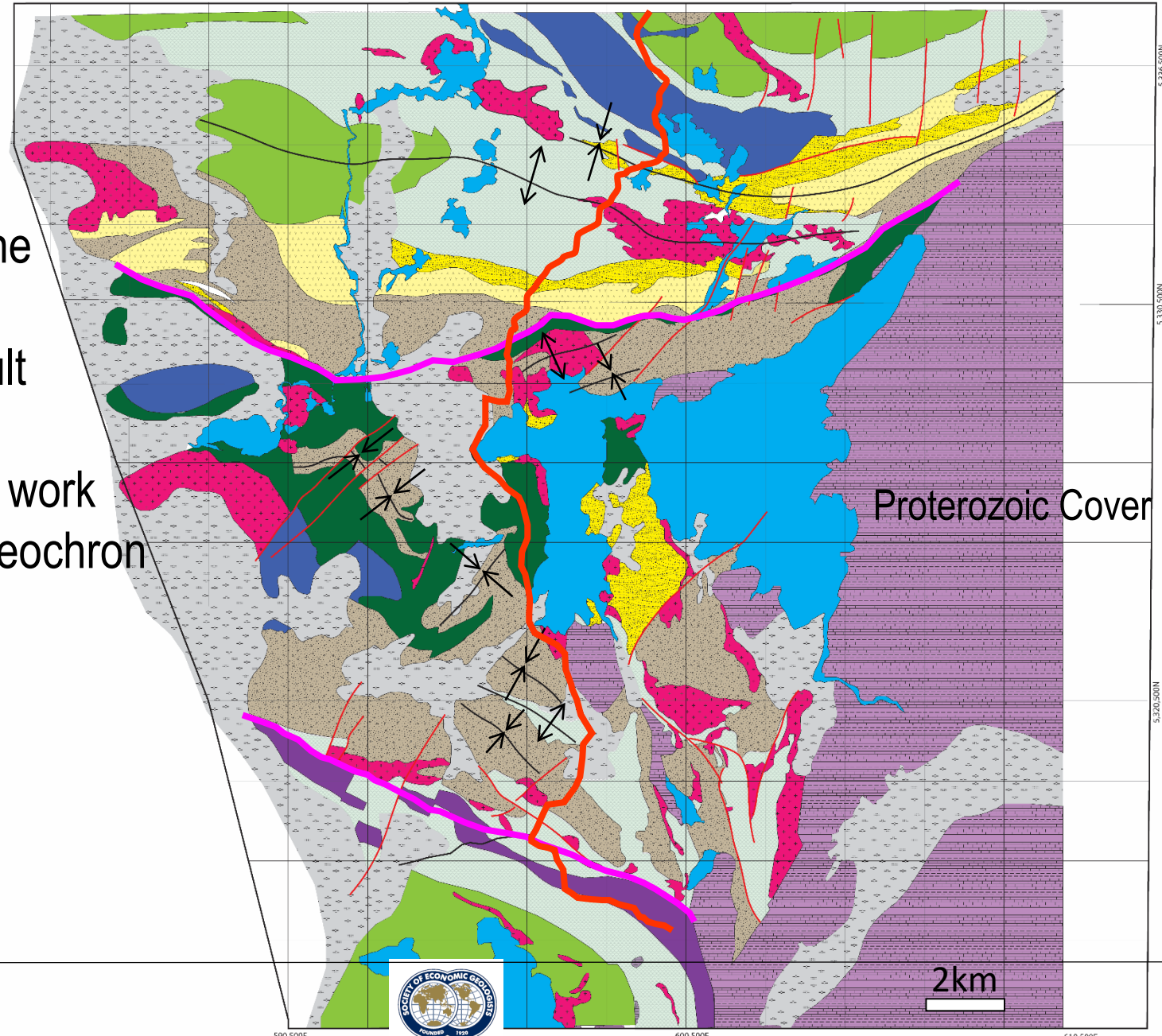
Metal Earth transect work

Geology/geochem/geochron

Seismic

MT

Gravity



From: Jackson, 1995, OGS Map 2628, 1:50,000

Larder Lake area, Mafic Volcanic Rocks

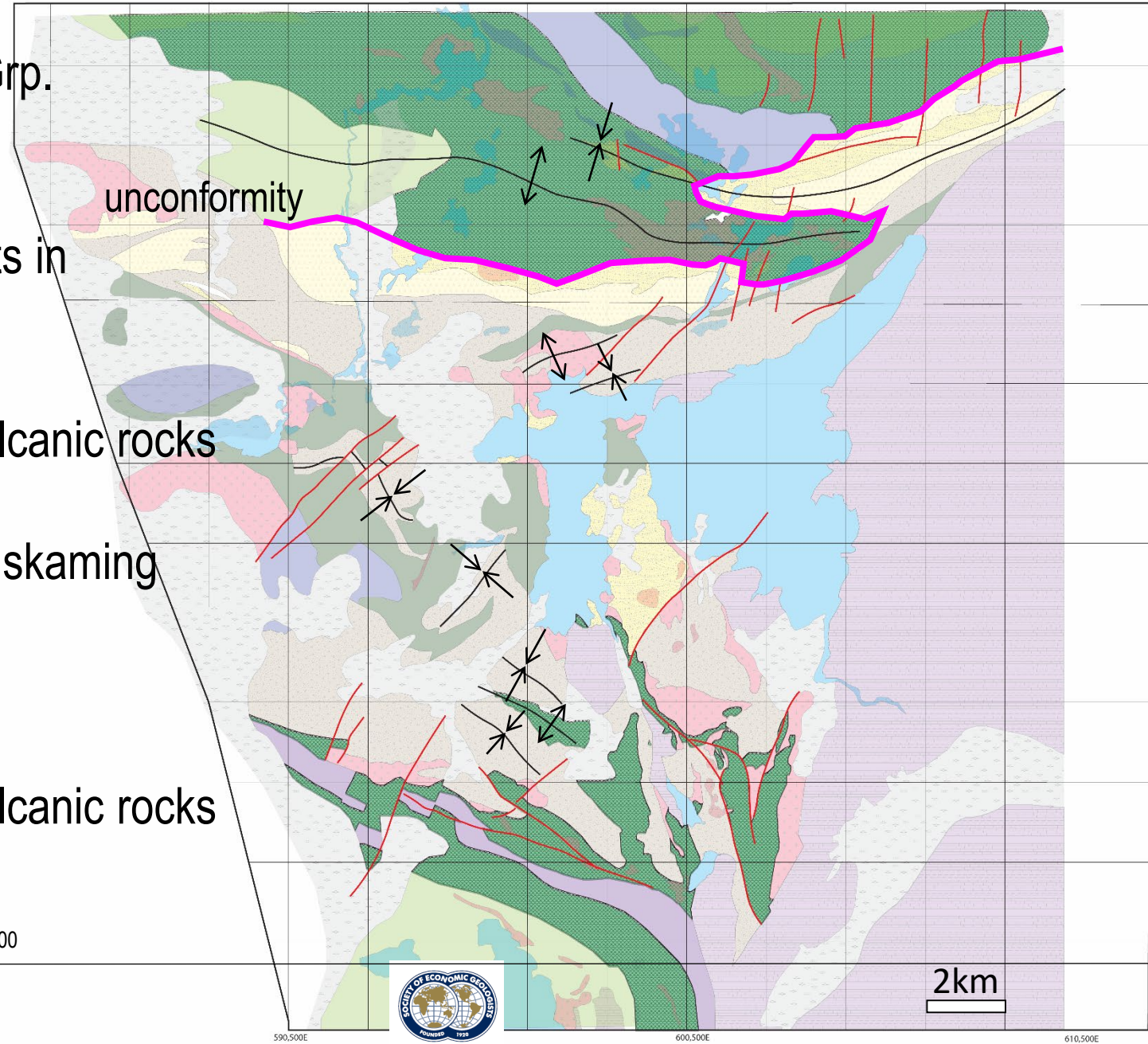
Lower Blake River Grp.
(2704–2701 Ma)

Host to VMS deposits in
Noranda

Dominantly mafic volcanic rocks

Unconformity at Timiskaming
contact

Dominantly mafic volcanic rocks
to south



From: Jackson, 1995, OGS Map 2628, 1:50,000



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2km

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Larder Lake area, Timiskaming Sedimentary and Volcanic rocks and other clastics

Light yellow

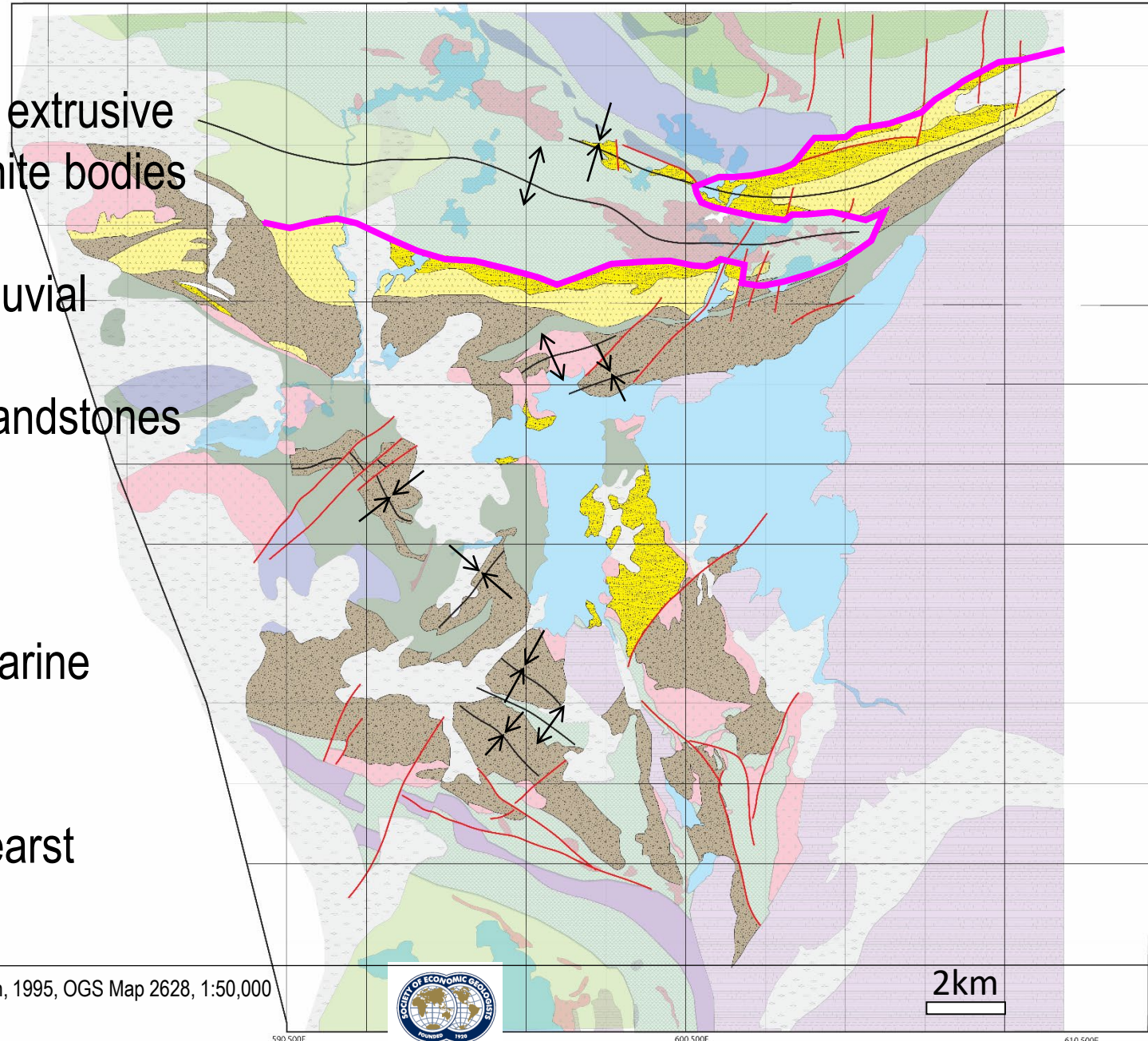
Alkalic volcanic rocks extrusive
equivalent of the syenite bodies

Dark Yellow, alluvial-fluvial
sedimentary rocks,
conglomerates and sandstones

Brown

In part Timiskaming
sedimentary rocks, marine
facies.

To south becomes Hearst
assemblage



From: Jackson, 1995, OGS Map 2628, 1:50,000



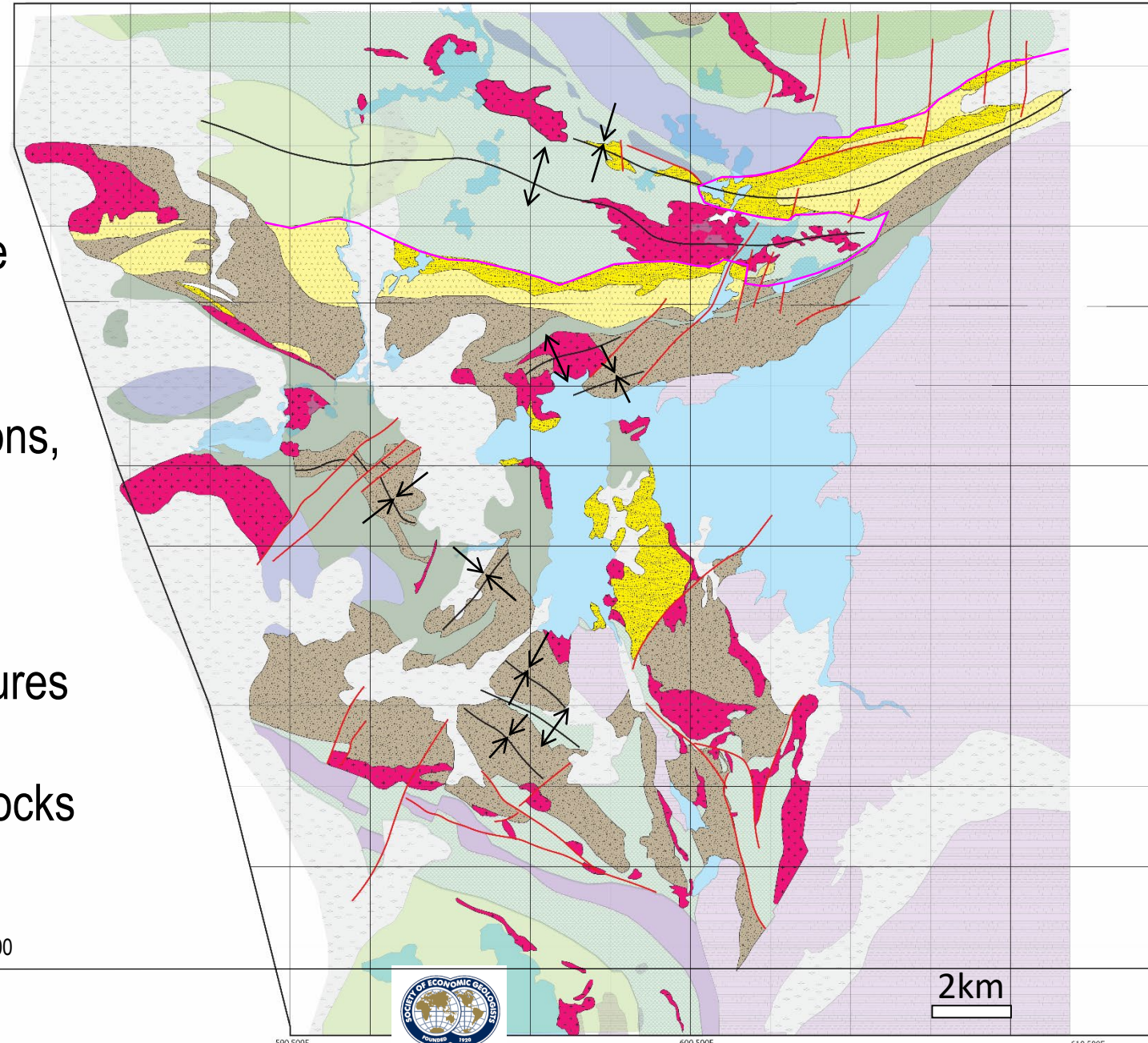
2km

Larder Lake area, Intrusive Rocks

Timiskaming intrusive rocks

Small volume intrusions, variable composition tends to be syenitic

Intrudes along structures and associated with clastic sedimentary rocks



From: Jackson, 1995, OGS Map 2628, 1:50,000

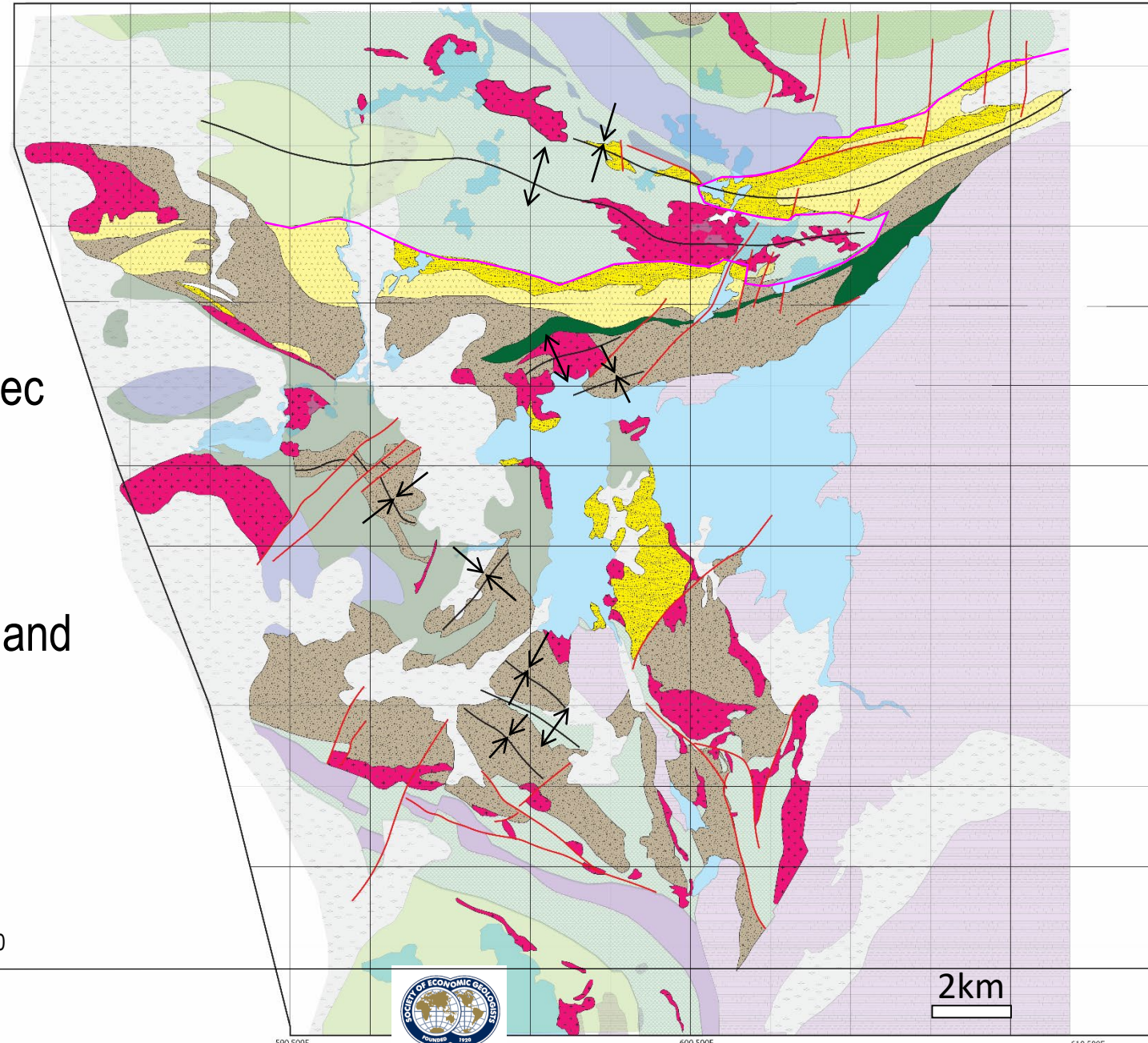
Larder Lake area, Larder Lake grp

Larder Lake group
(ca. 2705 Ma)

Piché group in Quebec

Defines the CLLDZ

Succession of mafic and
UM volcanic rocks



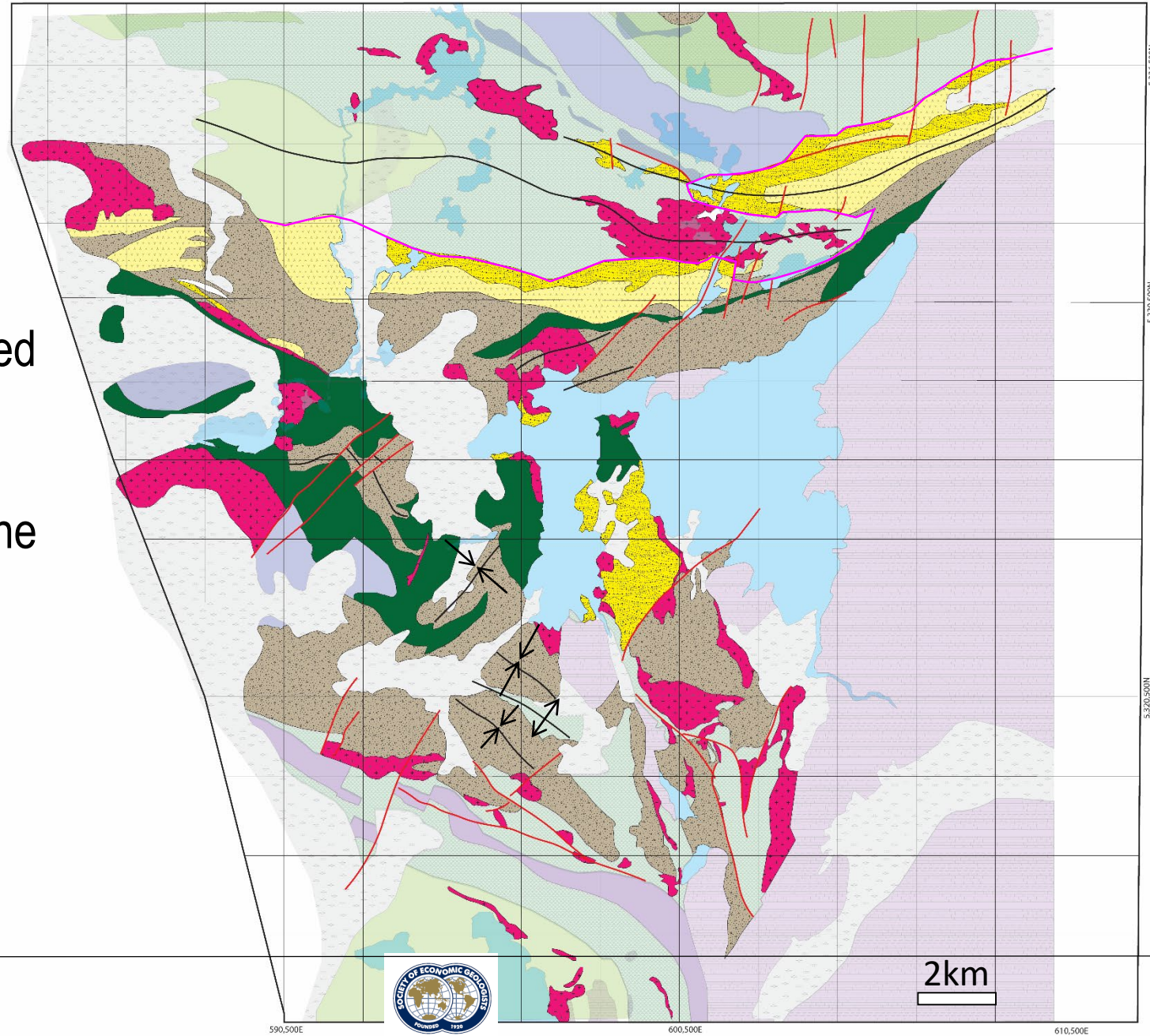
From: Jackson, 1995, OGS Map 2628, 1:50,000

Larder Lake area, Cadillac - Larder Lake Break and Gold Deposits

Larder Lake group

Other mafic-UM
volcanic rocks mapped
to the south possible
extensions of the
Larder Lake grp. or the
Piché

Significant for
mineralization



From: Jackson, 1995, OGS Map 2628, 1:50,000



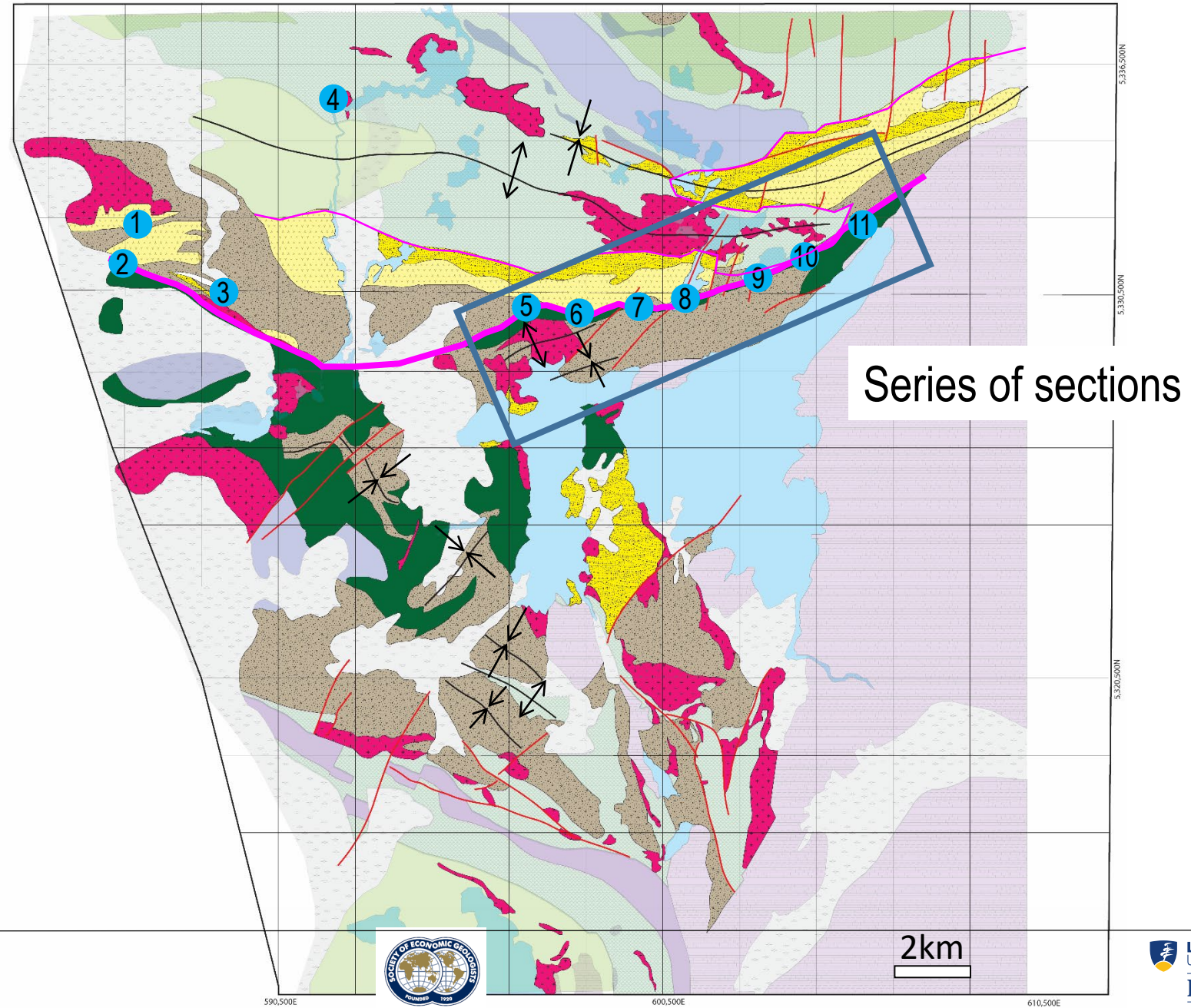
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2km

Larder Lake area, Cadillac - Larder Lake Break and Gold Deposits

1. Upper Canada
2. Anoki
3. McBean
4. Upper Beaver
5. Omega
6. Fernland
7. Cheminis
8. Bear Lake
9. Barber Larder
10. McGarry
11. Kerr Addison



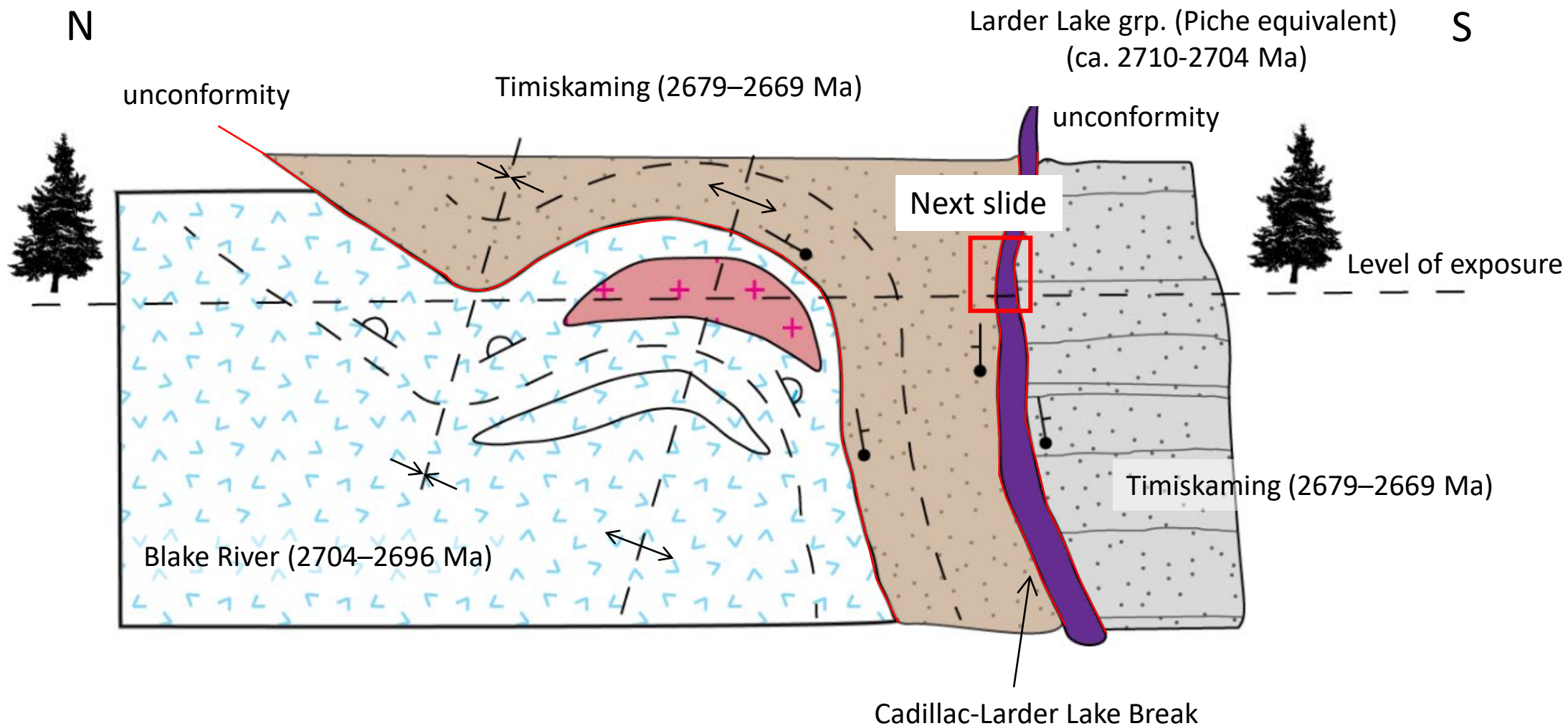
From: Jackson, 1995, OGS Map 2628, 1:50,000



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Cross section through the C-LL break



From Poulsen 2018

Surface Exposures of the Cadillac Larder Lake deformation Zone

Strongly deformed Timiskaming sedimentary rocks in contact with Larder Lake group



Fuchsite-carbonate altered ultramafic rocks
Larder Lake group

Omega Section 597,191E Looking East

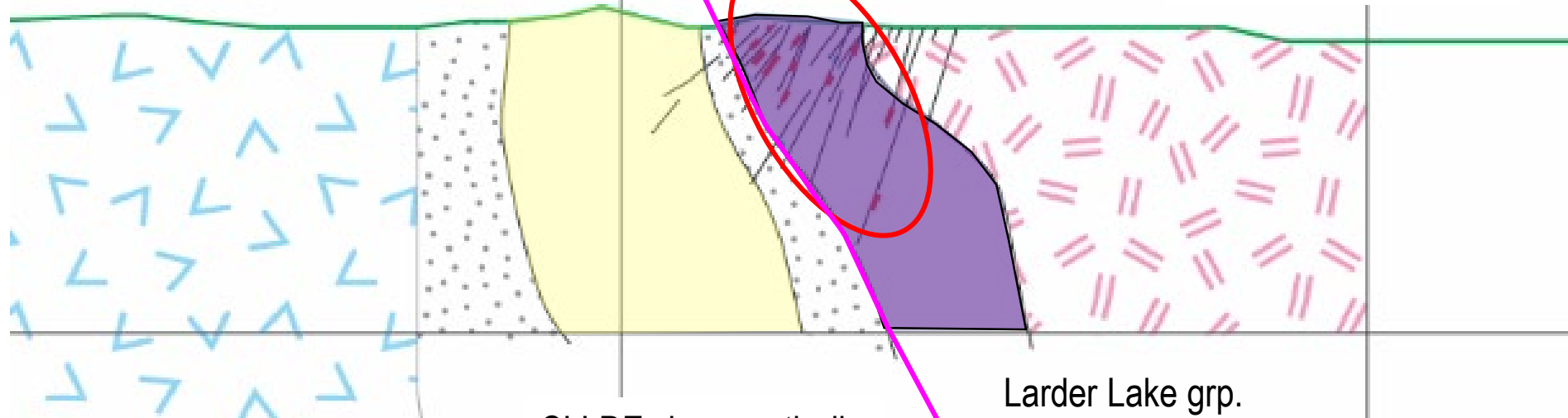
N

Timiskaming sedimentary
and volcanic rocks

Gold throughout LLg

S

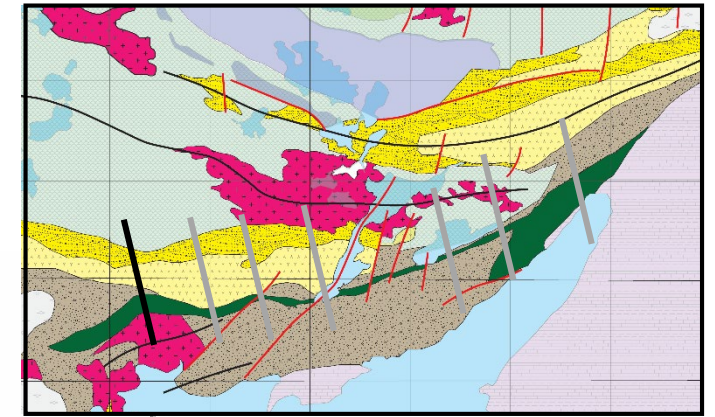
Timiskaming "Syenite"



Blake River

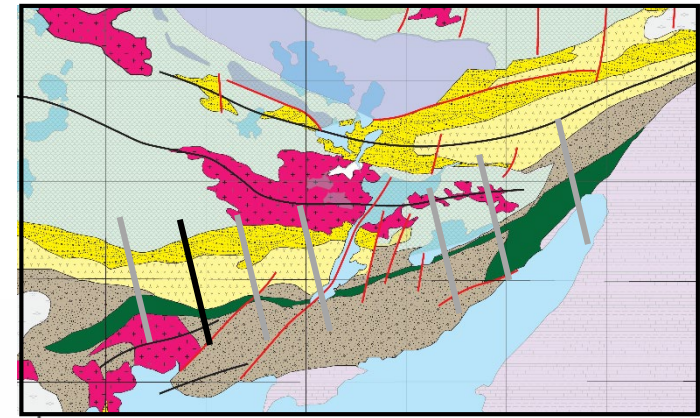
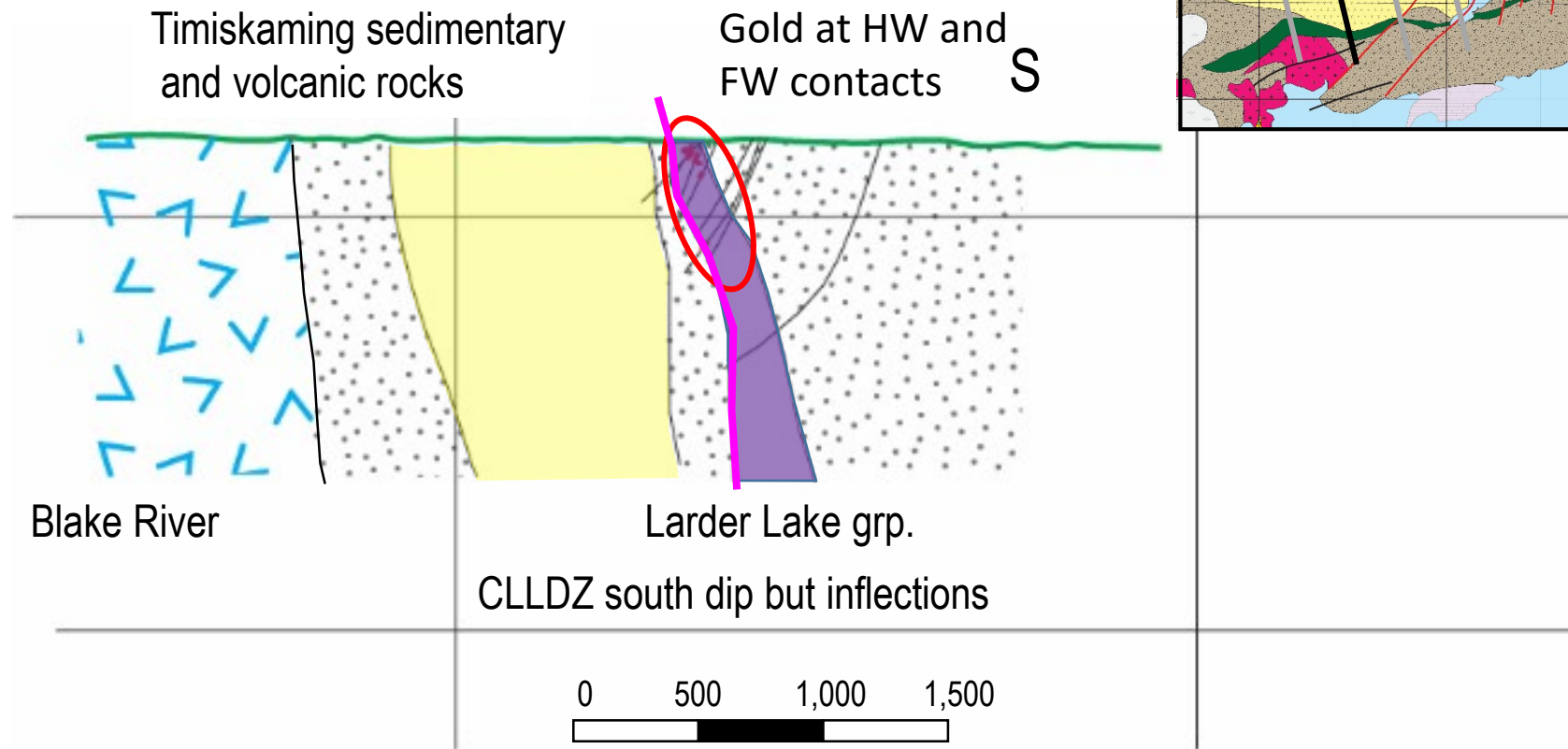
CLLDZ clear south dip

Larder Lake grp.

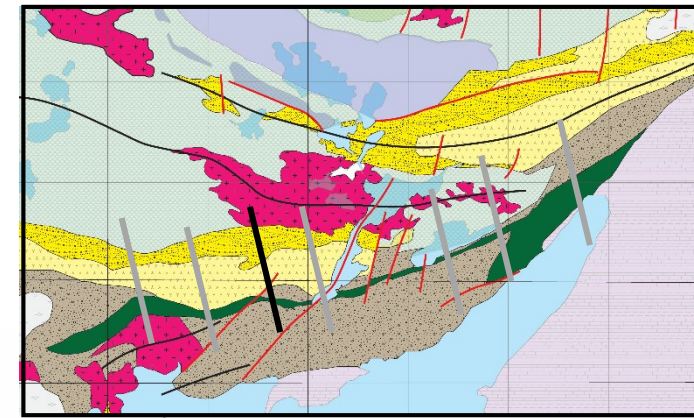
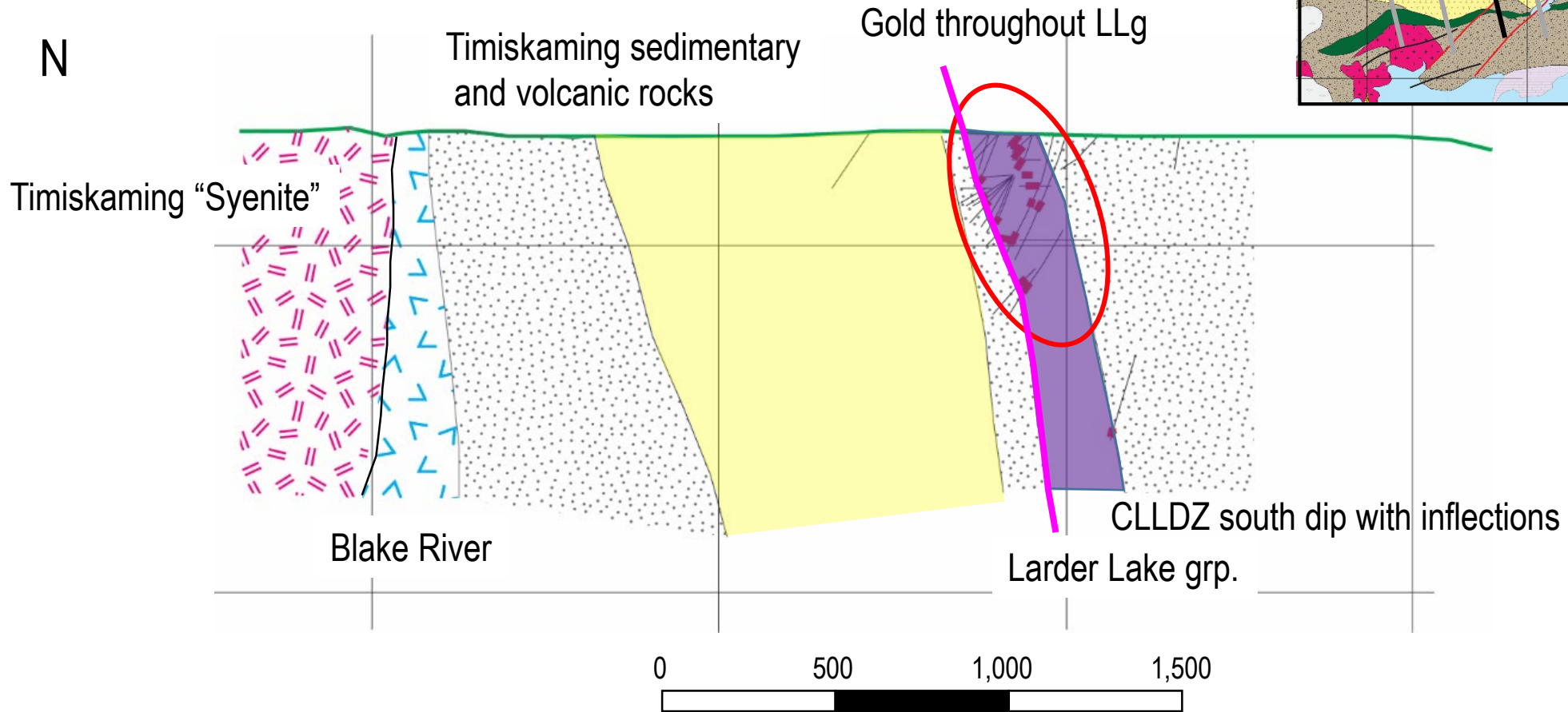


Fernland Section 598,200E looking east

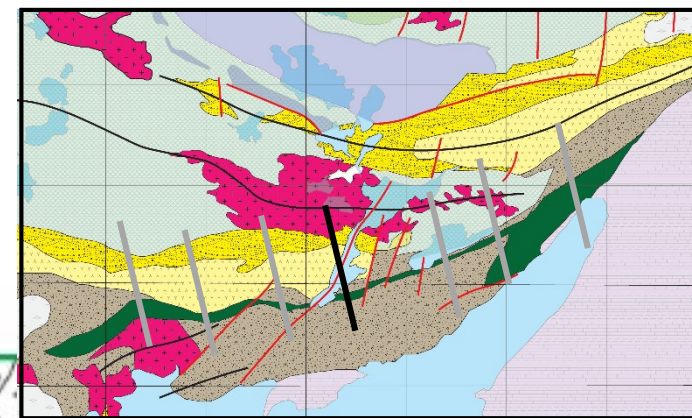
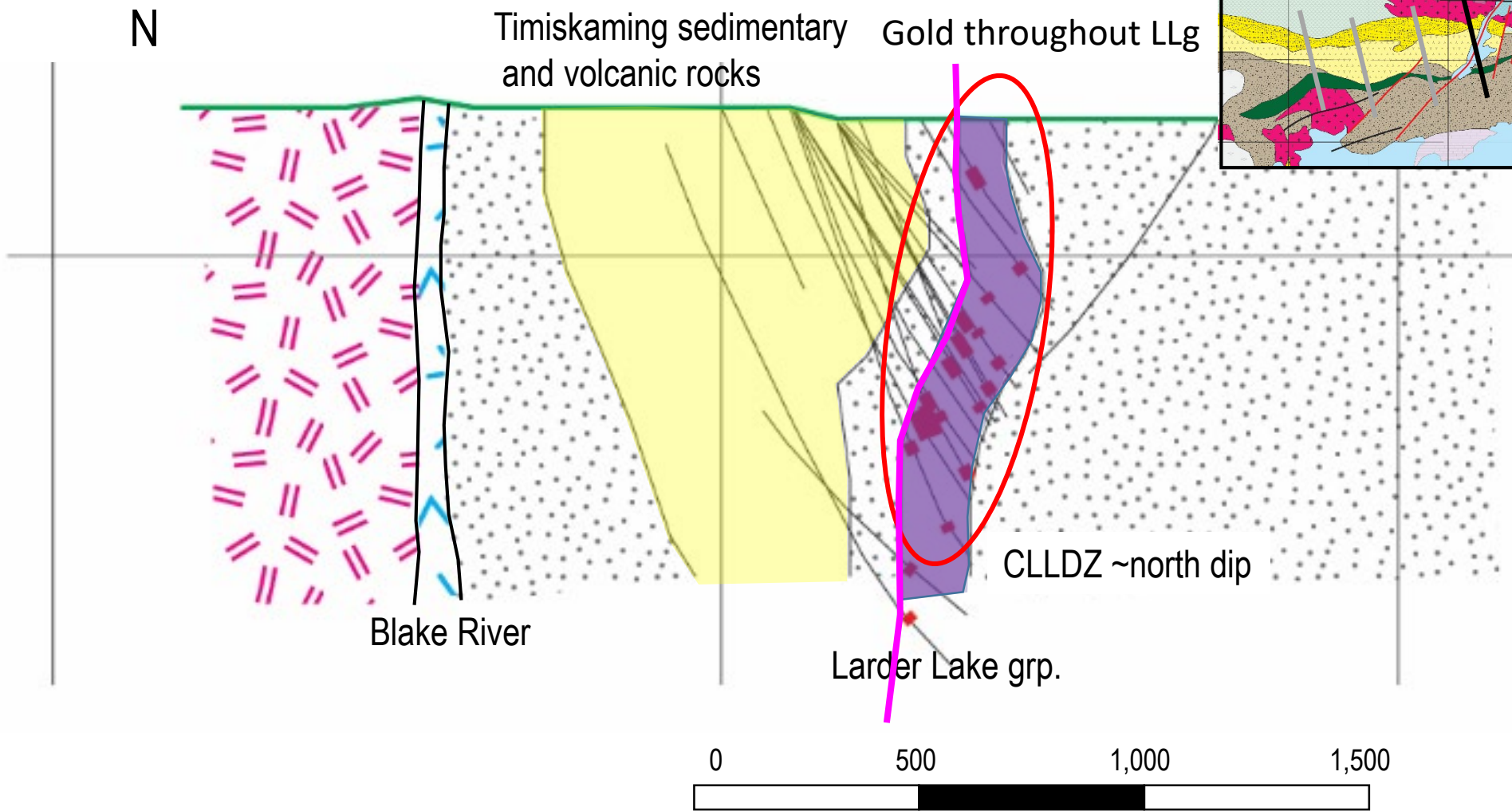
N



Cheminis Section 599,200E looking east

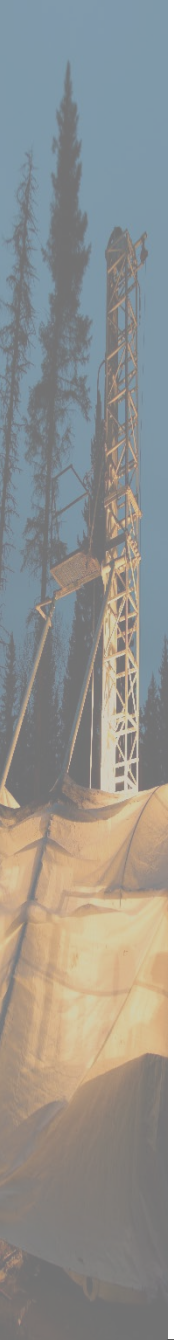
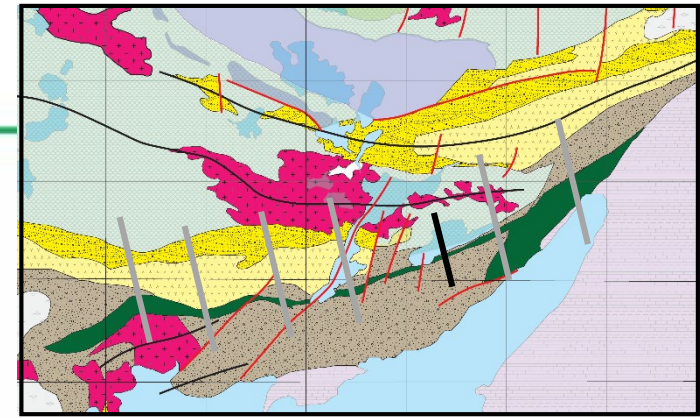
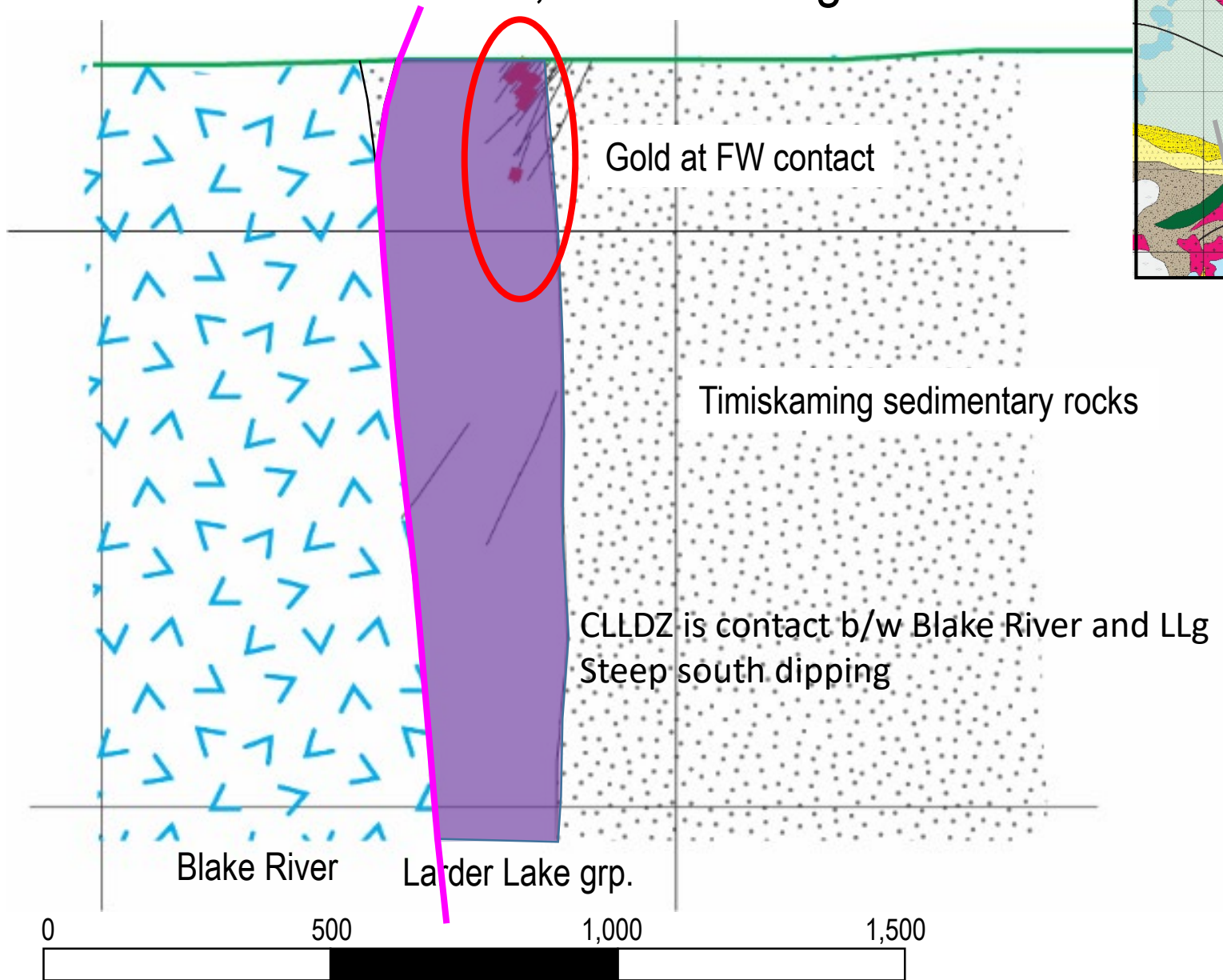


Bear Lake Section 600,800E looking east

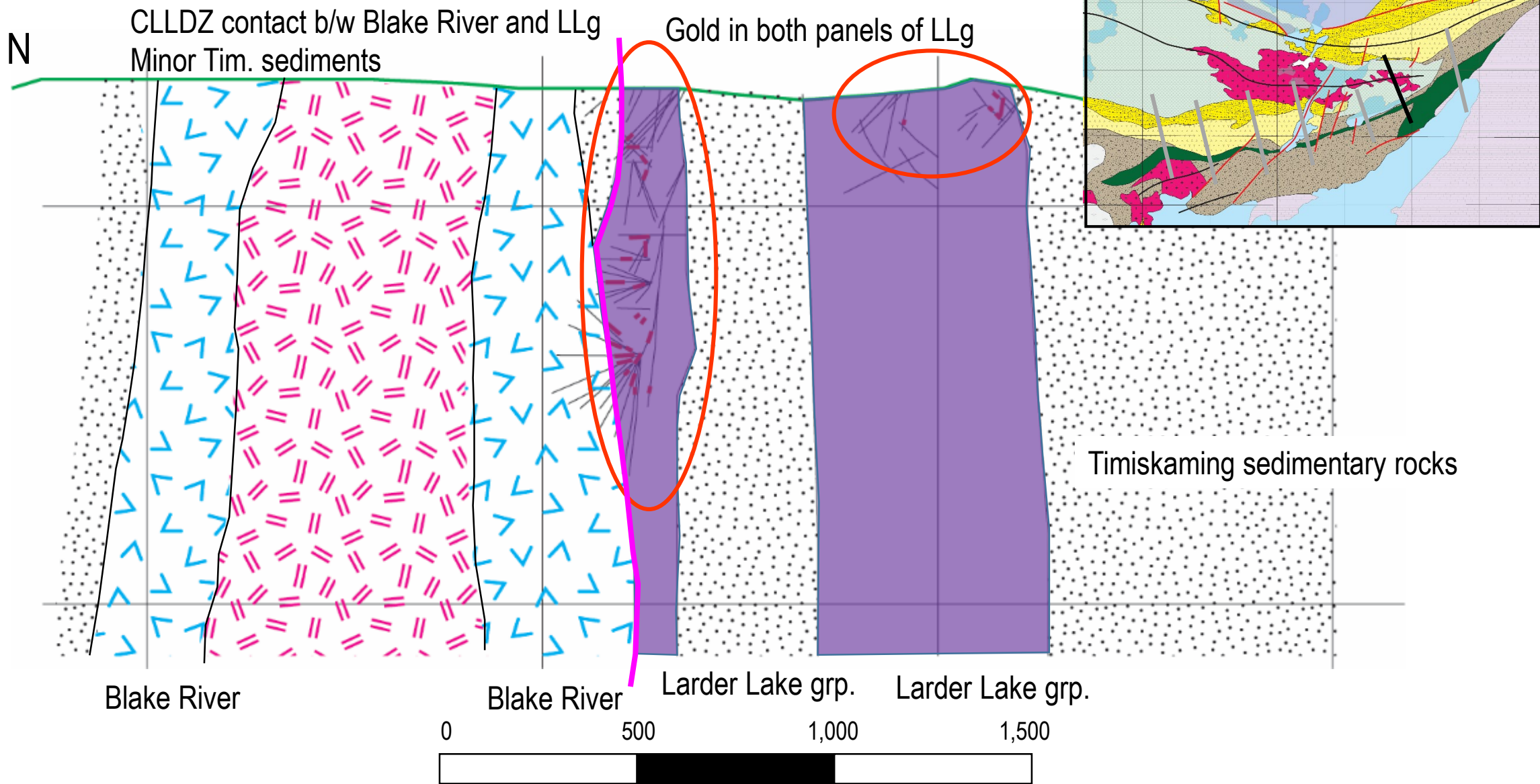


Barber Larder Section 603,400E looking east

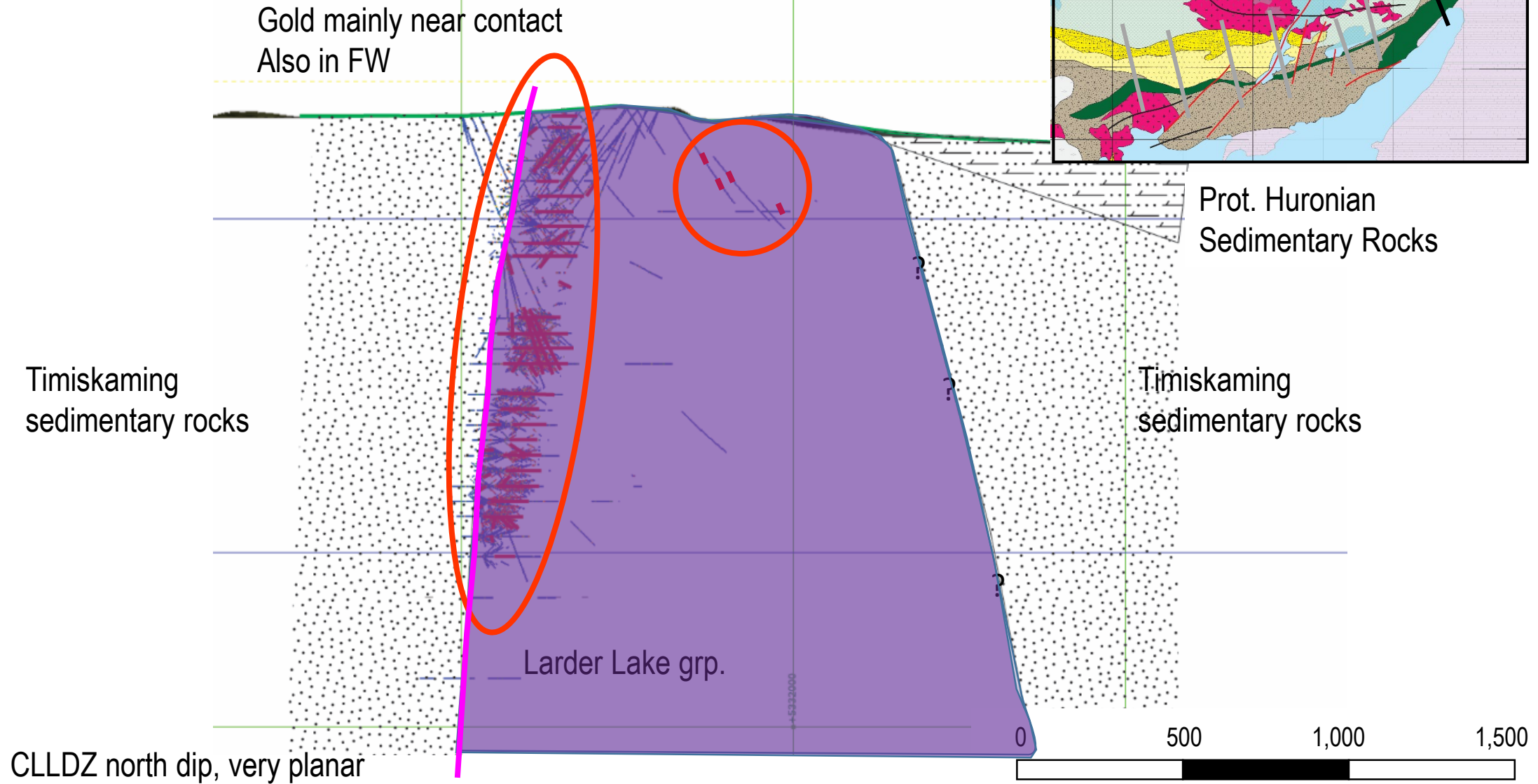
N



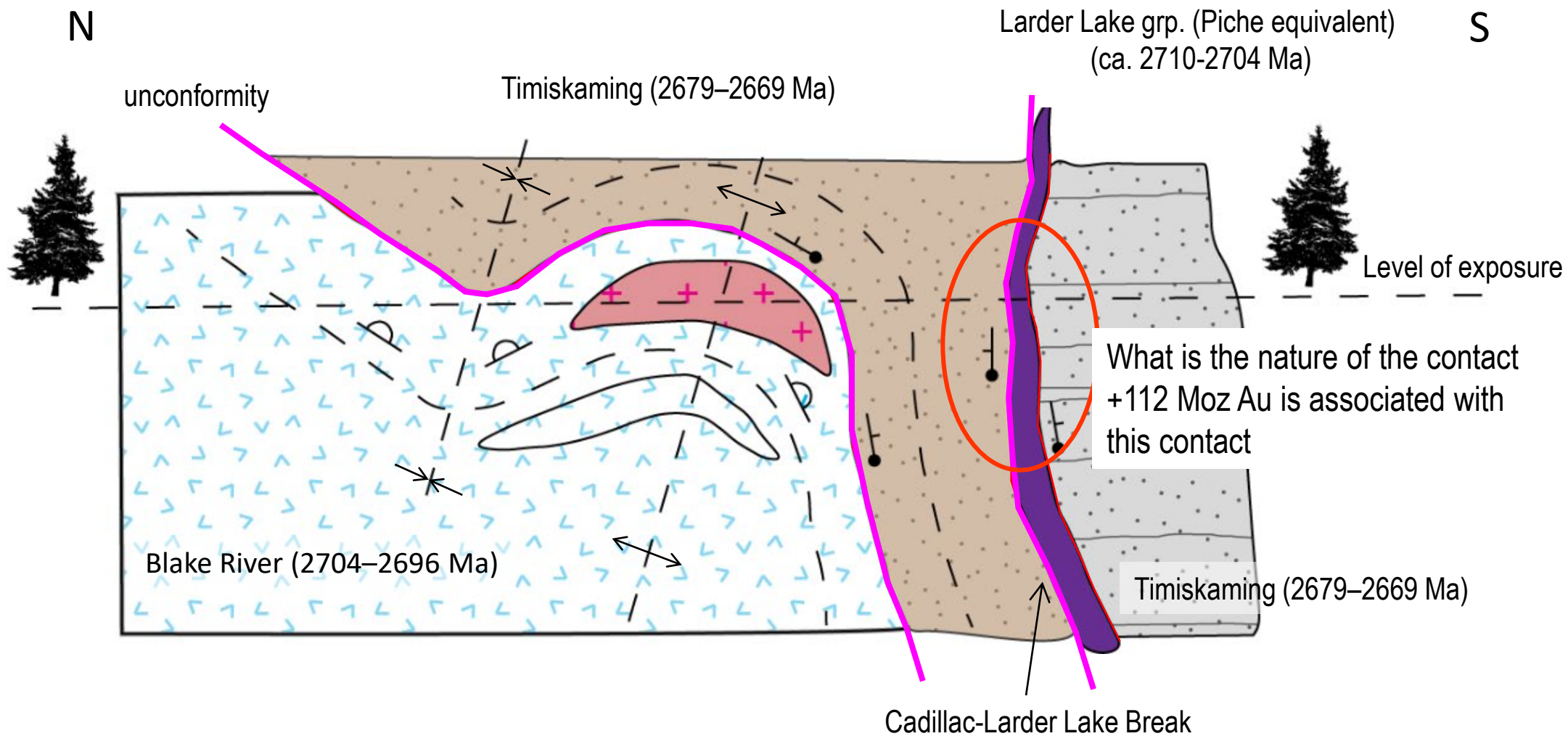
McGarry Section 604,400E looking east



Kerr-Addison Section 605,700E Looking East



Schematic cross section through the CLLDZ



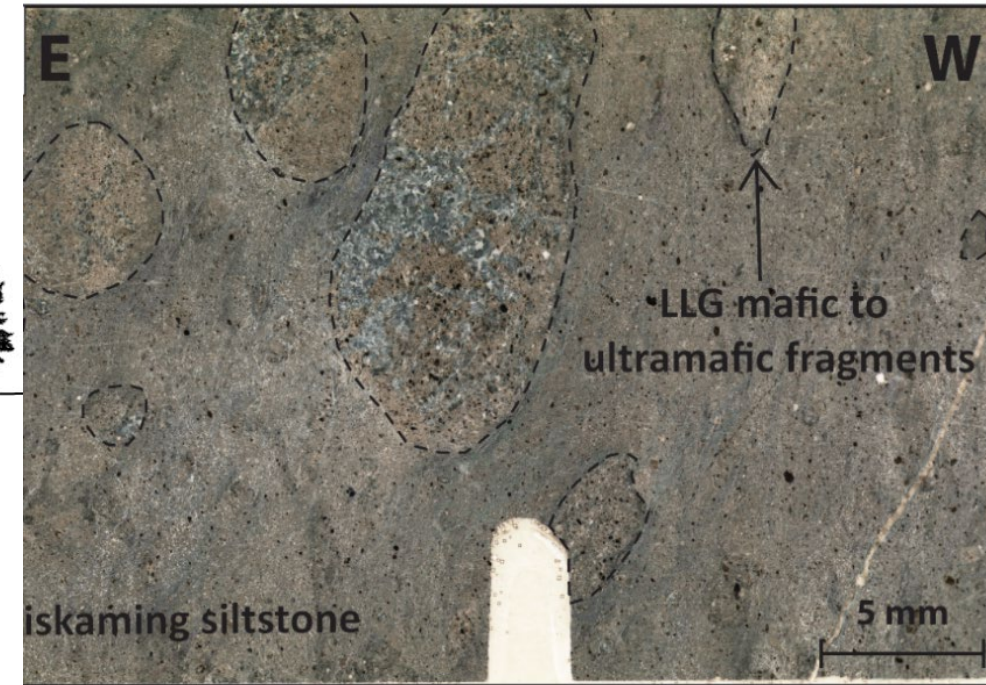
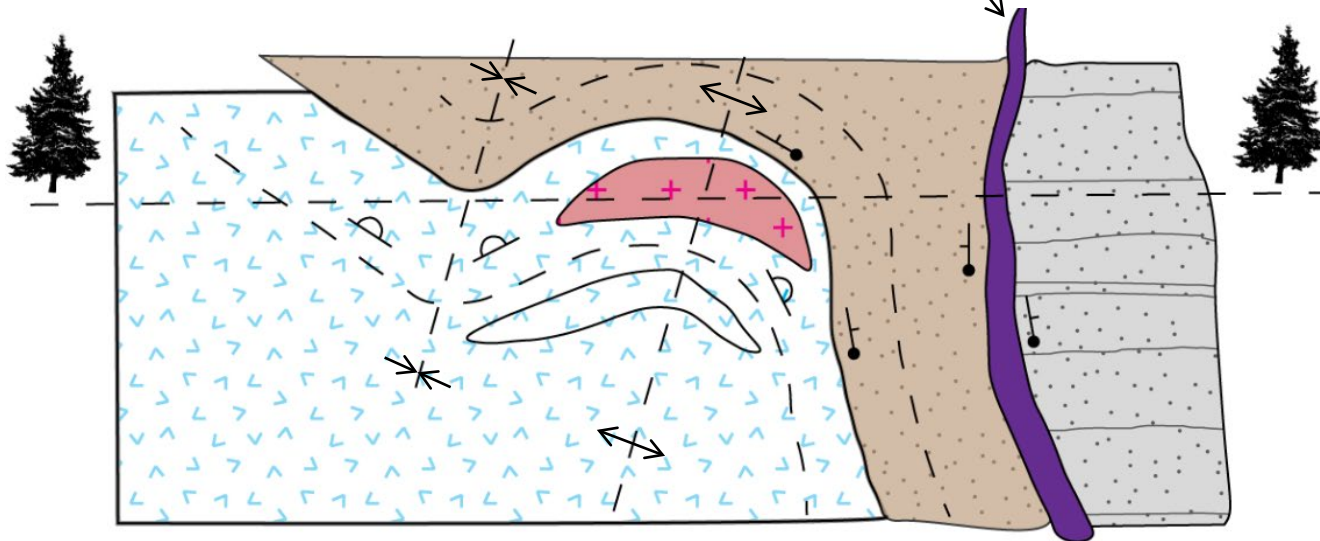
Poulsen 2018



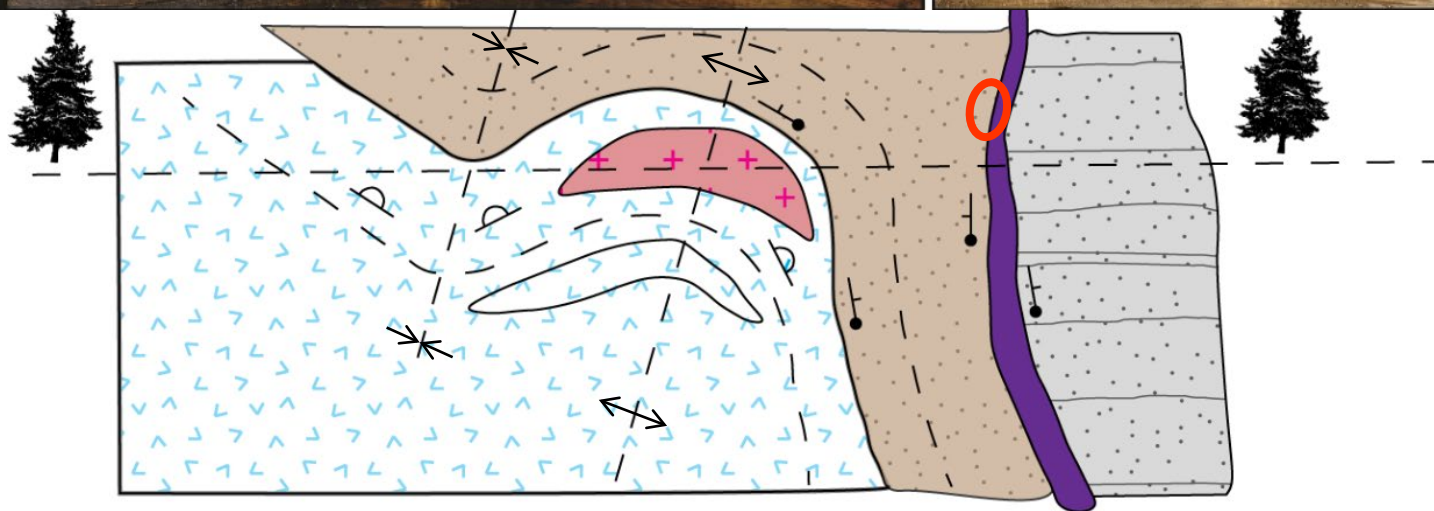
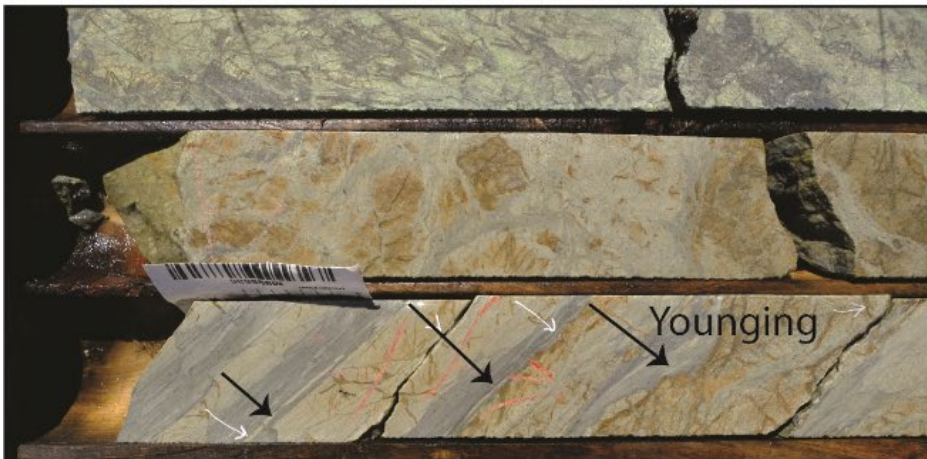
North contact between Larder Lake group and Timiskaming assemblage marked by a “transition zone”

1-3 m of UM-mafic clasts with a sandy matrix

Younging direction away from LLg (north and south)



Photos from Nadia St-Jean MSc thesis



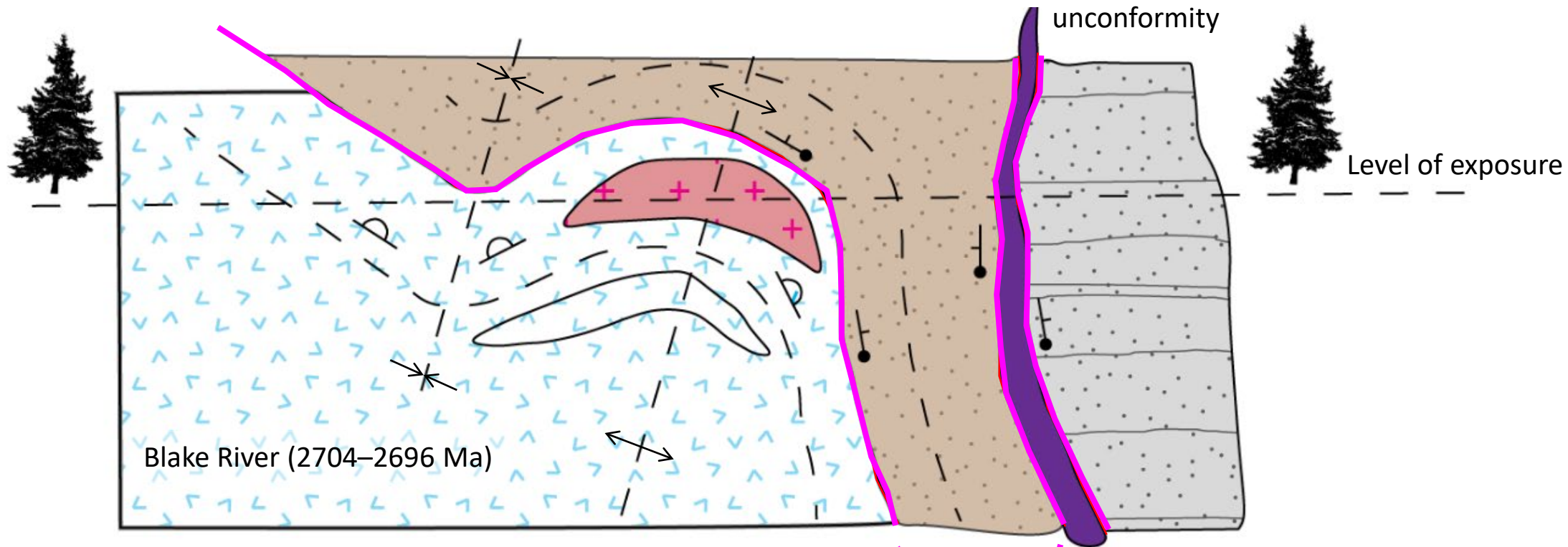
Drill core across the N contact at Cheminis

Presents as an unconformity

Modified by subsequent deformation

Photos from Nadia St-Jean MSc thesis

Schematic cross section through the CLLDZ



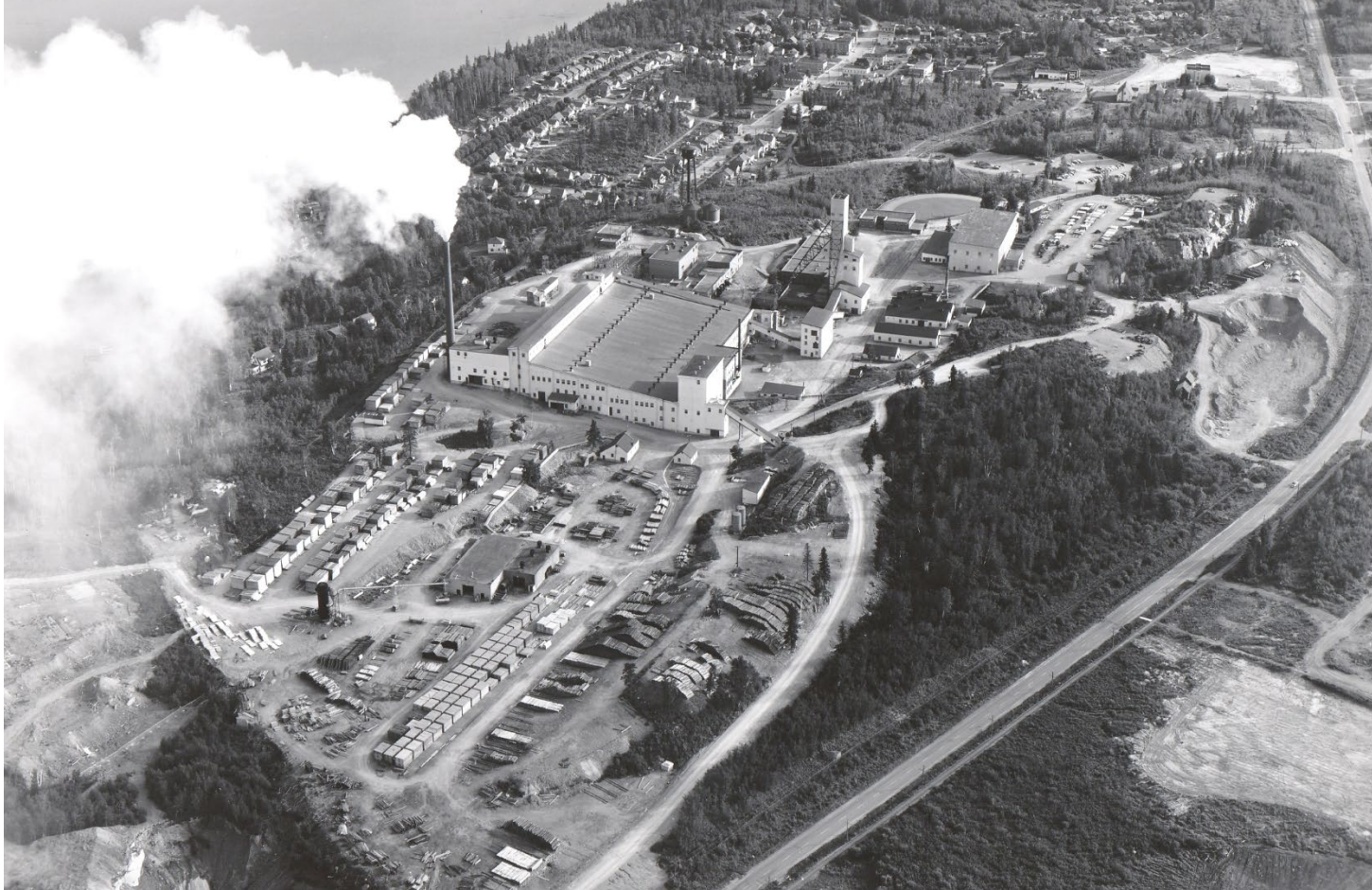
Proto-Cadillac-Larder Lake deformation zone

Structural juxtaposition between the
Blake River and Larder Lake grps.

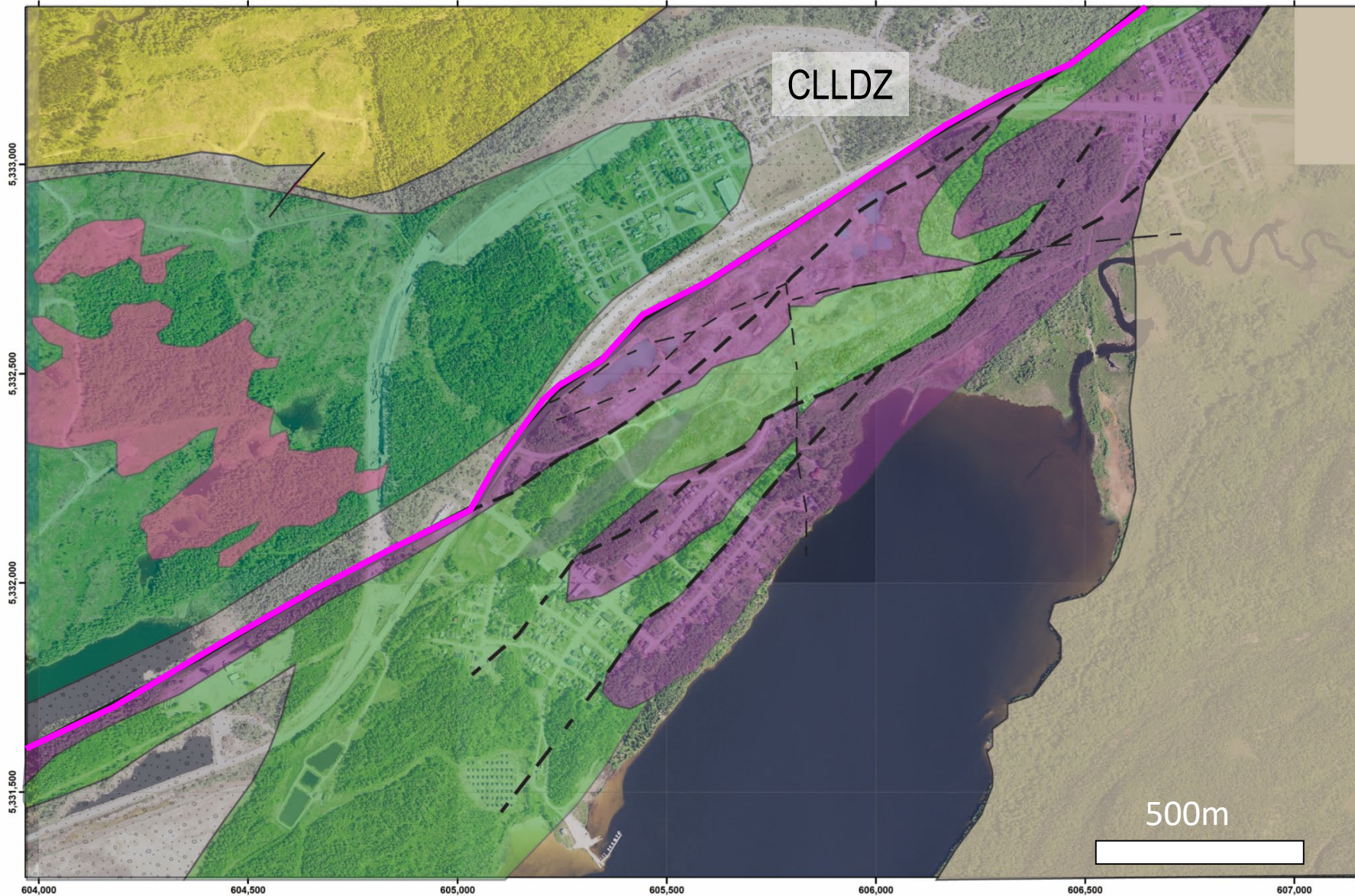
+112Moz of Au
associated with the contact

Kerr Addison Mine

- Kerr-Addison deposit discovered in 1906
- In production between 1938 and 1996, ~11 Moz at ~9 g/t Au



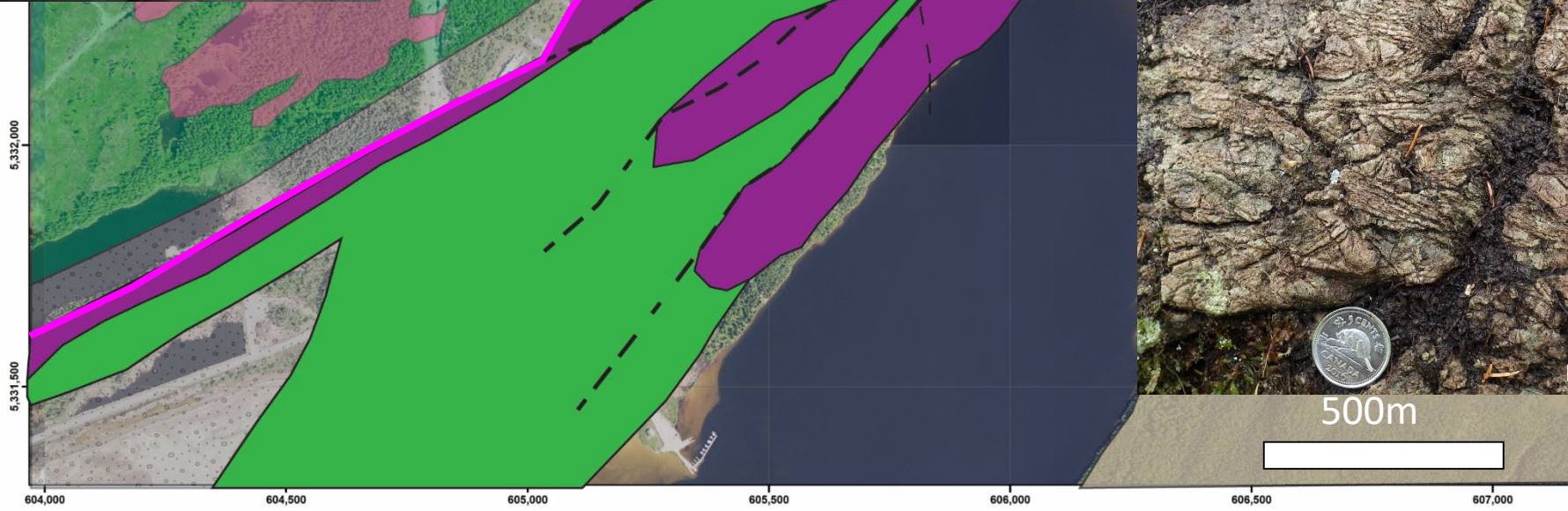
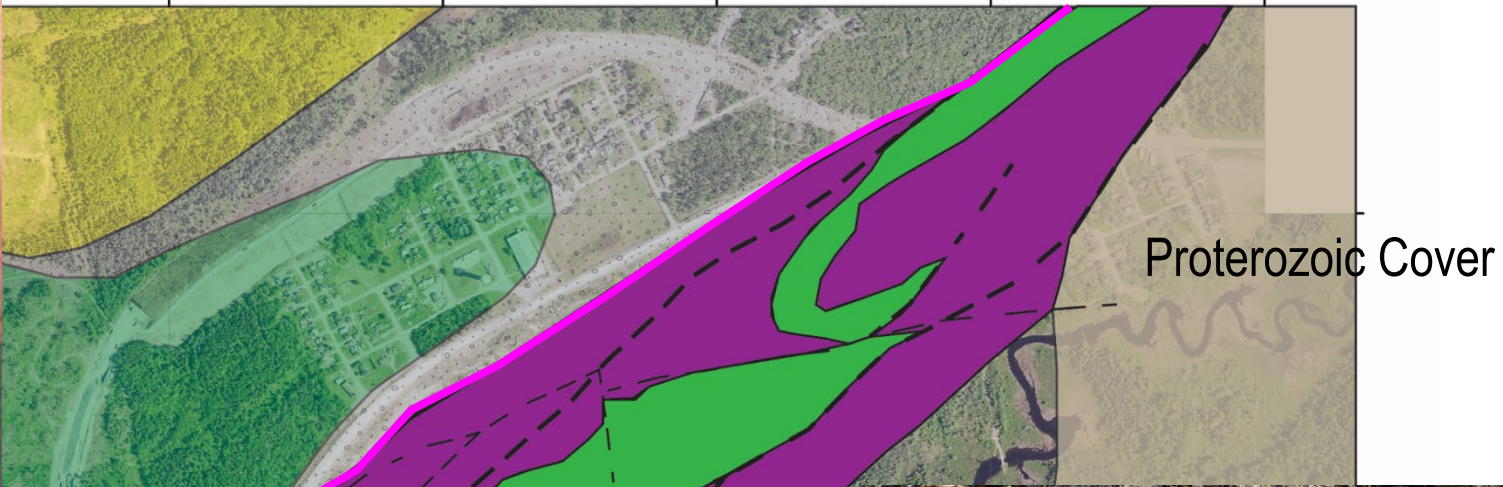
Kerr Addison Geology



J. Blackwell P. Com 2019

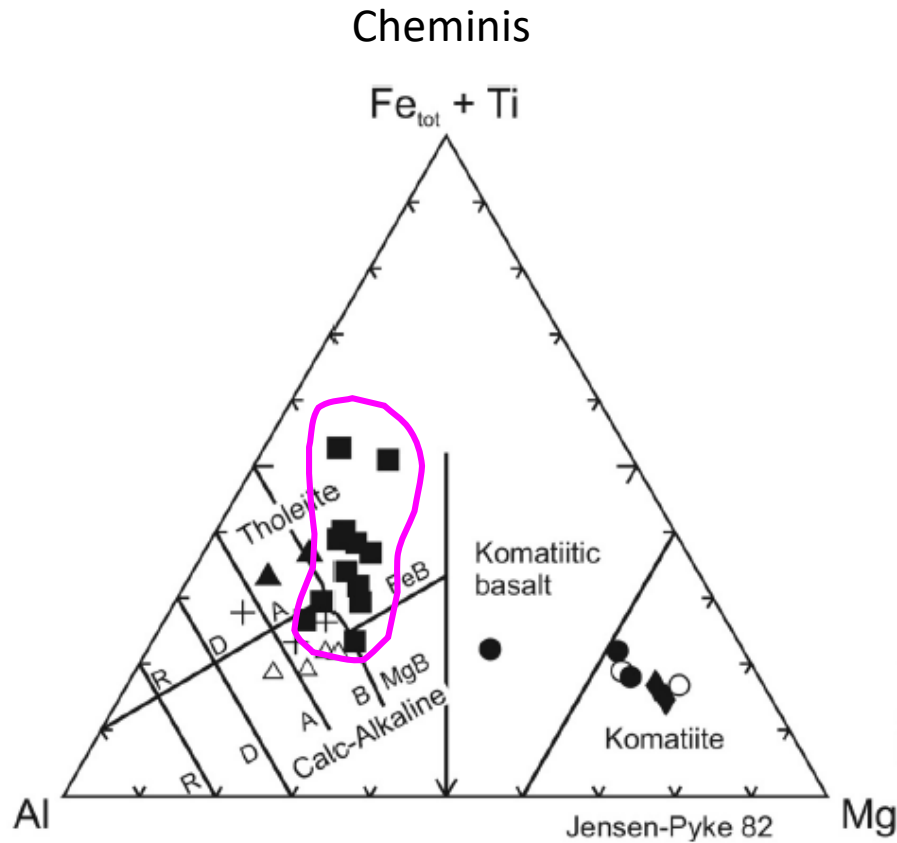


Kerr Addison Geology Larder Lake grp



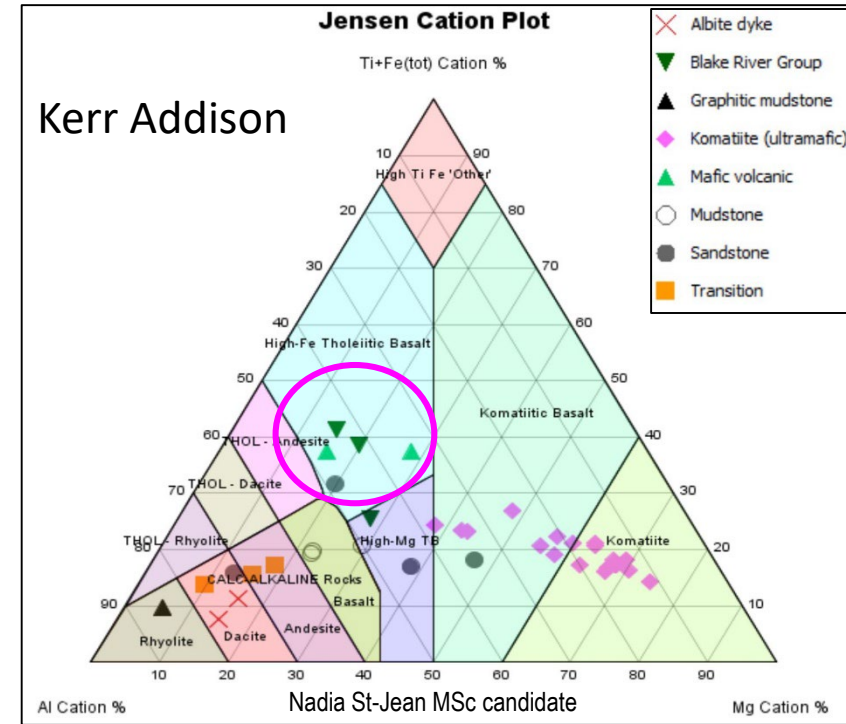
J. Blackwell P. Com 2019

Kerr Addison Geochemistry of Volcanic Rocks



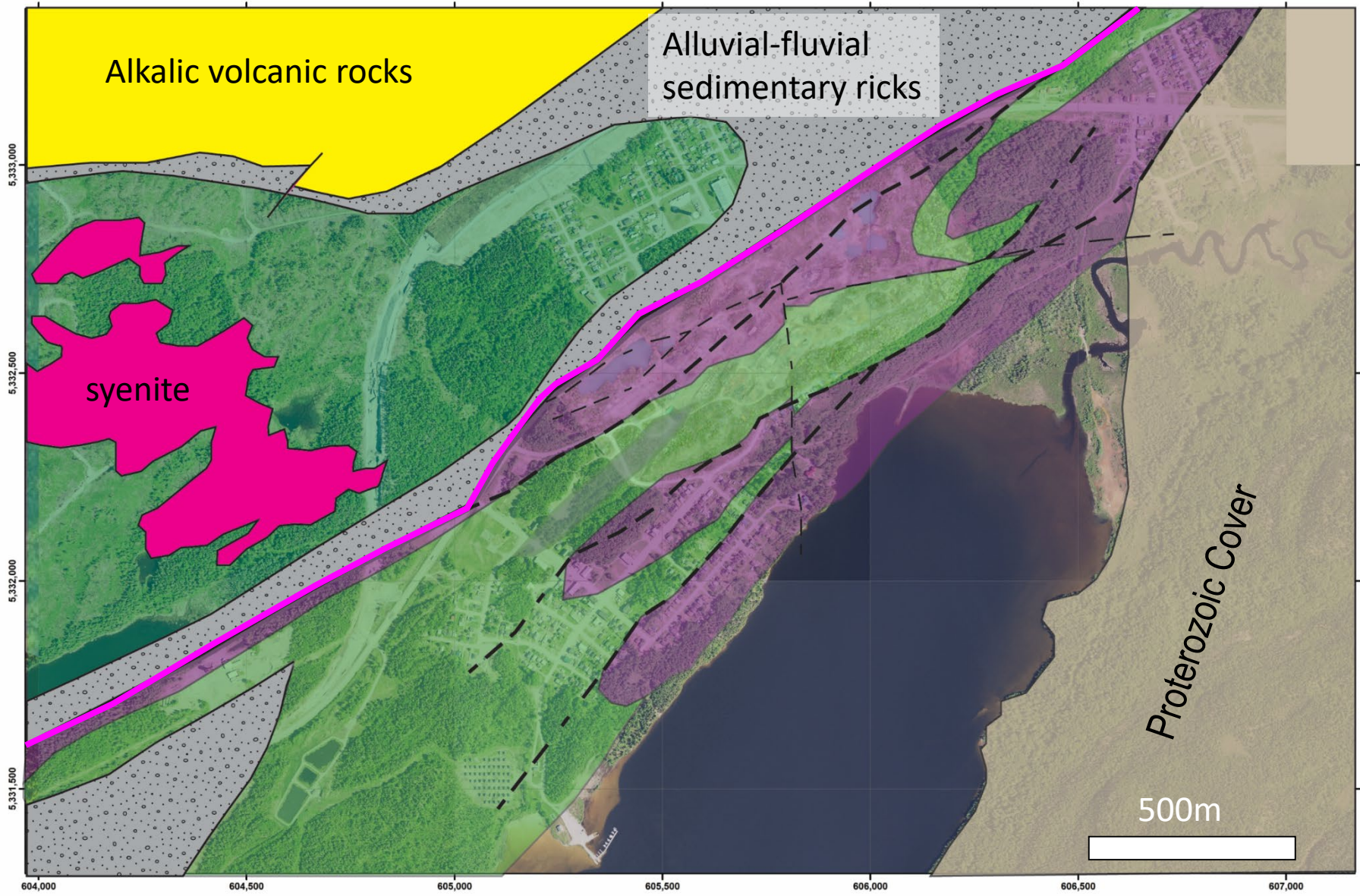
B. Lafrance 2015, CJES 52, 1093-1108

UM rocks are komatiite – basaltic komatiite
Basalts are high Fe tholeiites



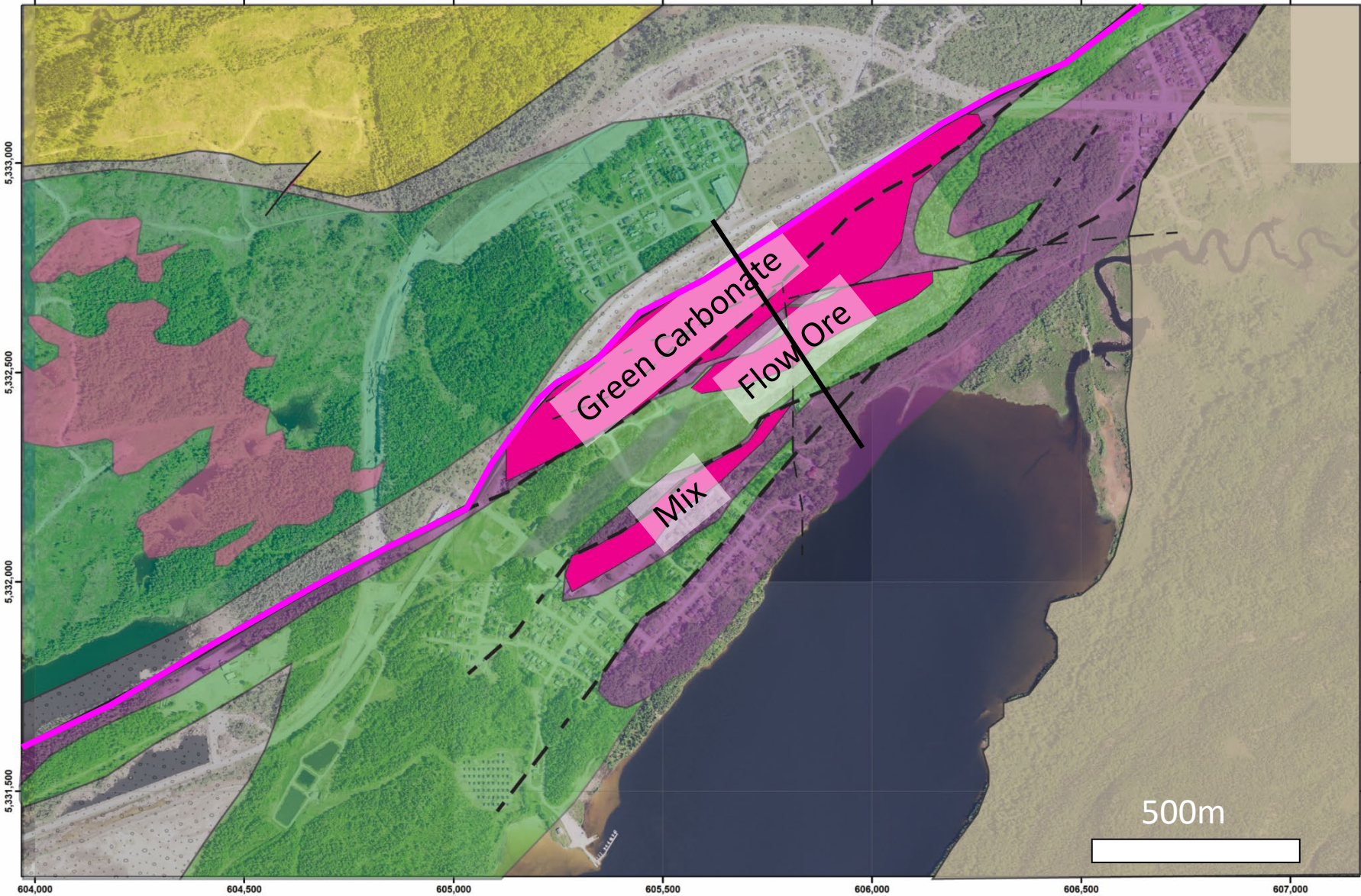
- + sandstone
- △ syenite dike
- Fe-rich tholeiitic basalt
- green fuchsite-carbonate ultramafic rock
- grey chlorite-carbonate ultramafic rock
- ◆ black talc-chlorite ultramafic rock

Kerr Addison Geology Timiskaming Assemblage



J. Blackwell P. Com 2019

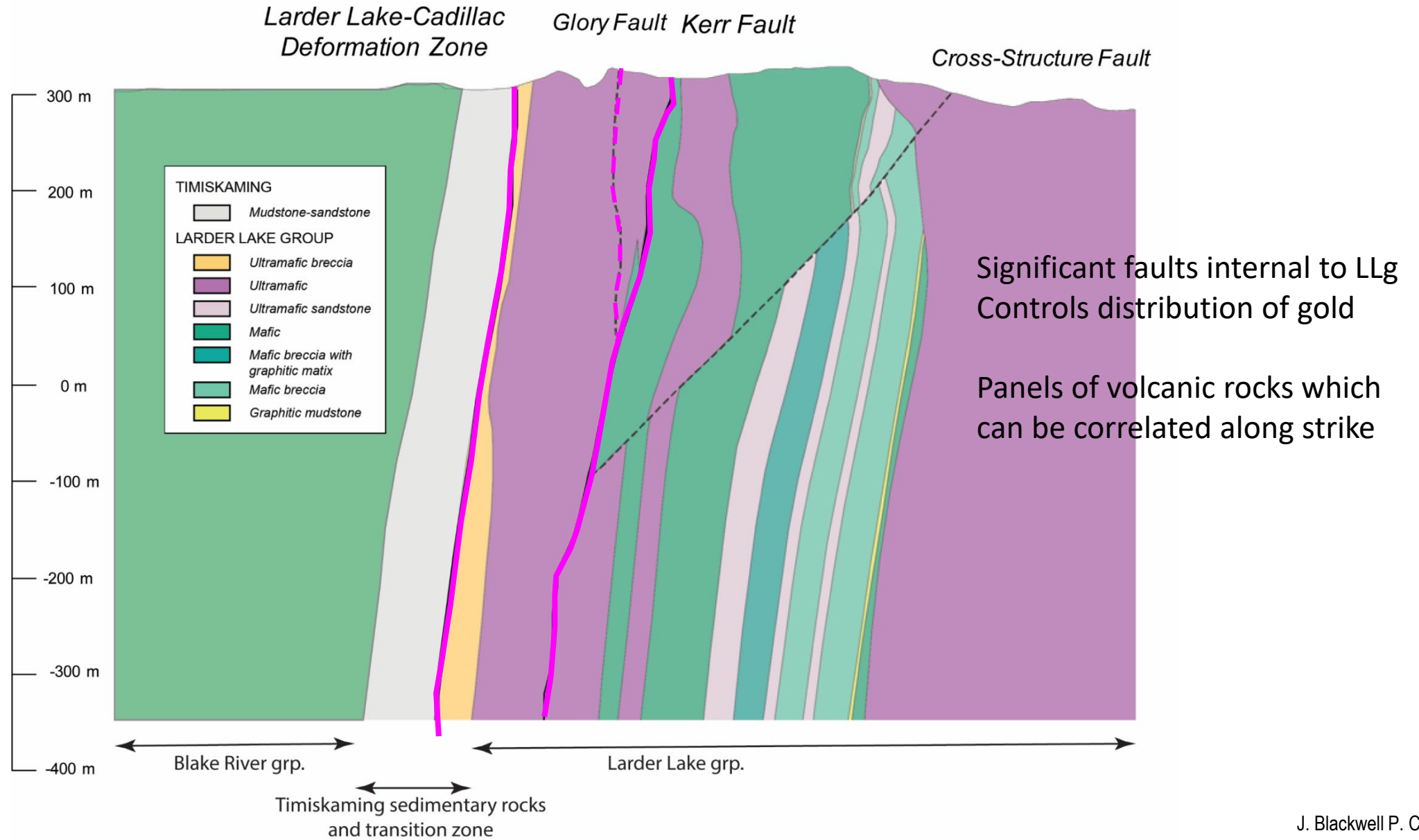
Kerr Addison Geology - Mineralization



J. Blackwell P. Com 2019

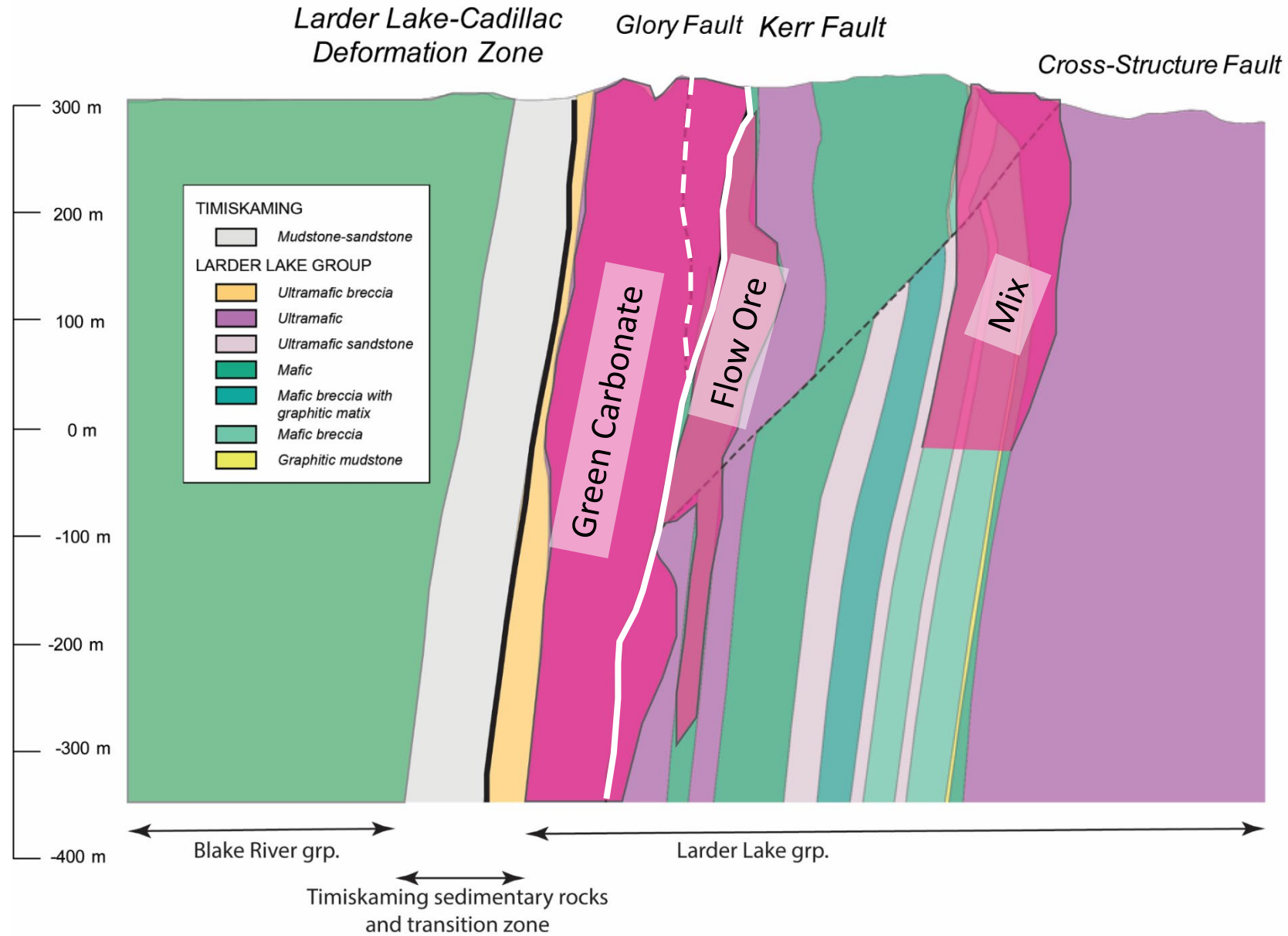


Kerr Addison Geology Section, Looking East



J. Blackwell P. Com 2019

Kerr Addison Geology – Mineralization Section, Looking East



J. Blackwell P. Com 2019

Structure / Veins & Mineralization

Veining was emplaced during regional D2, south over north compression

Textural relations between alteration and cleavage indicates that mineralization is syn-cleavage (Lafrance 2015)

Carbonate alt'n is early, what is the relationship to mineralization

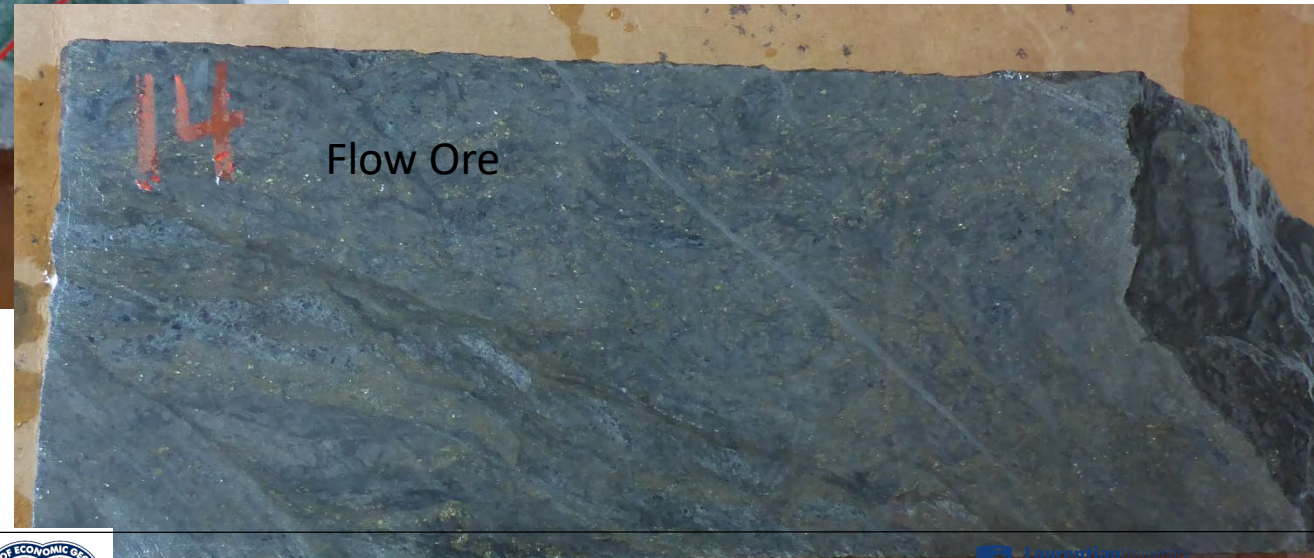
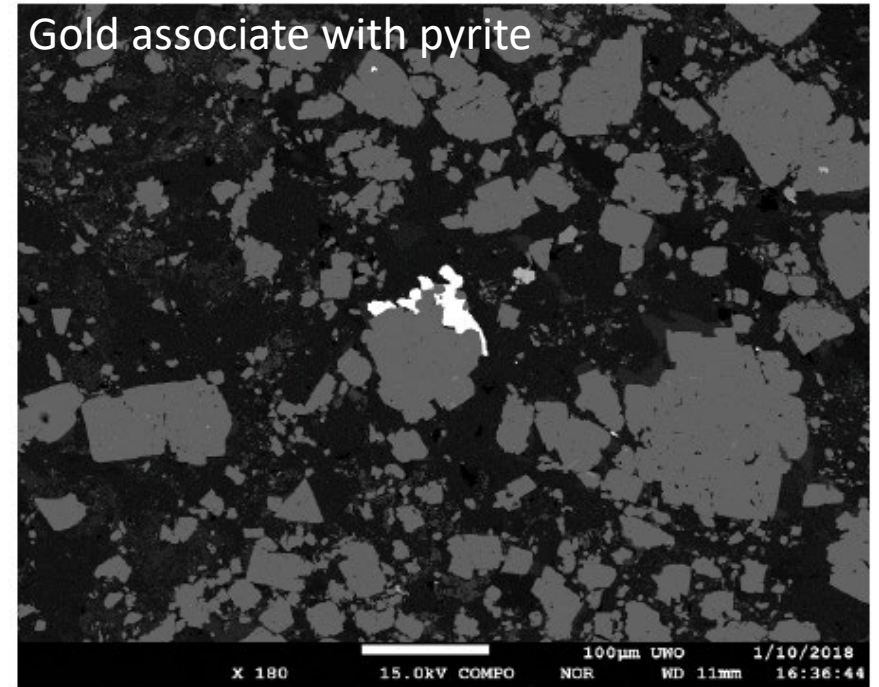
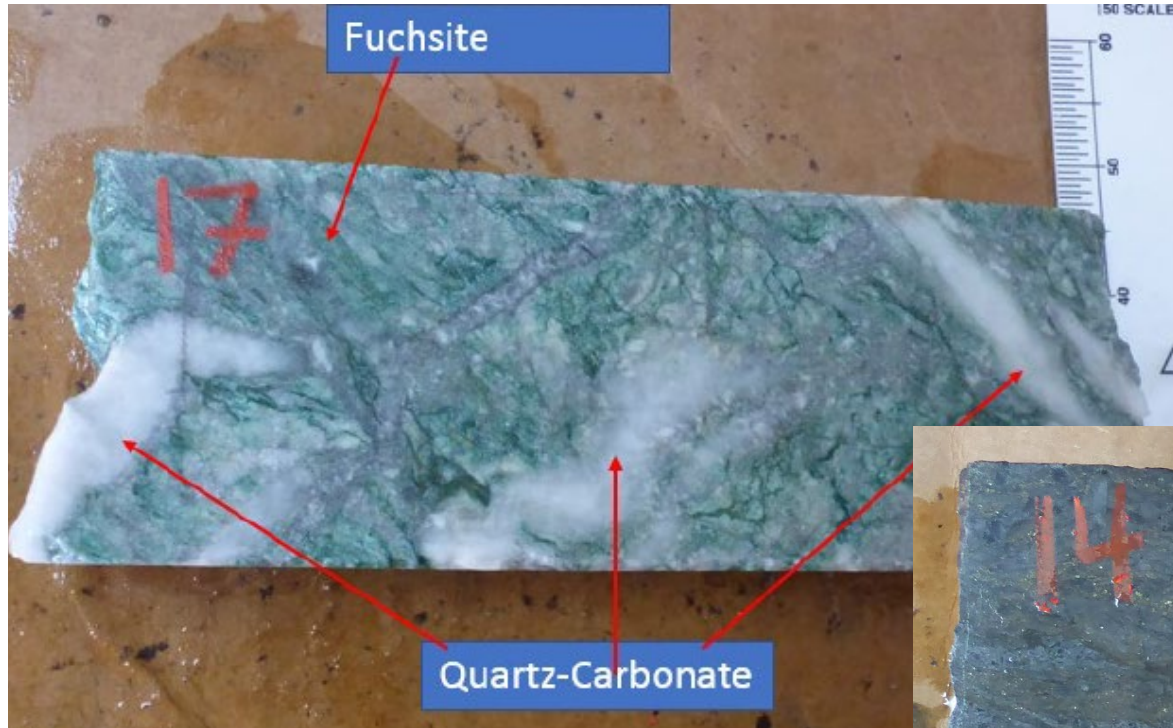


Photos courtesy of Gyorgyi Tuba

Kerr Addison styles of mineralization

Both styles have similar mass change suggesting the same fluid
Differences reflect the different protolith (Lafrance 2015)

Green carbonate



Max Sandering Taylor, HBSc 2017

Kerr Addison Albitite Dykes



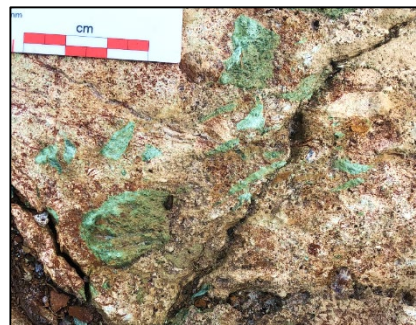
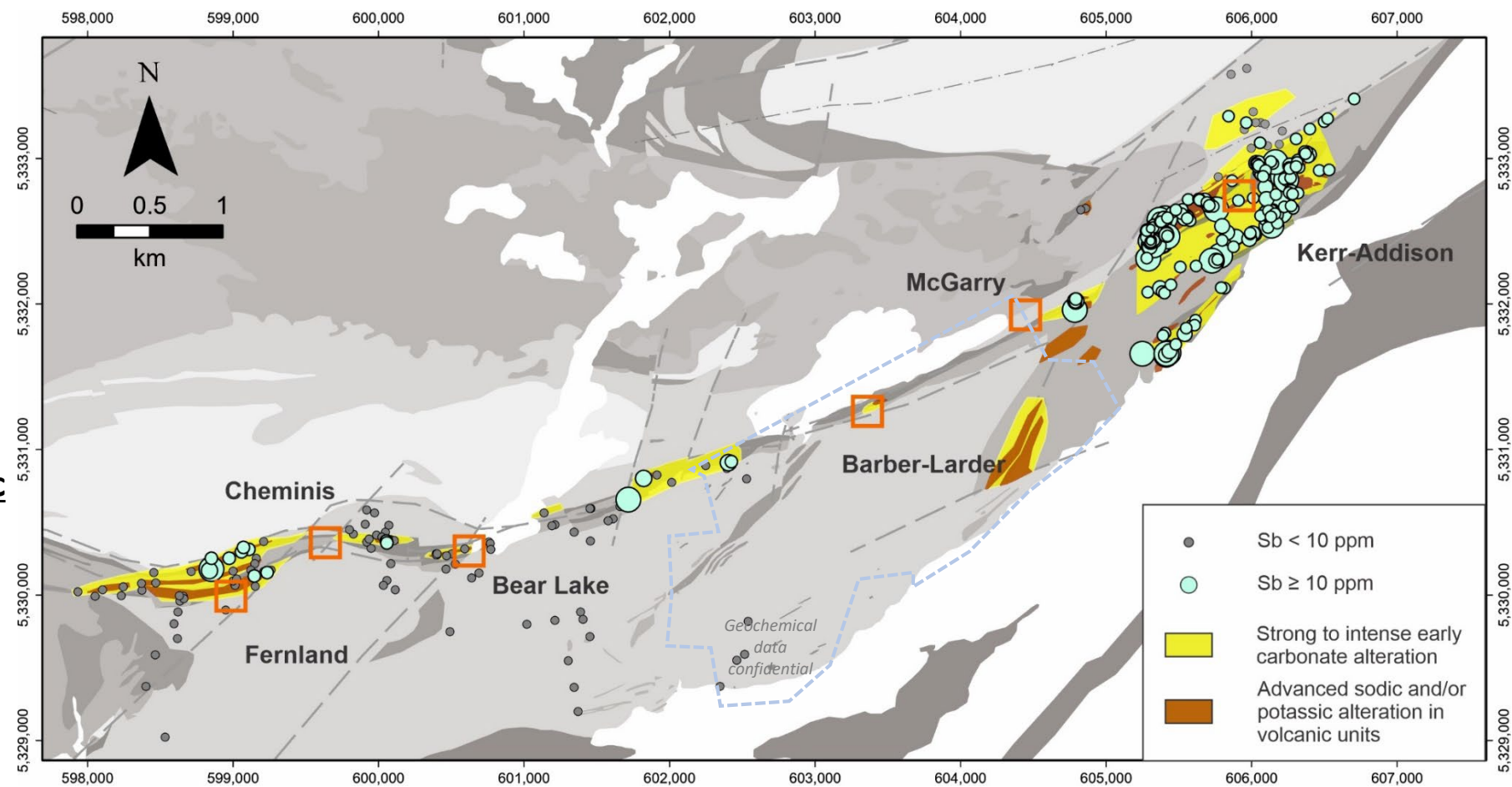
Photos courtesy of Gyorgyi Tuba

Regional context for the Larder Lake area

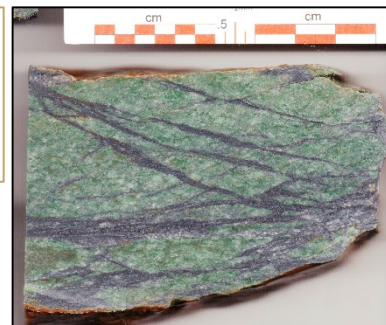
Distribution and geochemical systematics of alteration assemblages along the LLCZ

Potassic and advanced sodic alteration

- Focused in areas of strong to intense carbonate alteration
- Au, As, Sb contained within potassic and sodic zones



Fuchsitic komatiite clasts in Timiskaming conglomerate



Fuchsitic komatiite

Hydrothermal quartz-carbonate breccia



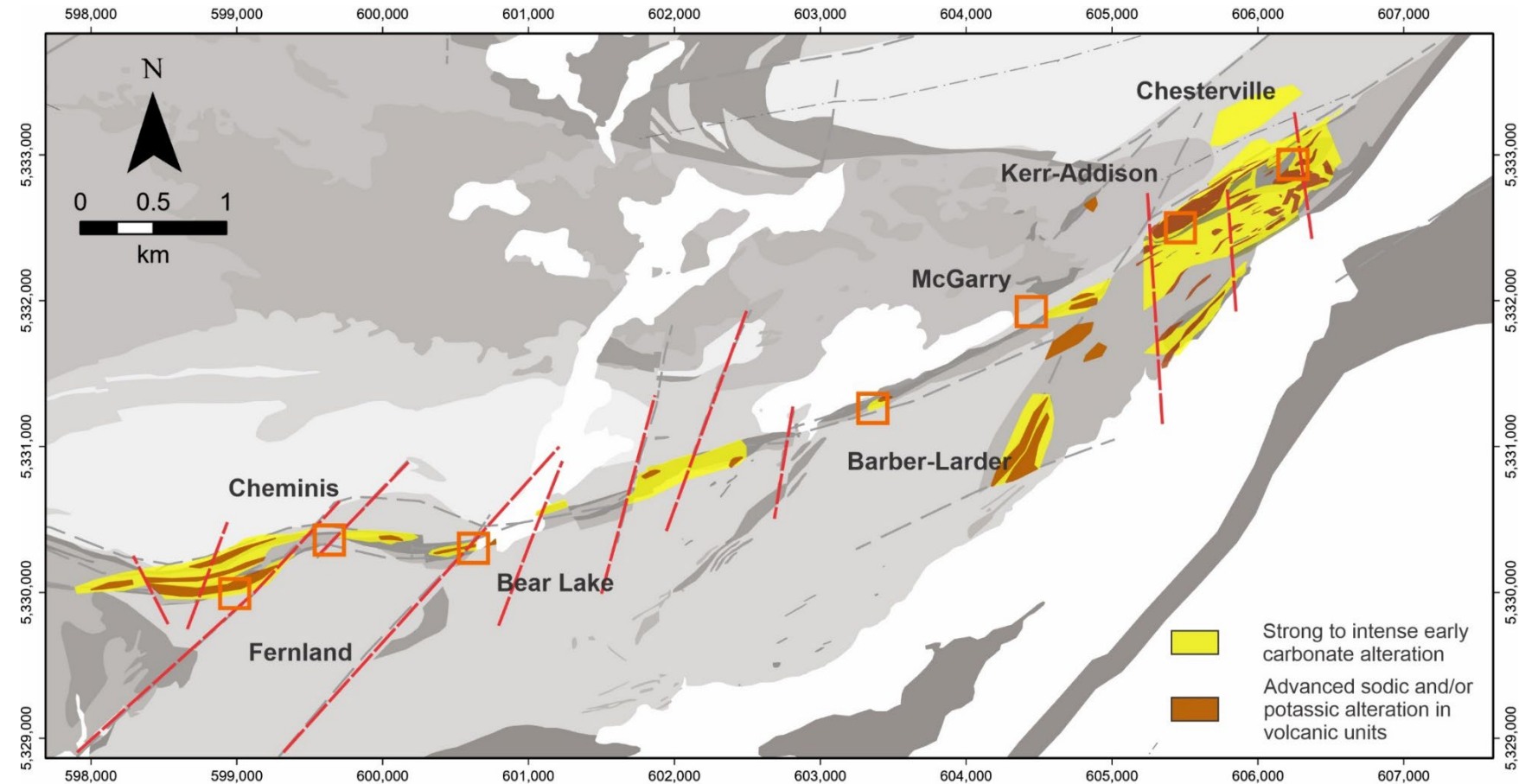
Györgyi Tuba
Pers. com

Regional context for the Larder Lake area

What makes the Kerr-Addison system special?

Compared to the Cheminis area:

- host rocks, alteration and mineralization characteristics are very similar (cf. Lafrance, 2015)
- trace element characteristics are similar
- historic grade of the deposits are similar
- timing of mineralization vs D₂ is the same (cf. Lafrance, 2015)
- Similar strike length along LLCDZ
- Similar intensity of alteration
- Significantly different thickness of the Larder Lake volcanics (ca. 250 m at Cheminis vs >700 m at Kerr) with more significant LLCDZ “splays” identified

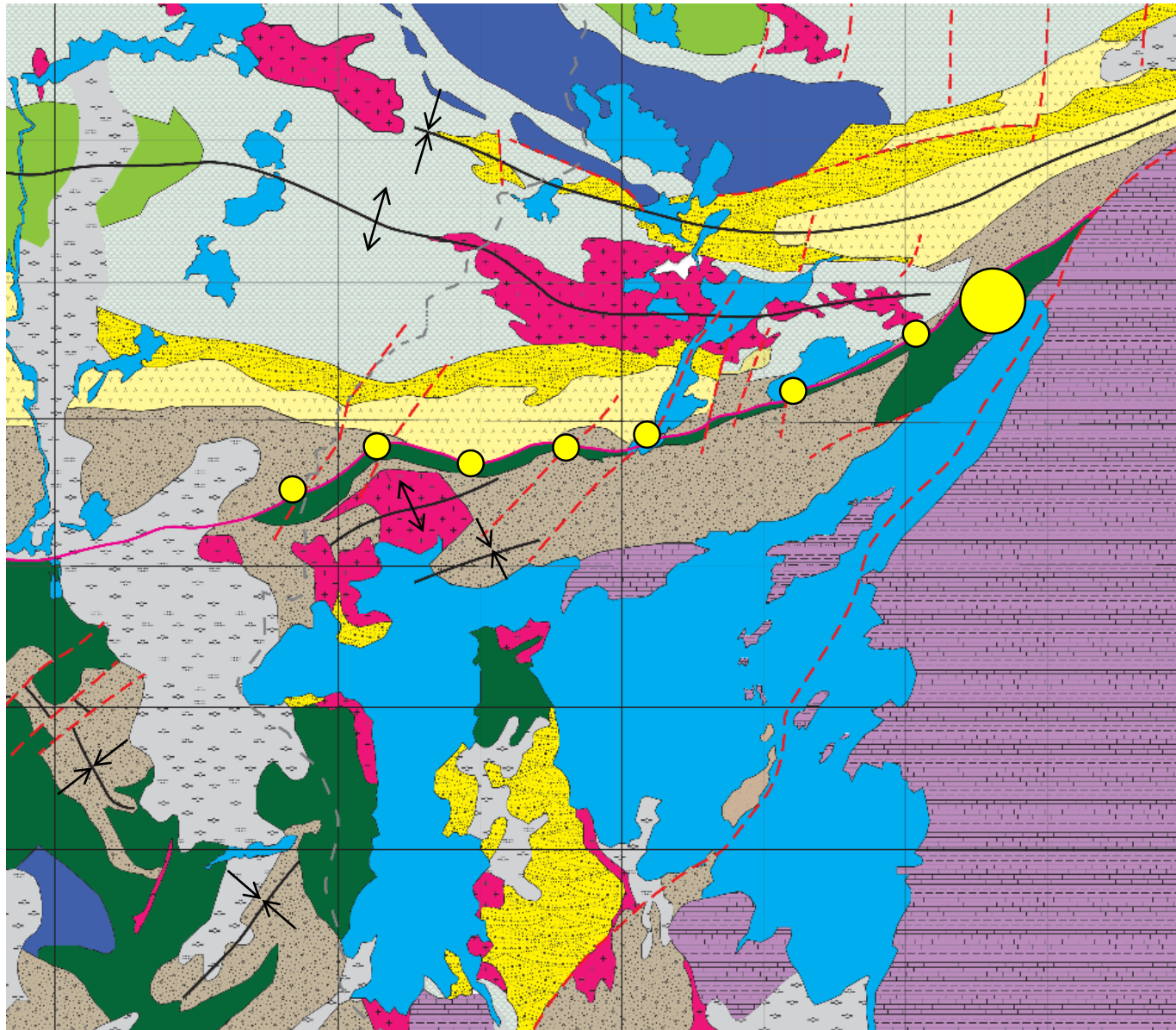


Györgyi Tuba
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Same fluid, same hydrothermal system

– increased fluid volume

Metal Earth Role of NE trending faults



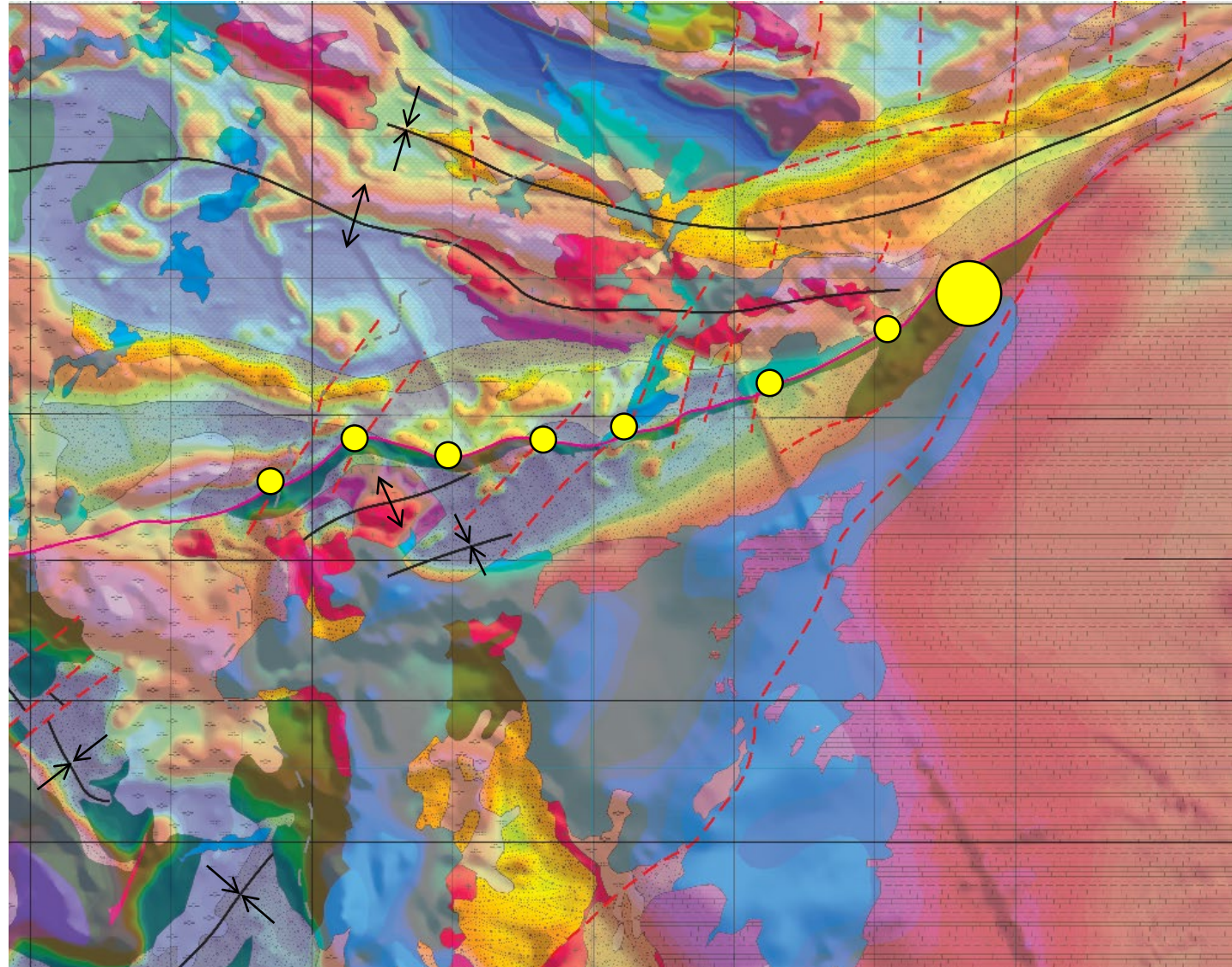
Role of NE trending faults

No offset on lithologic contacts

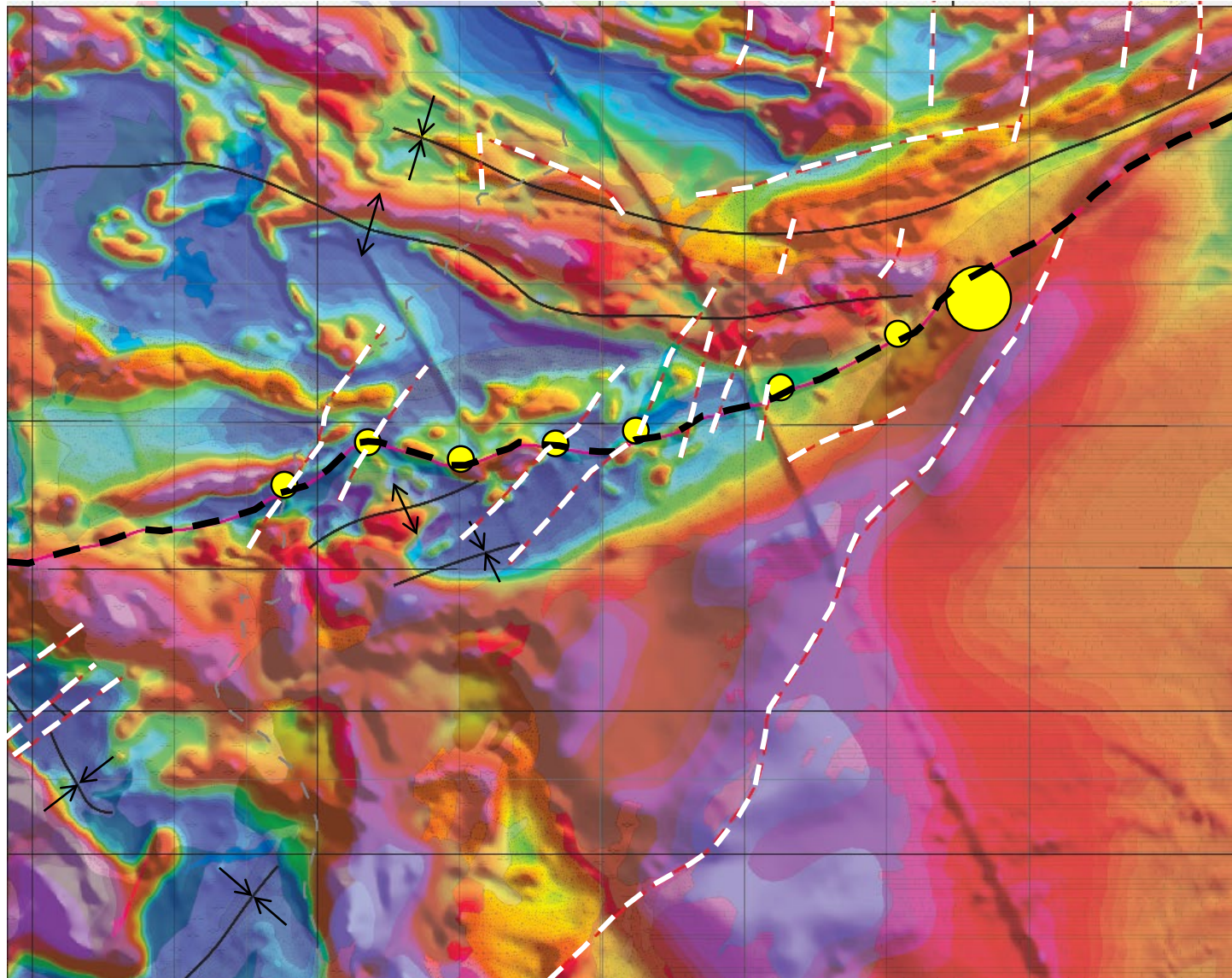
Mainly within the Timiskaming Assemblage

Clearly mapped with magnetics

Metal Earth



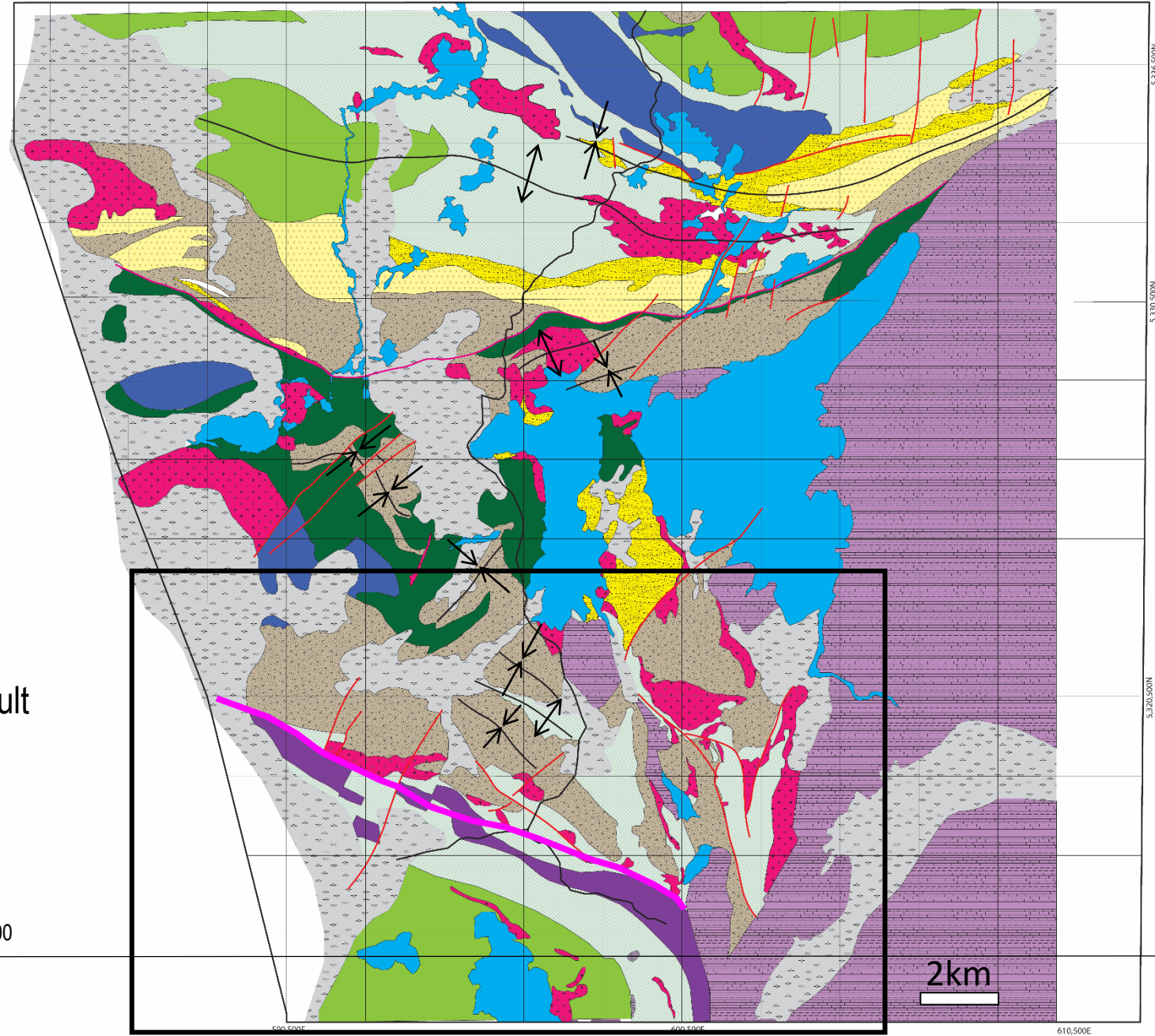
Metal Earth



Intersection of CLLdz
And NE faults
localizes deposits

Largest NE fault,
controls Paleozoic
sedimentary rocks
Is the largest gold
deposit

Lincoln Nipissing area



Lincoln Nipissing fault

From: Jackson, 1995, OGS Map 2628, 1:50,000



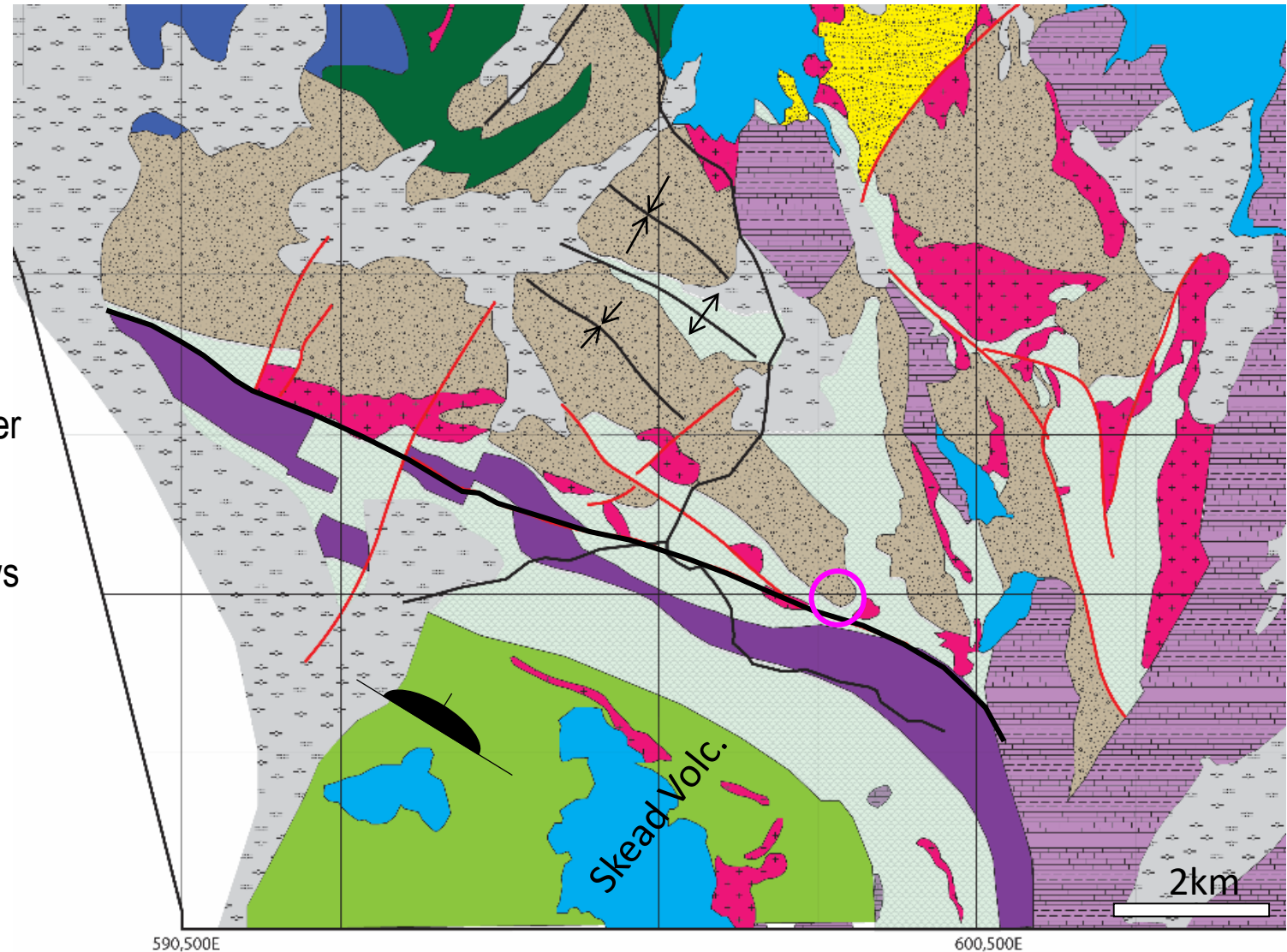
Lincoln Nipissing area

Unconformity developed at contact between clastic sediments and UM volcanic rocks

LN fault system juxtaposes

Skead volcanic rocks against younger volc strata

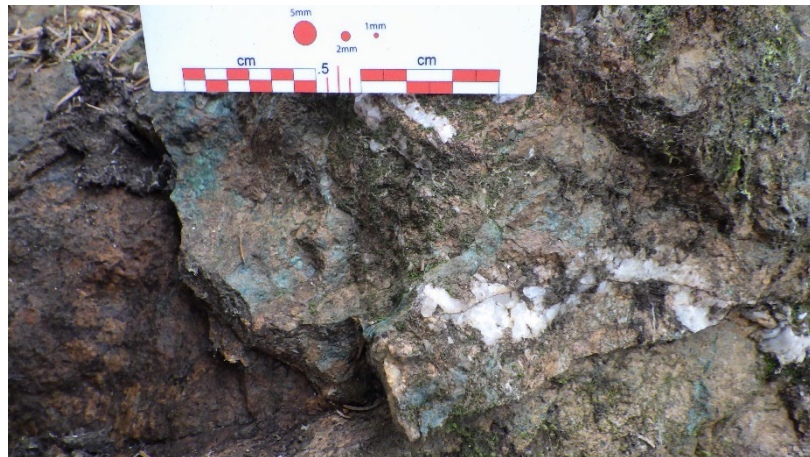
Marked by peridotite – komatiite flows



From: Jackson, 1995, OGS Map 2628, 1:50,000

Structure and Veins

Lincoln Nipissing deformation fabric



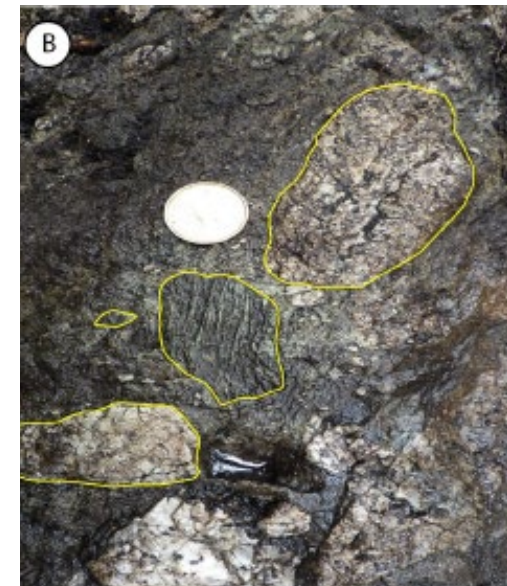
Fuchsite-quartz in LN deformation zone

Photos courtesy of Kate Rubingh

Lincoln Nipissing shear zone

Basal unconformity developed between (a) the Larder Lake grp. (ca. 2710-2704 Ma) and (B) the Hearst ass. (> ca. 2700 Ma)

Similar structural / stratigraphic relationships as the Cadillac-Larder Lake break

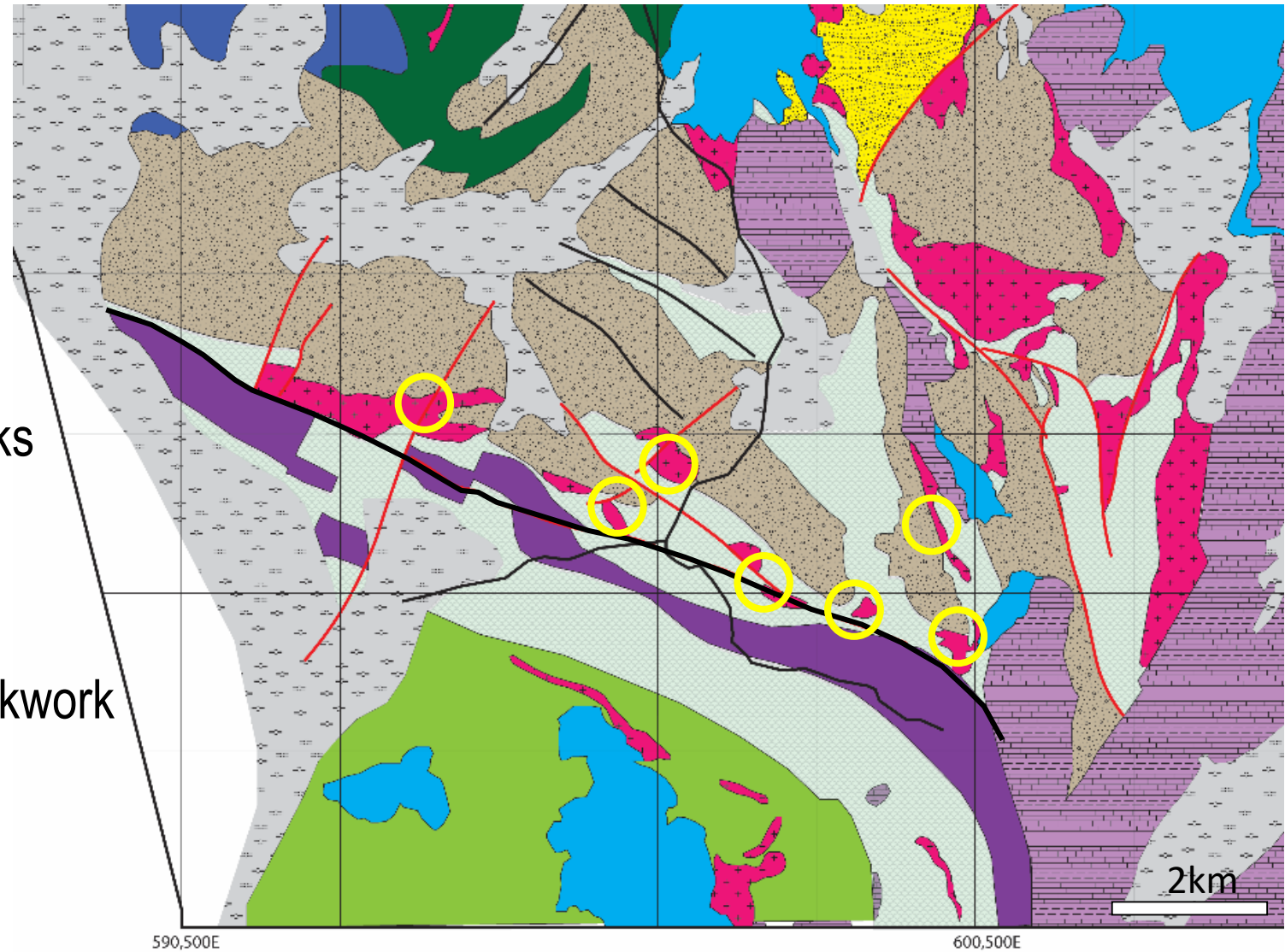


Lincoln Nipissing mineralization

Small volume intrusive stocks

Stitch the LN fault system

Associated with gold in stockwork veins



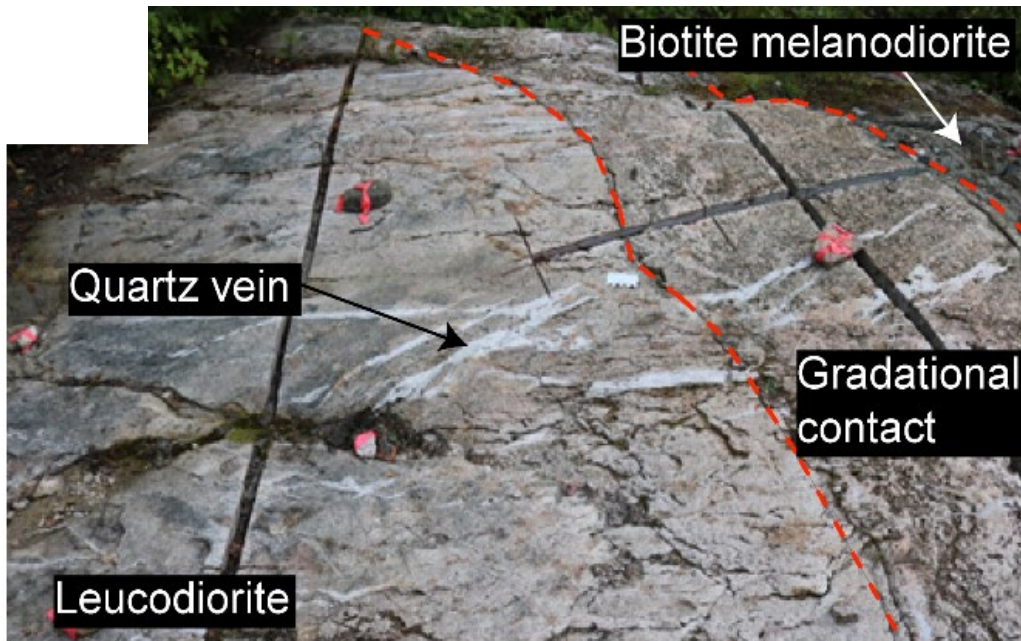
From: Jackson, 1995, OGS Map 2628, 1:50,000

Lincoln Nipissing intrusive rocks

Intrusives ca. 2675Ma ~ Timiskaming in age

Despite intense alteration of host rocks

Gold was found exclusively in the felsic intrusive rocks within late quartz ± carbonate veins



Sean Brace MSc candidate

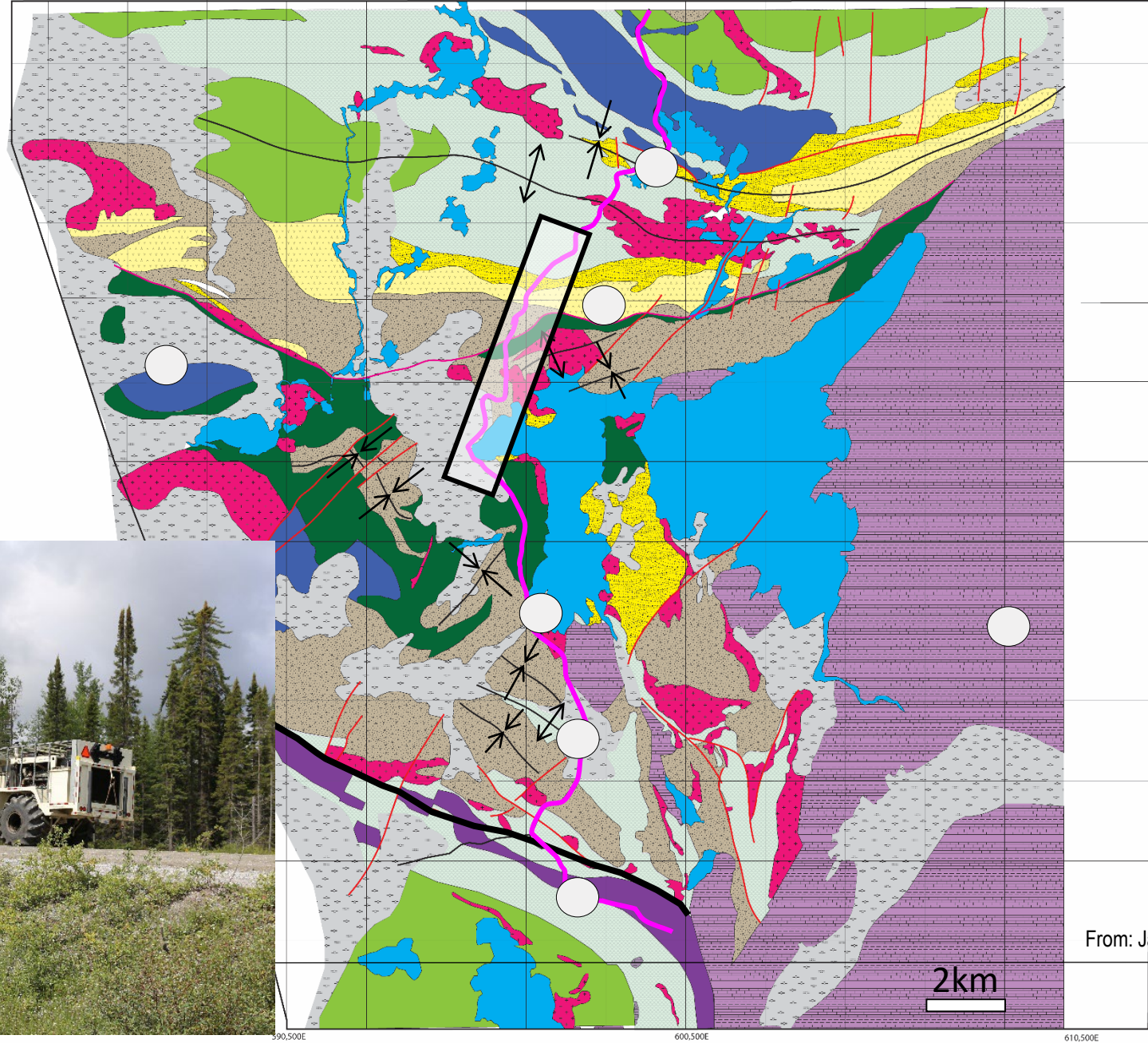
Metal Earth

how are these faults expressed geophysically

Transect Scale Research

Larder Lake Transect

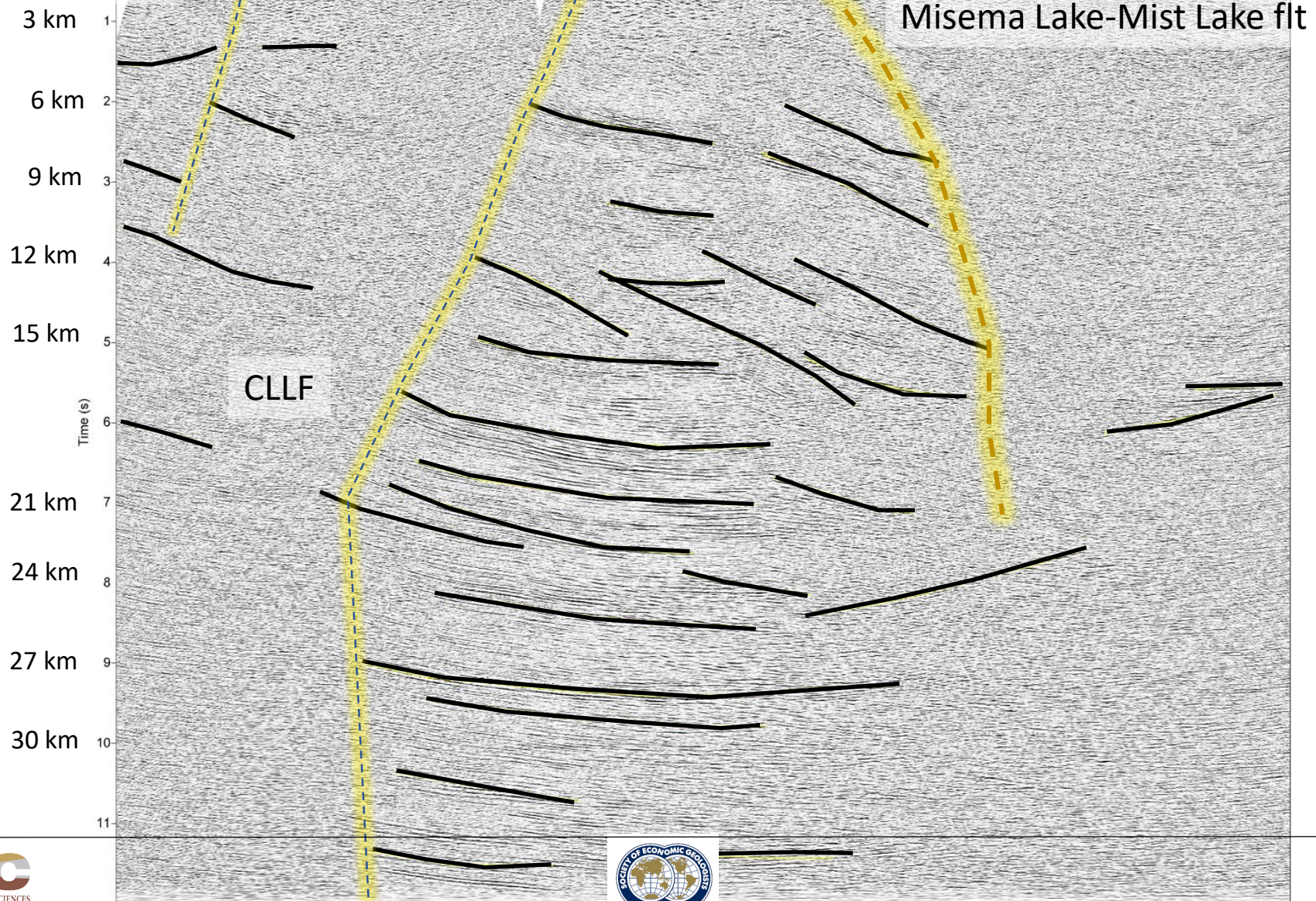
Seismic & MT



From: Jackson, 1995, OGS Map 2628, 1:50,000

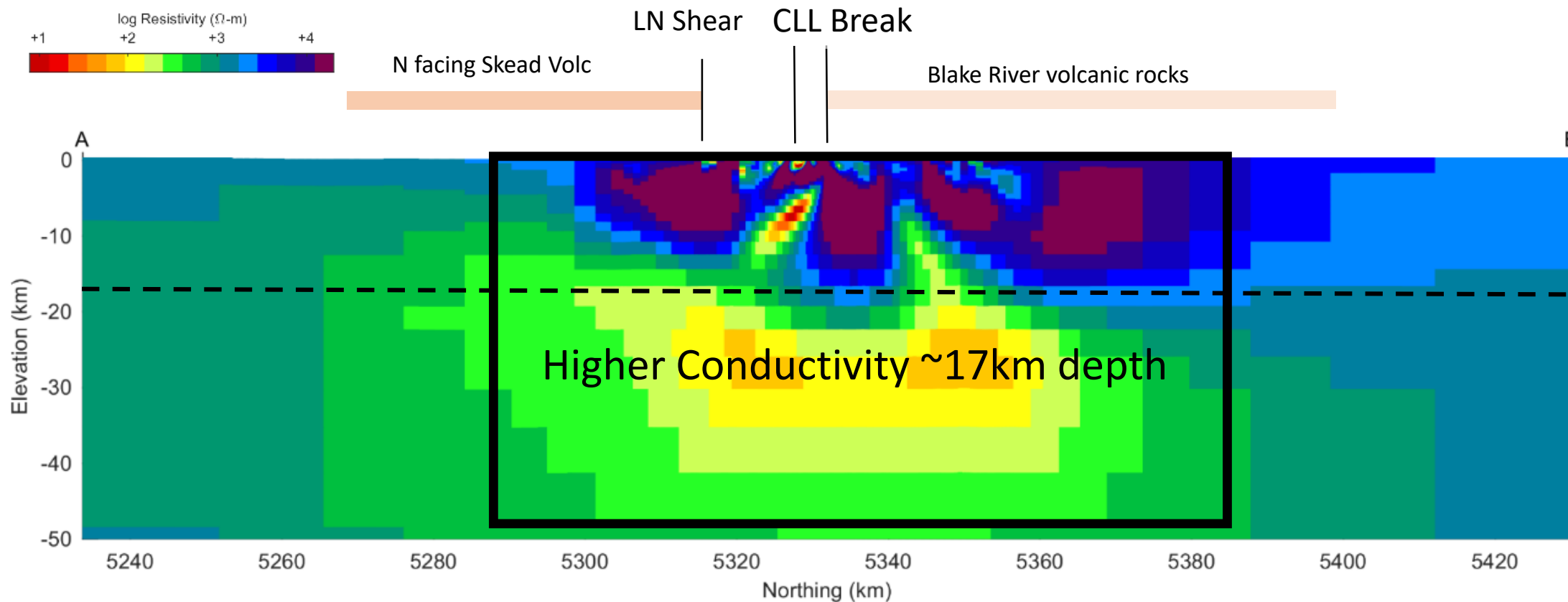
Metal Earth

Lincoln Nippising



Larder Lake MT – AMT section, 3D inversion

LL181112-allm1s : Model 11: ice=53 South-North View

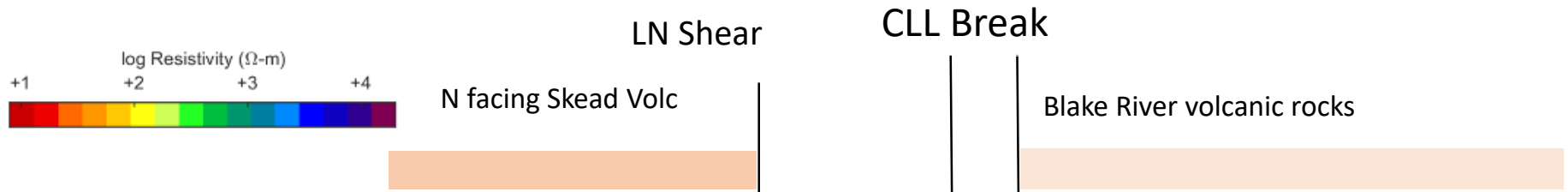


Graham Hill, Personal Com..



Larder Lake MT – AMT section, 3D inversion

LL181112-allmdls : Model 11: ice=53 South-North View

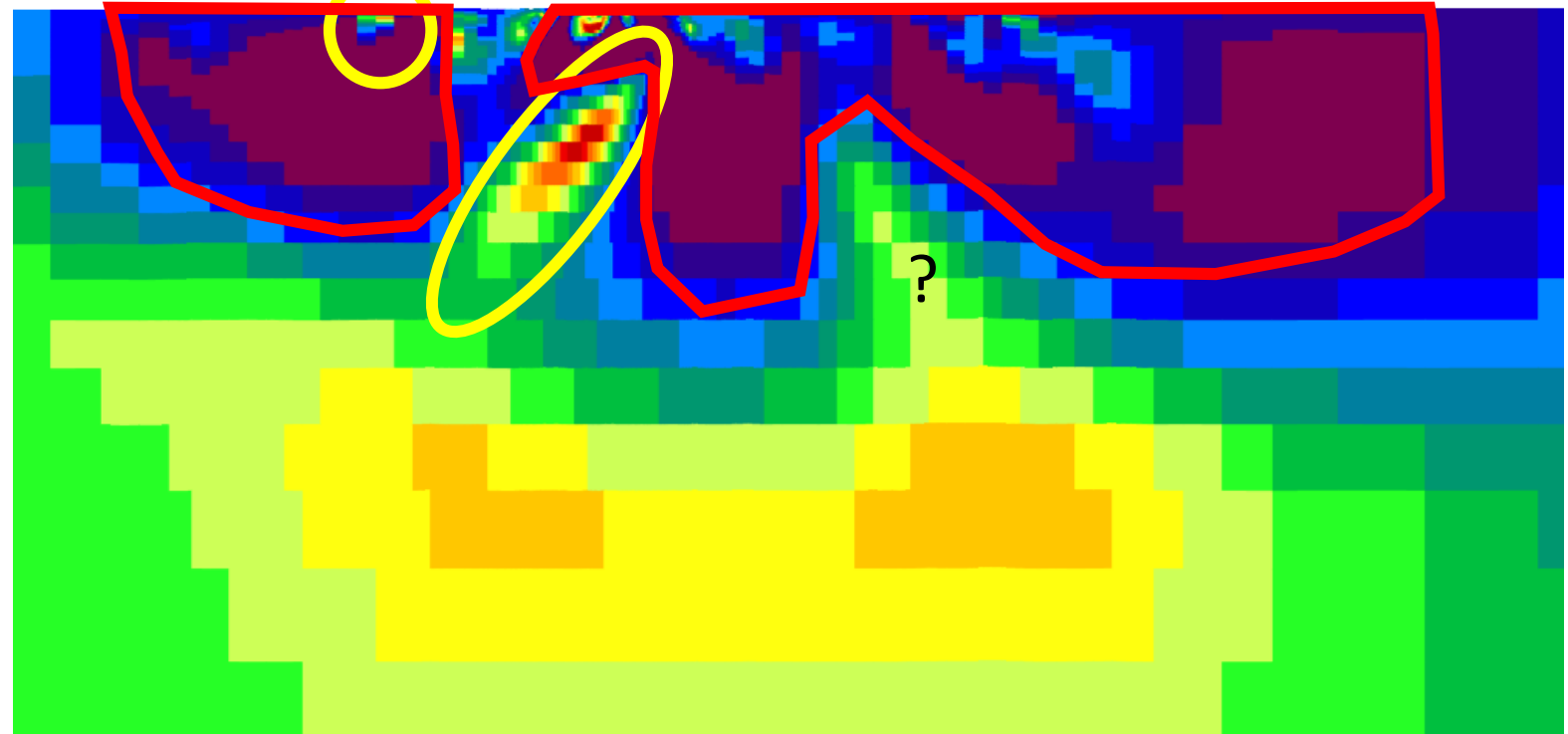


Mapping high resistivity volcanic blocks

C-LL break has conductivity contrast traced to +30km

LN shear very minor conductivity contrast to under 3km

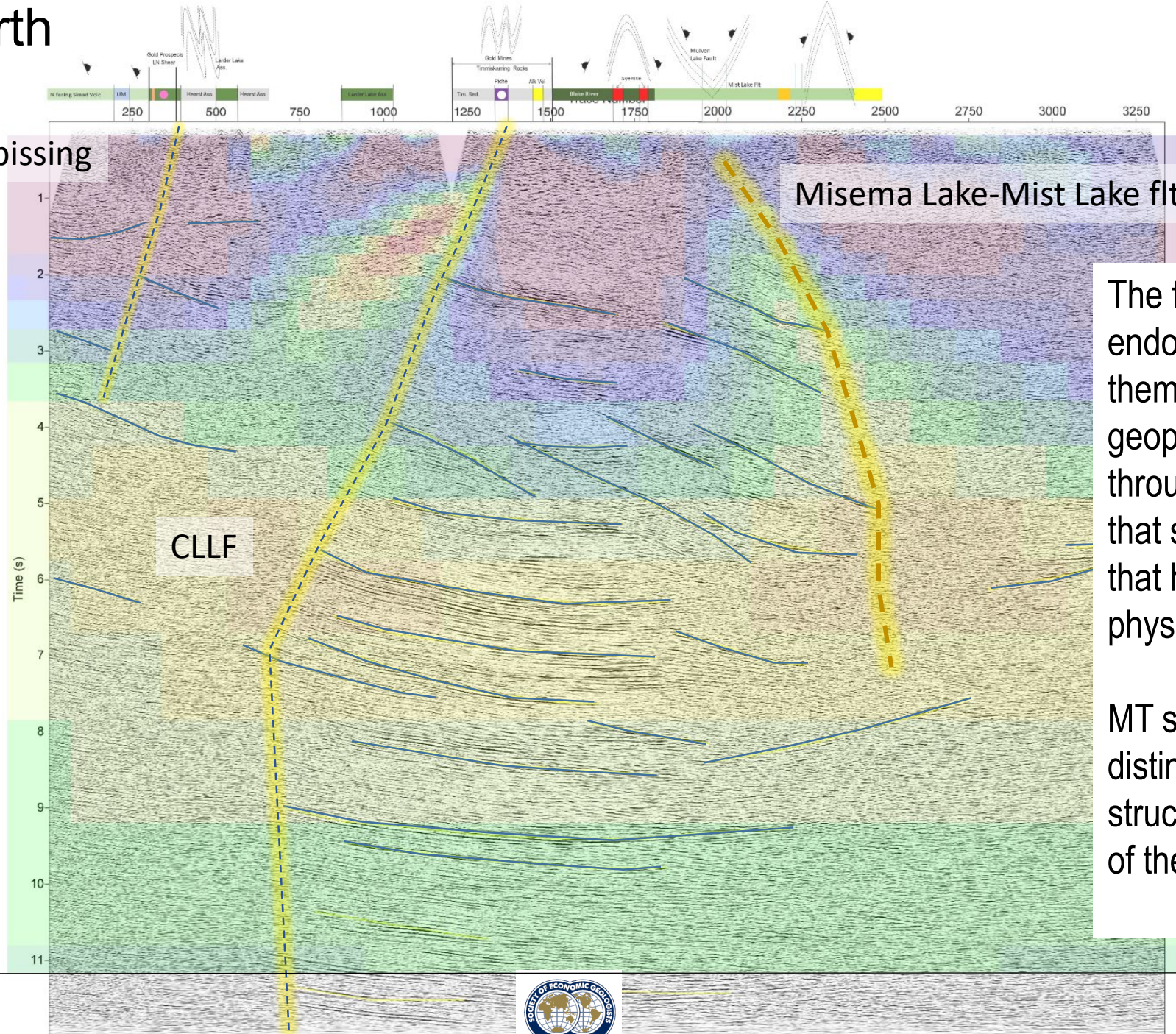
Contrast typically considered alteration effect



Graham Hill, Personal Com..

Metal Earth

Lincoln Nipissing



The fertile, highly endowed faults manifest themselves geophysically as large through going features that separates domains that have distinct physical properties.

MT surveys shows a distinct contrast in the structural hanging wall of the fertile systems.

Summary

- Cadillac Larder Lake Deformation Zone (CLLDZ), accounts for the main gold endowment in the Superior, +112Moz
- CLLDZ is variable in orientation and likely rotated around a horizontal axis
- Pre-Timiskaming the ancestral fault was likely the juxtaposing between the Blake River and the Larder Lake groups
- Gold is associated with mafic and UM rocks of the LLg, alteration assemblages are dependent on the host lithology
- Veining-alteration and mineralization is associated with regional D2 event
- Other fault systems (LN) have similar structural an stratigraphic setting
- The fertile, highly endowed faults manifest themselves geophysically as large through going features that separates domains that have distinct physical properties. MT surveys shows a distinct contrast in the structural hanging wall of the fertile systems.
- Isotropic to seismic



Area Selection Tool

Apply methodology to greenfields environments as a way of prioritizing exploration efforts

Areas without framework geoscience

Such as Birimian of West Africa
Guiana Shield South America



Thank you.

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