



**GEOLOGICAL SURVEY OF CANADA  
OPEN FILE 7490**

**The GEM Chesterfield gold project:  
understanding controls on  
western Churchill gold endowment  
from the bottom up**

**S.J. Pehrsson, M. Coyle, R. Berman**

**2014**



Natural Resources  
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Canada

**Canada**



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A bright sunburst is centered in the upper half of the image, casting a shimmering reflection on a calm lake below. The sky is a clear, deep blue, and distant mountains are visible on the horizon. The word 'GEM' is written in a large, white, serif font on the left side of the image, partially overlapping the sunburst.

# GEM

**The GEM Chesterfield gold project:  
understanding controls on  
western Churchill gold endowment  
from the bottom up**

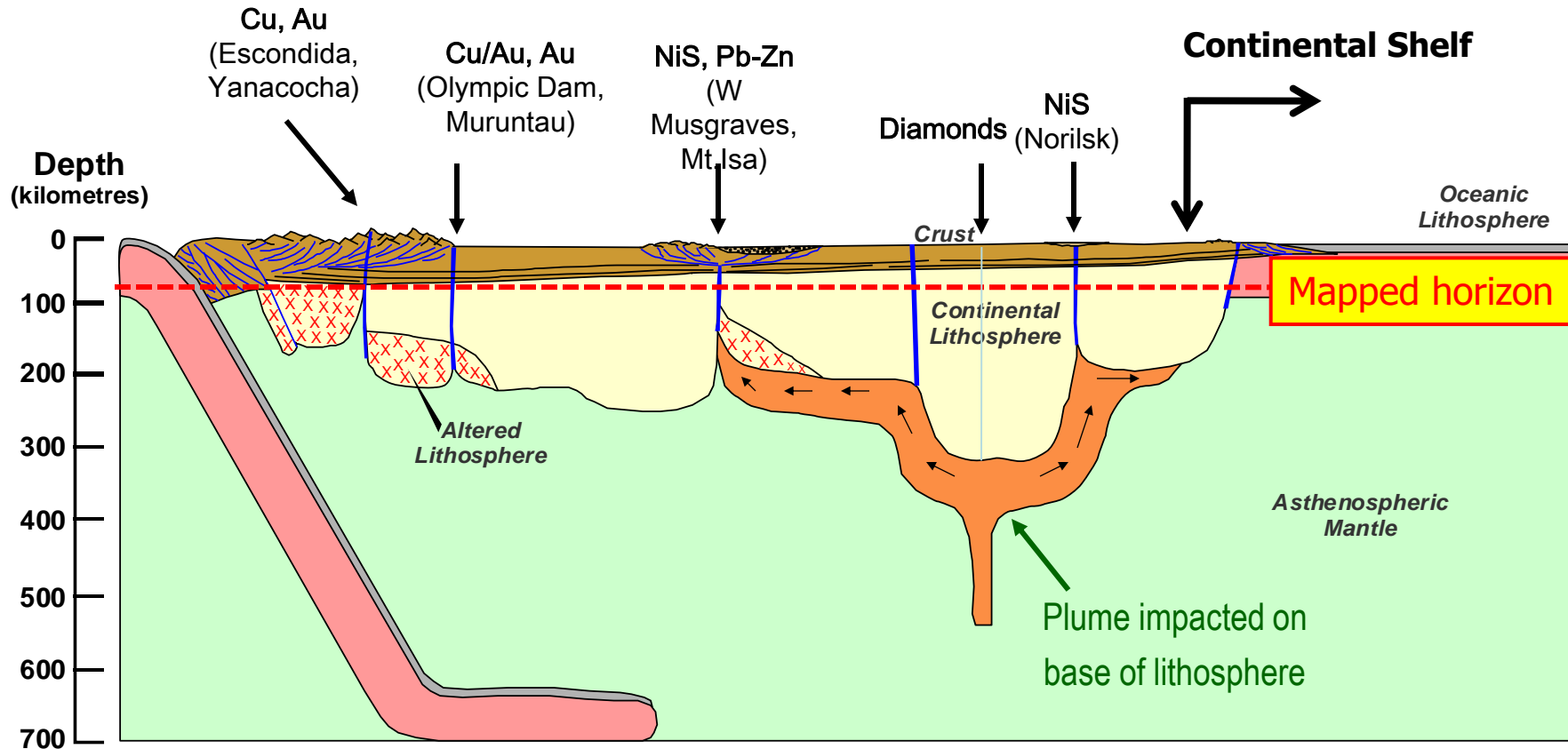
**Sally Pehrsson, Maurice Coyle and Rob Berman  
Geological Survey of Canada**



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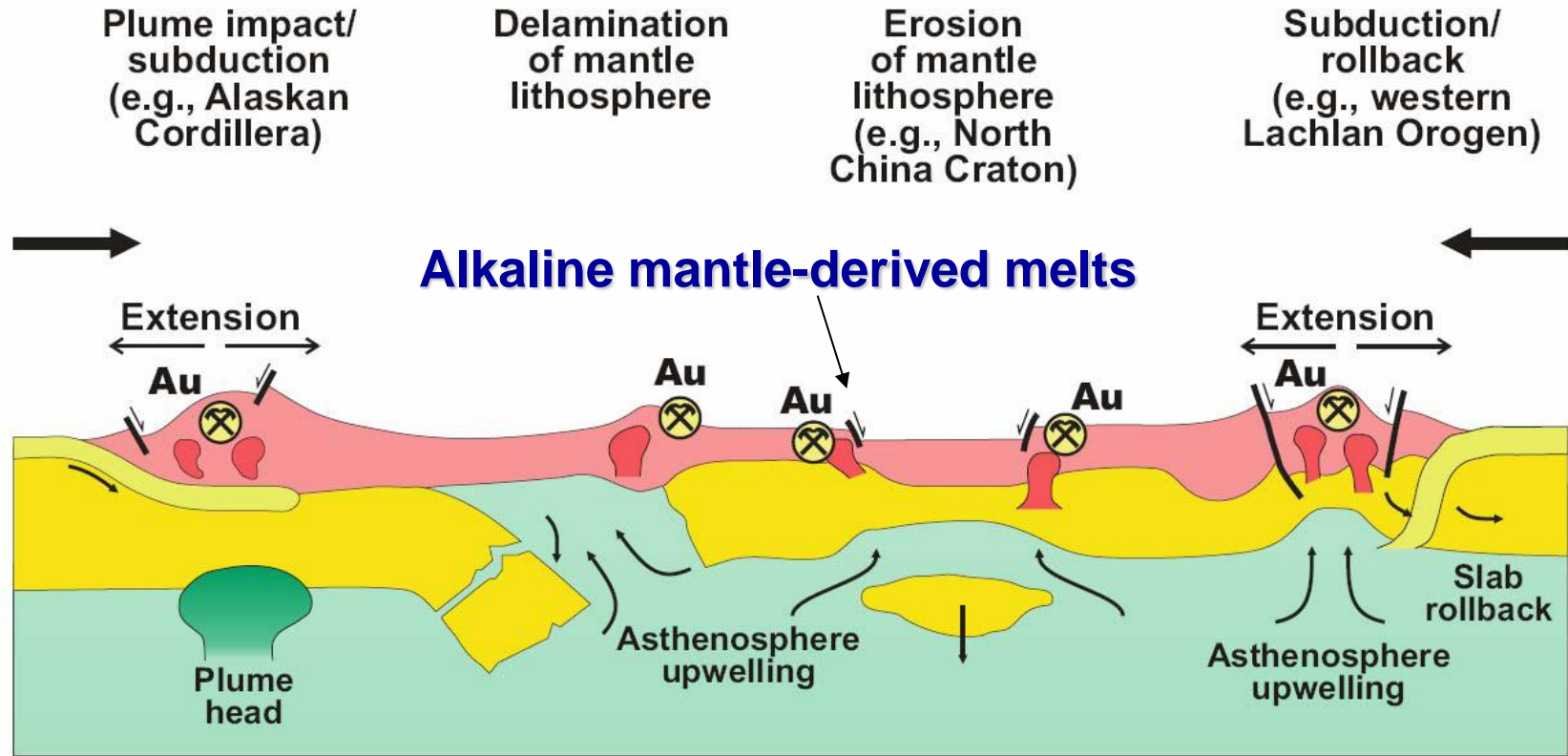


## MANTLE STRUCTURES IN KEY SETTINGS



**Giant magmatic & hydrothermal ore deposits controlled by mantle structures and combined mantle-crustal processes**

# Greatest favourability where SCLM has been modified through metasomatism



100-200 km  
60-100 km

- Accreted/stable continental crust
- Oceanic crust
- Syn- to post-gold granitoids
- Mantle plume
- Asthenosphere
- Lithospheric mantle

**Au** Orogenic gold deposit

*after Bierlein, 2008*



# Riding the Supercontinent Cycle

The crust is a passenger!

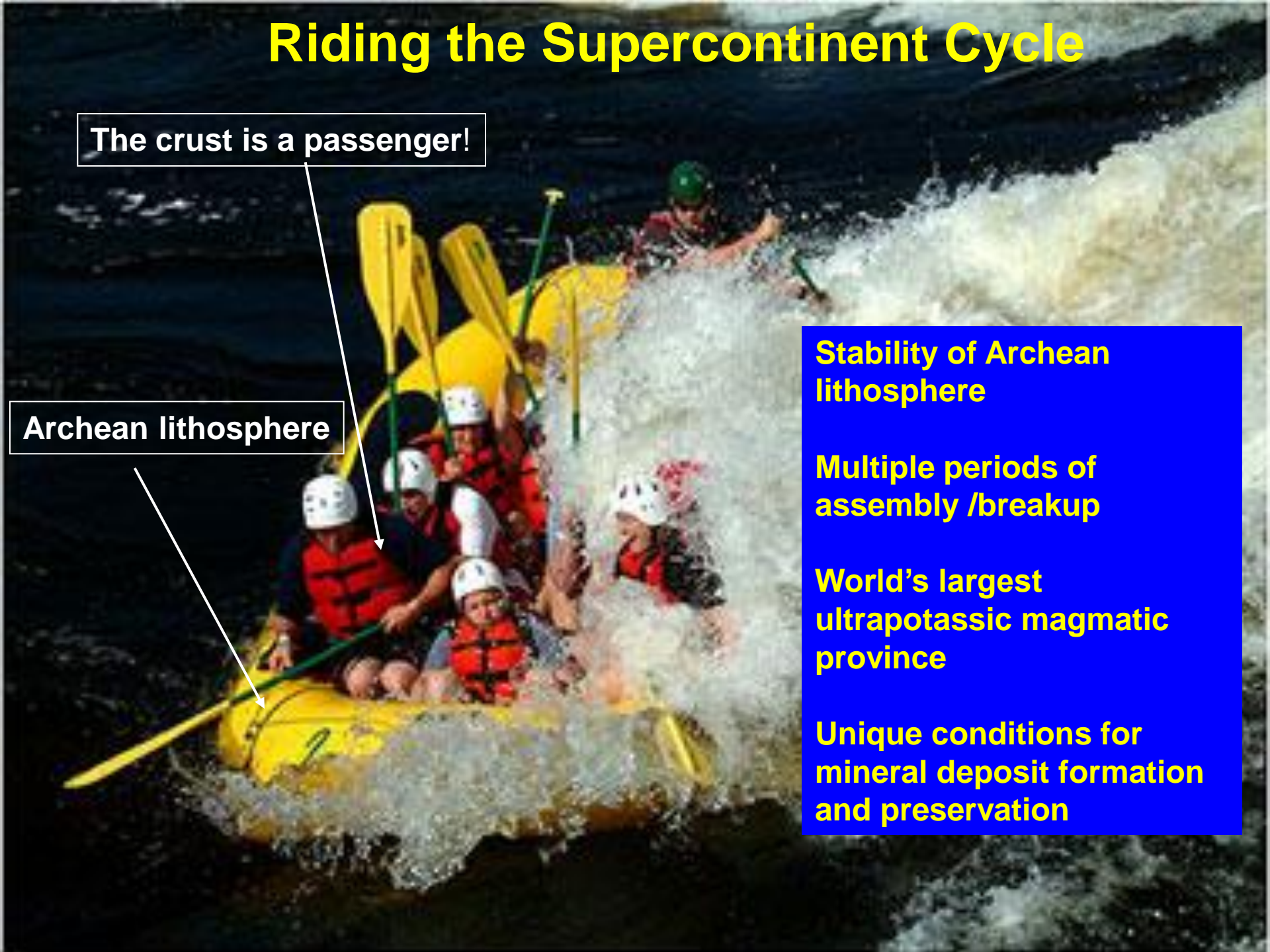
Archean lithosphere

Stability of Archean lithosphere

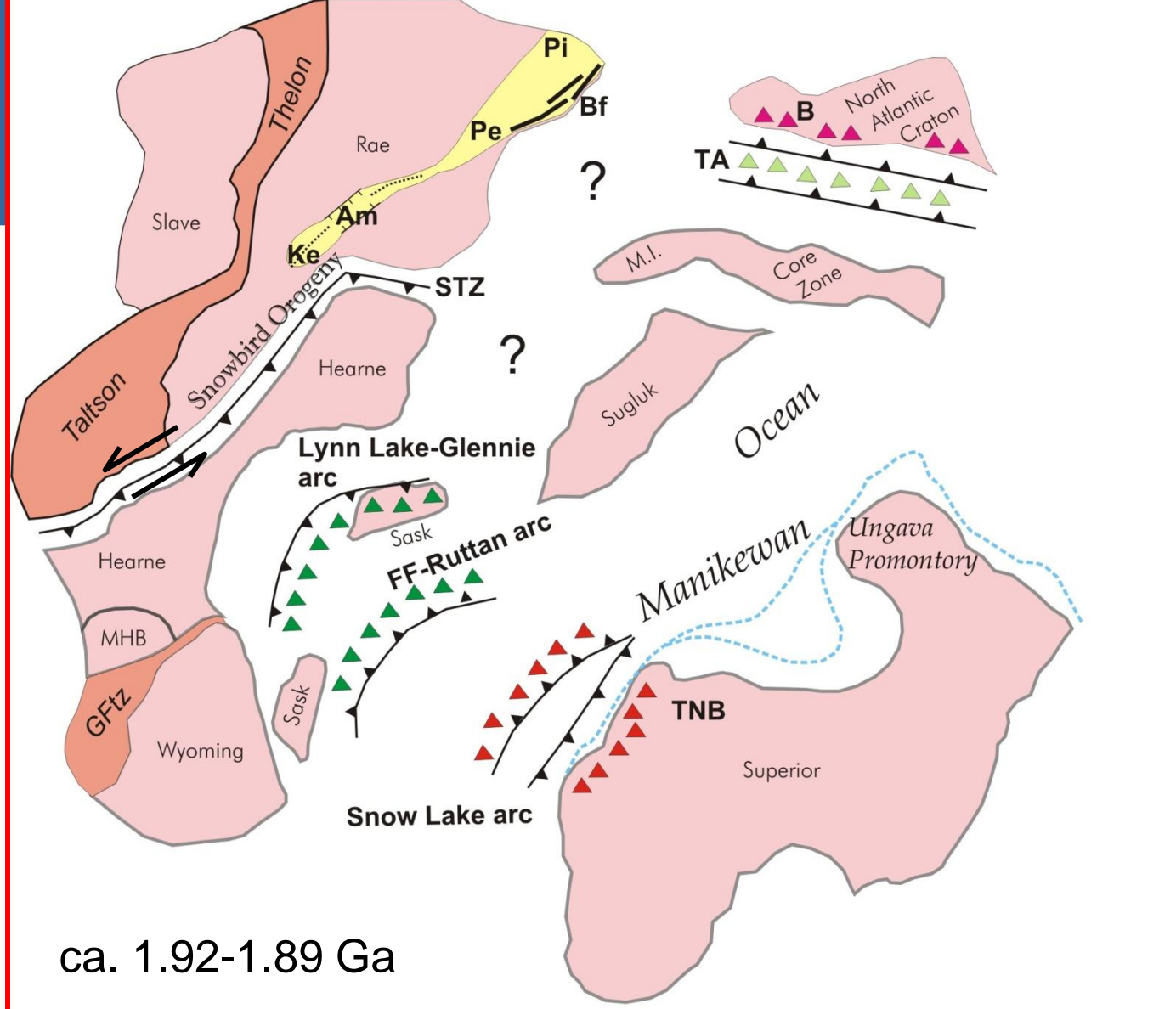
Multiple periods of assembly /breakup






World's largest ultrapotassic magmatic province

Unique conditions for mineral deposit formation and preservation



**Churchill was amalgamated through successive collisions during 1.92-1.85 Ga closure of the Manikewan Ocean and assembly of *Nuna***

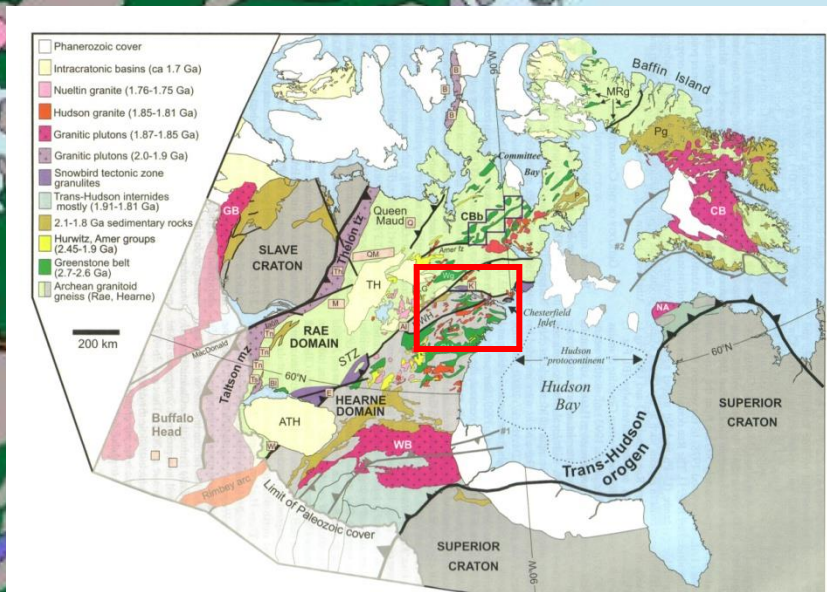
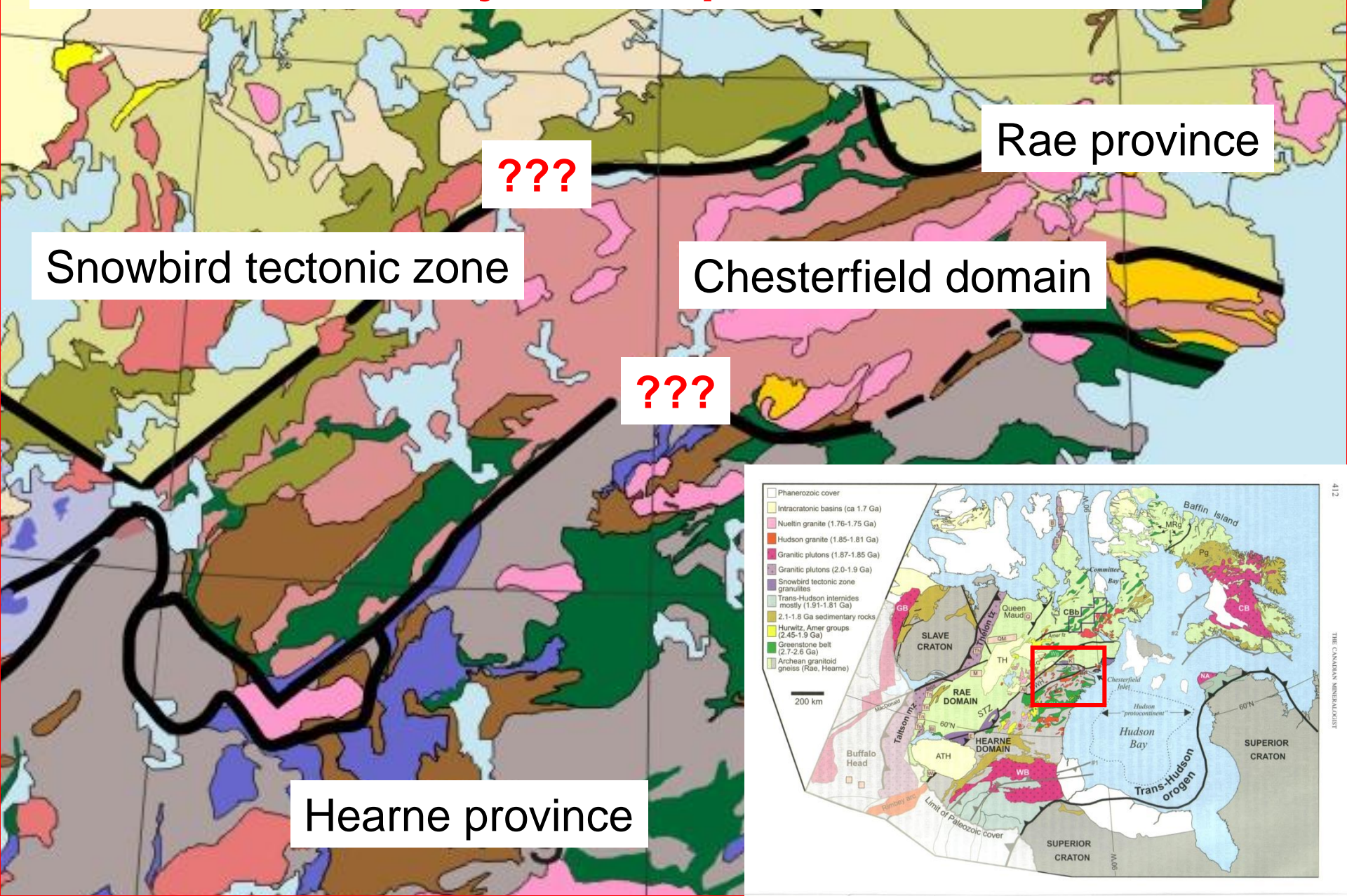


-  Flysch basin (Longstaff Bluff fm)
-  Arc, pericratonic on Sask
-  Arc, pericratonic or cratonic on Superior
-  Thrust Fault, active
-  Thrust Fault, inactive

*Corrigan and Pehrsson, in press.*

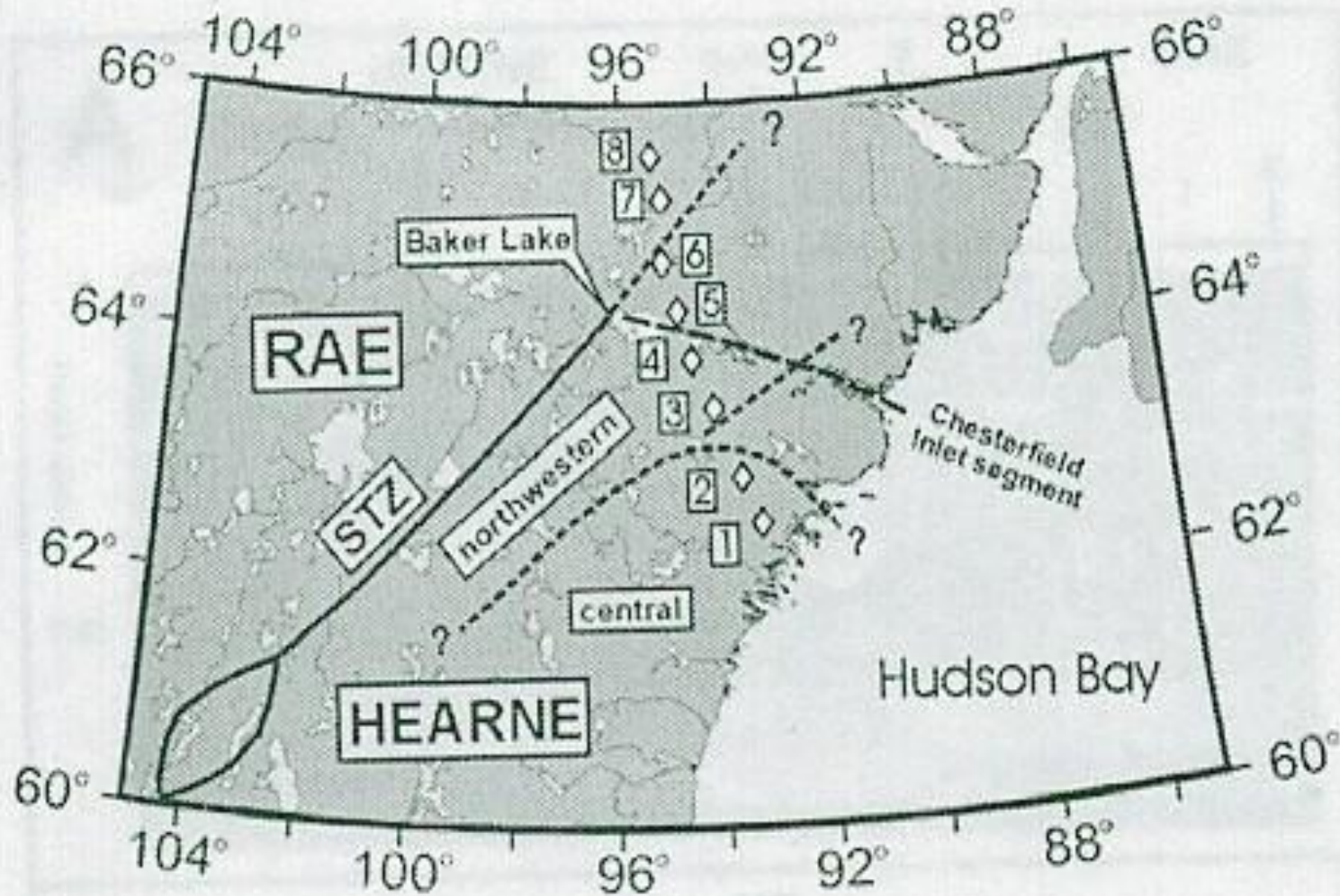


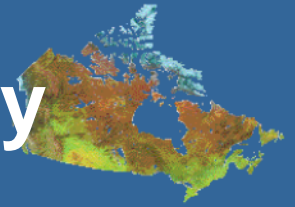
# Where are the major lithospheric boundaries?





# Where are the major lithospheric boundaries?

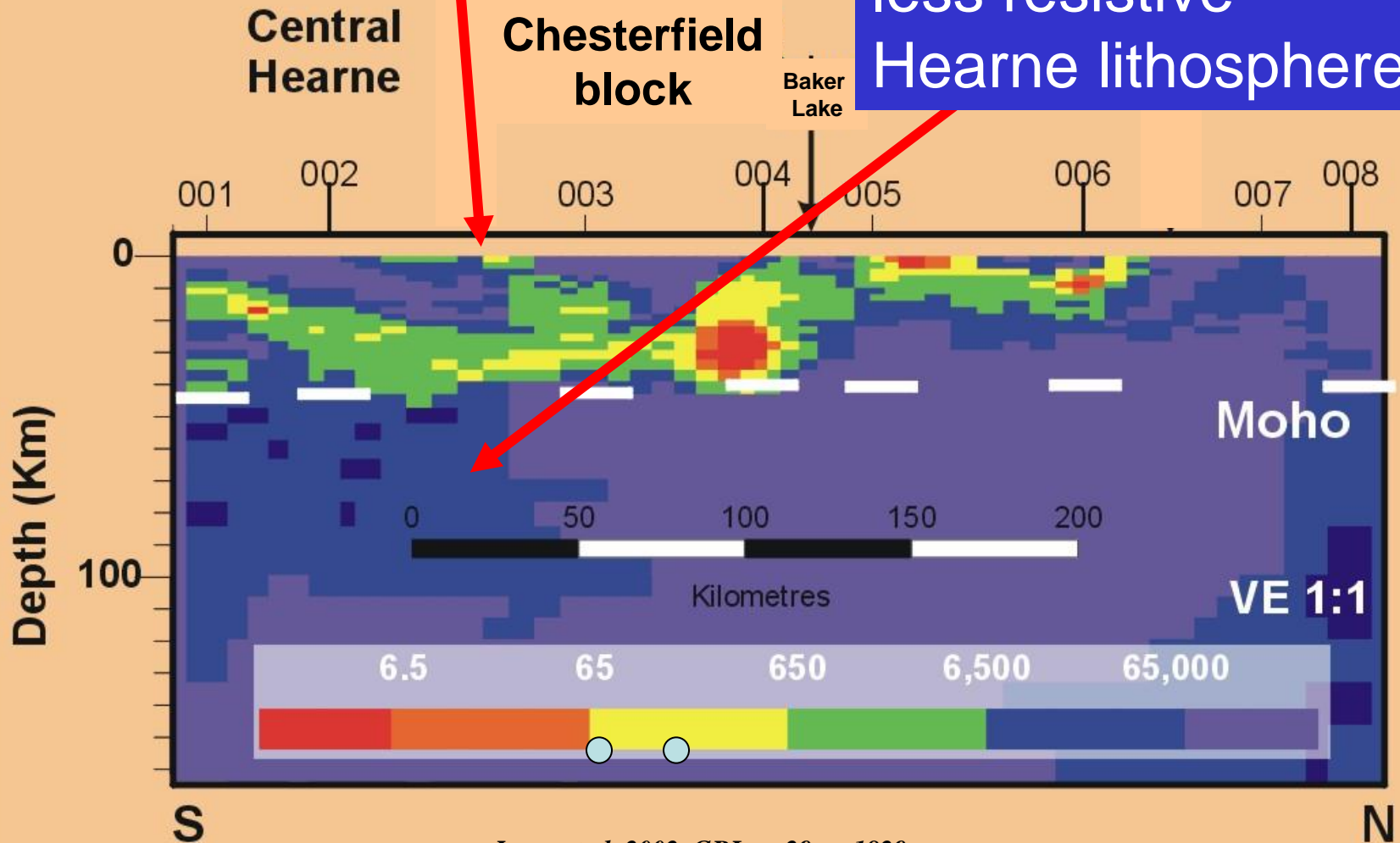




8

Pyke break

less resistive  
Hearne lithosphere





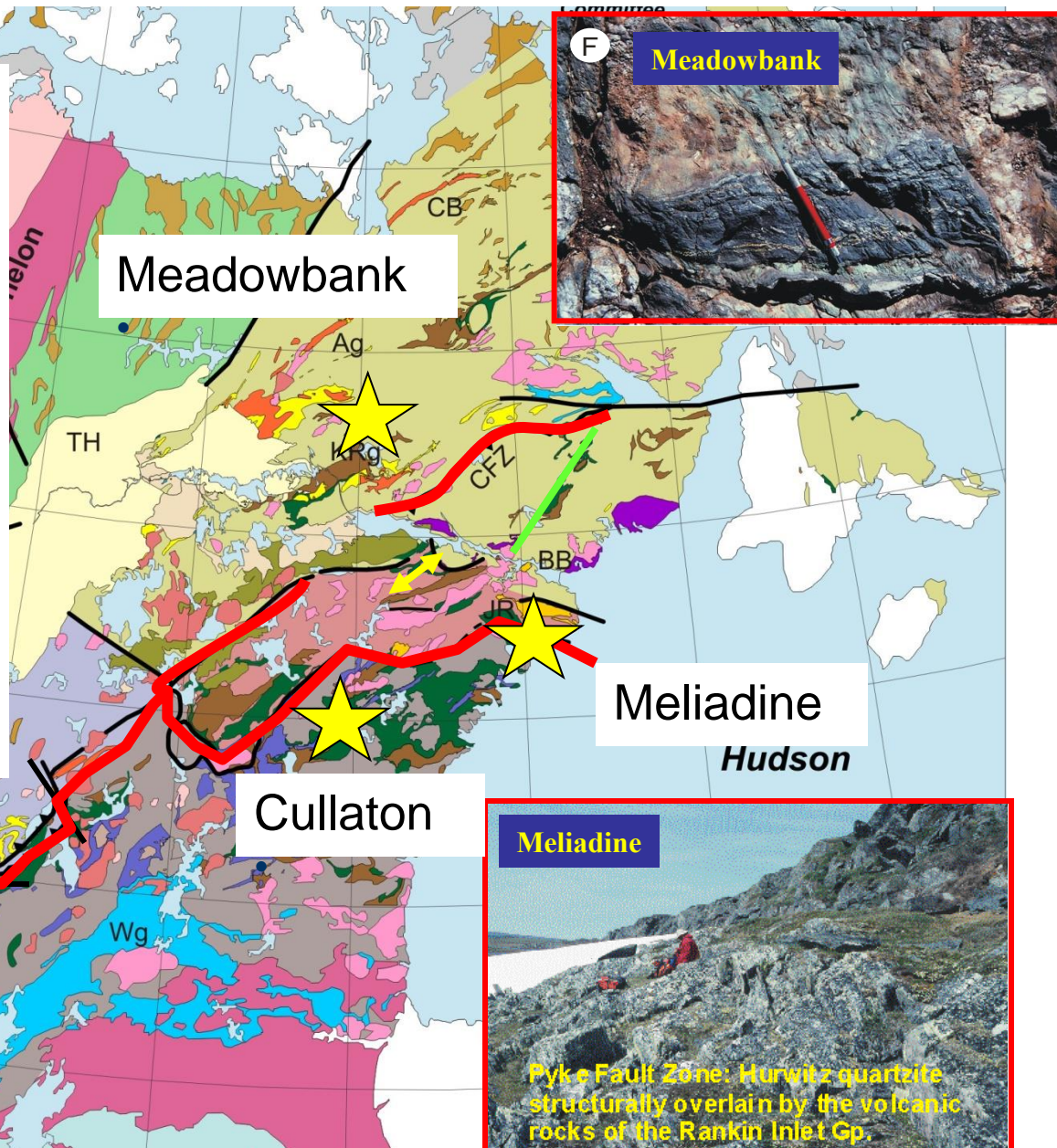
# Paleoproterozoic gold?

68°N

60°N

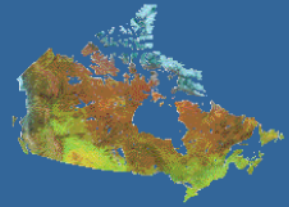
58°N

- NW-vergent, fold-thrust belts, localized transpr. shear zones
- Low to moderate P-high T metamorphism
- Crustal-scale and related structures localize, and remobilize gold\*



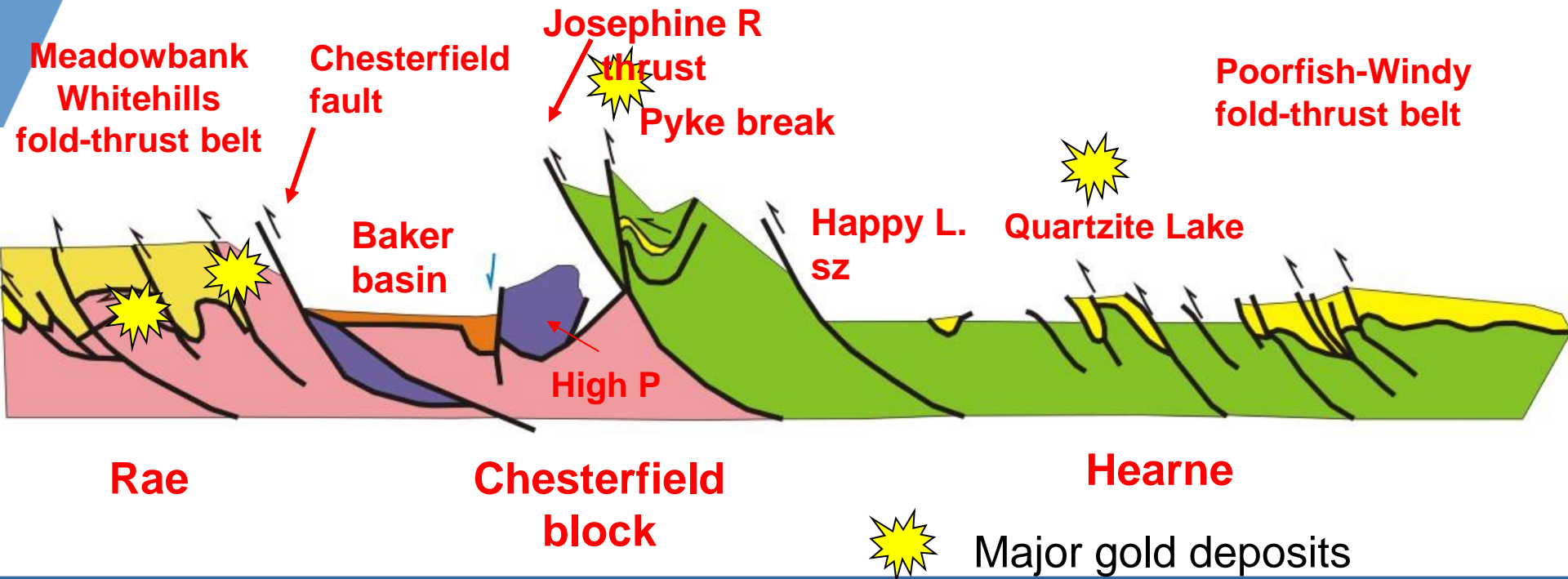
\*Goff and Kerswill, 1999; Barham, 2004; Sherlock et al., 2004\*; Carpenter et al., 2005 \*

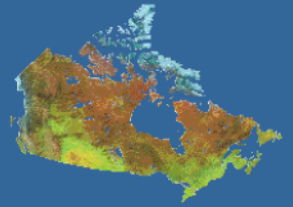




10

Is there a relationship between focusing of gold mineralization and the first order breaks bounding the Chesterfield block?





11

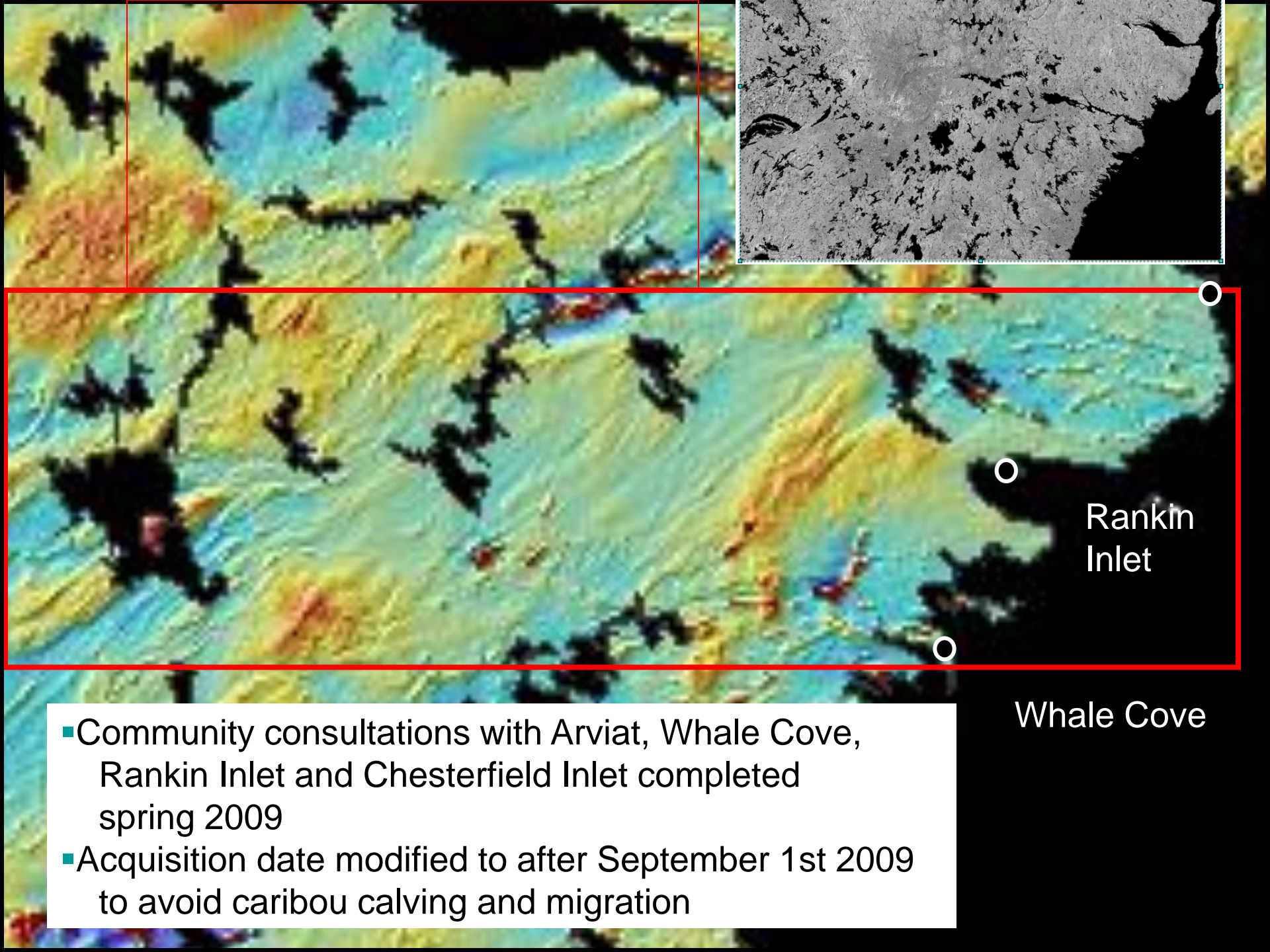
Address the inadequate knowledge of:

- the location and character of bounding structures
- age and architecture of gold deposits
- tectonostratigraphic controls on gold-bearing units

to improve gold exploration targeting





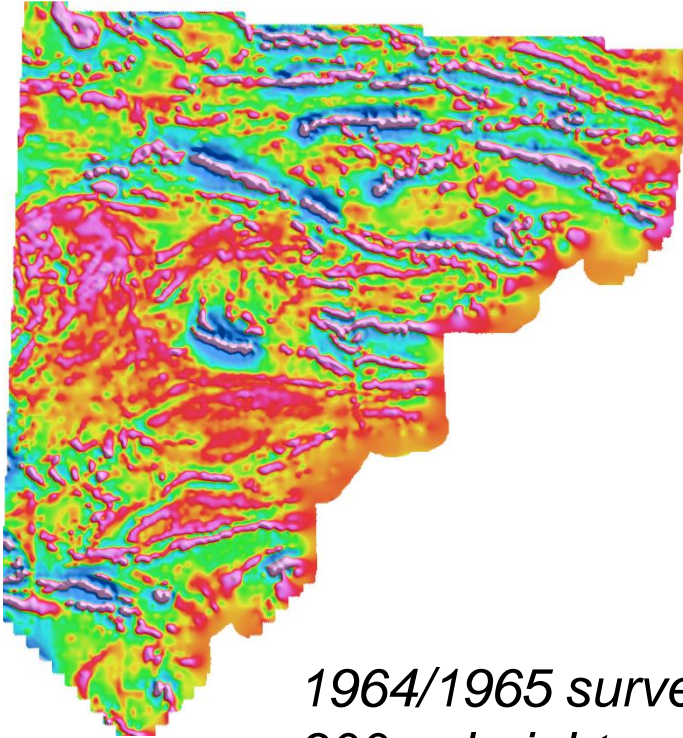
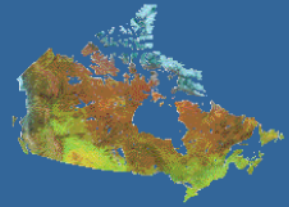


Rankin Inlet

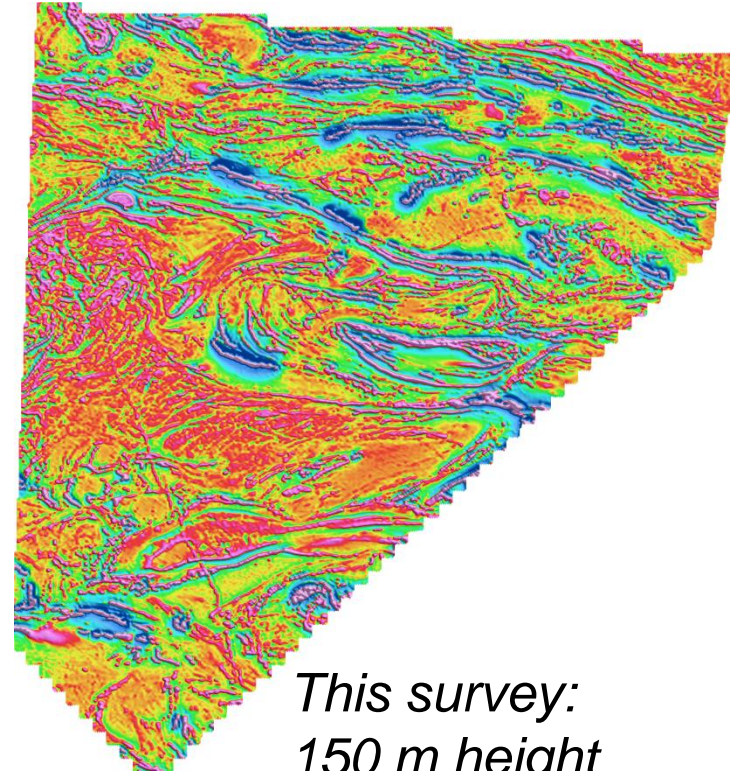
Whale Cove

- Community consultations with Arviat, Whale Cove, Rankin Inlet and Chesterfield Inlet completed spring 2009
- Acquisition date modified to after September 1st 2009 to avoid caribou calving and migration

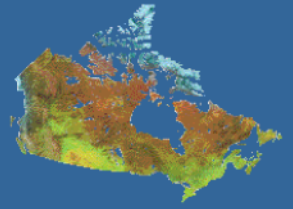




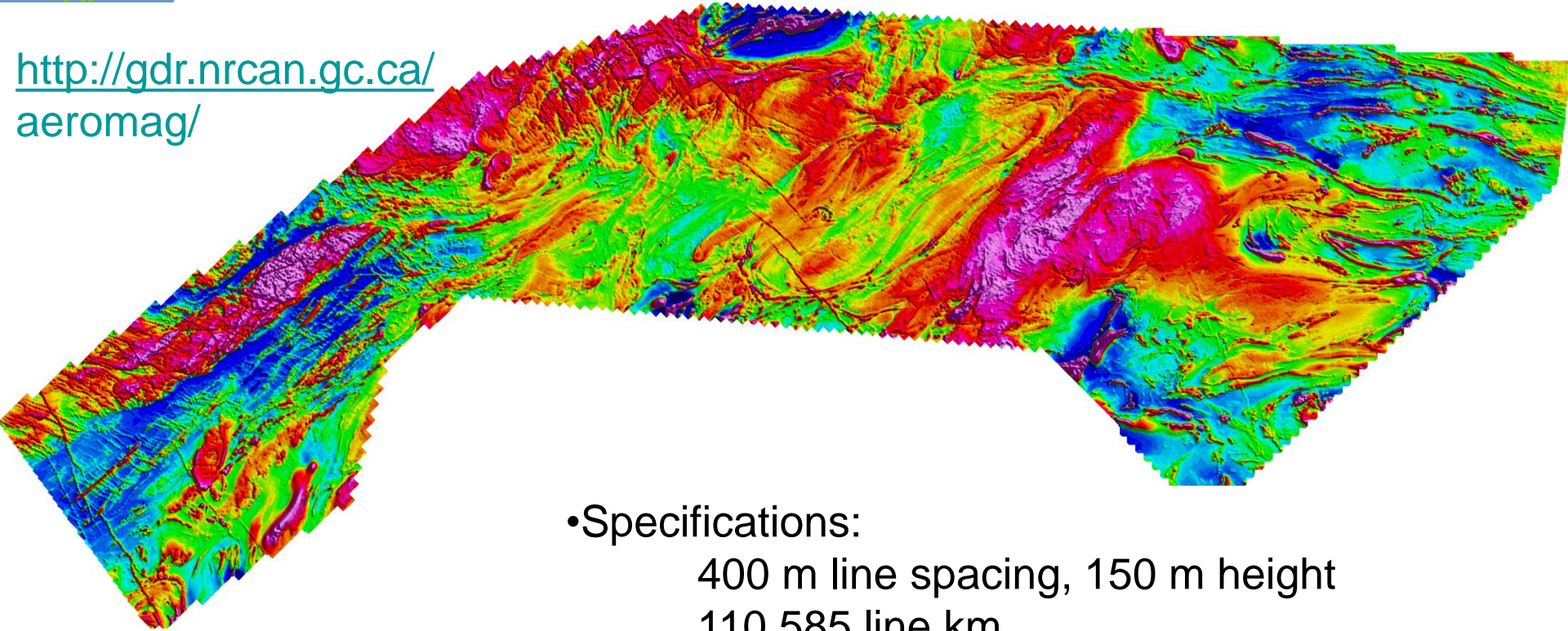
*1964/1965 survey:  
300 m height  
800 m line spacing*



*This survey:  
150 m height  
400 m line spacing*



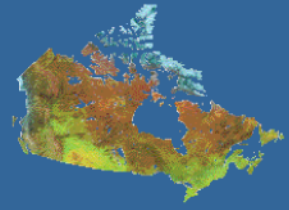
<http://gdr.nrcan.gc.ca/aeromag/>



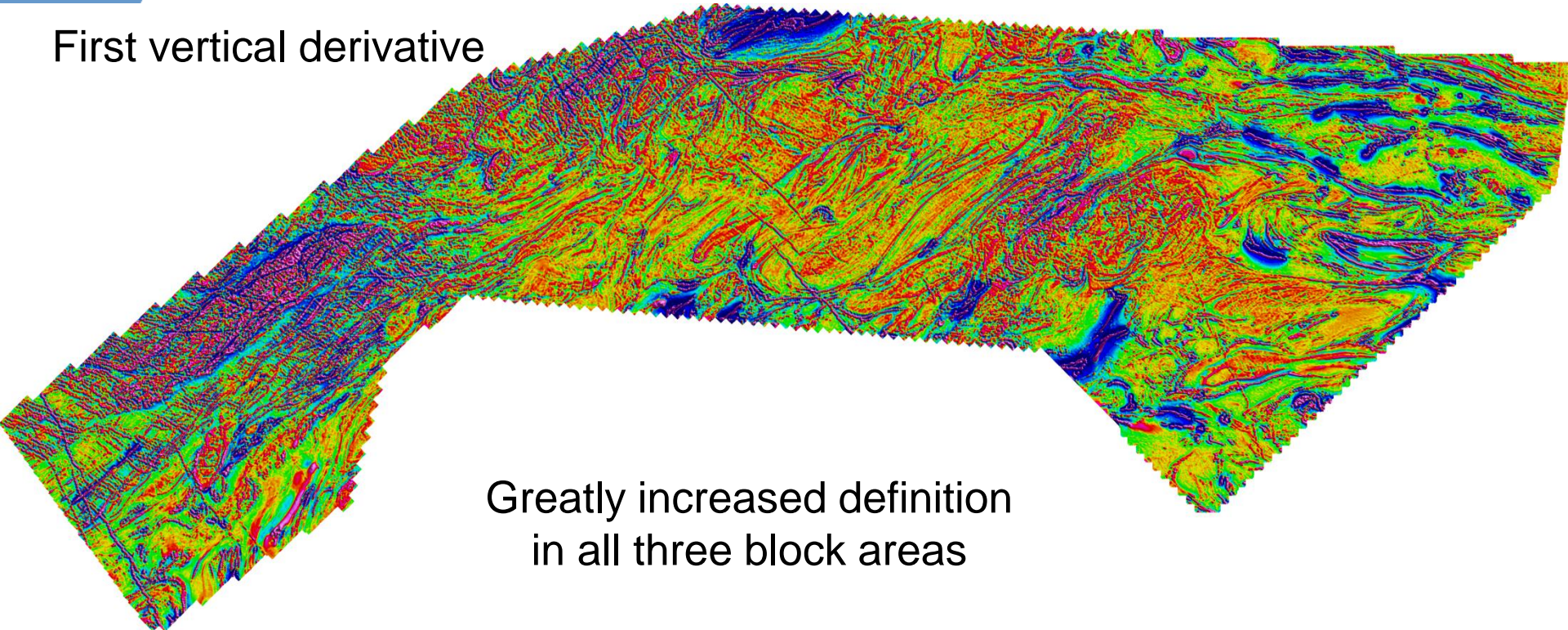
Total field

- Specifications:  
400 m line spacing, 150 m height  
110,585 line km
- Line orientations changed across 3 blocks to maximize proper flight orientations in arcuate survey area with curving geology



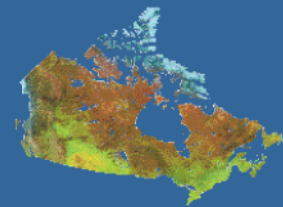


First vertical derivative

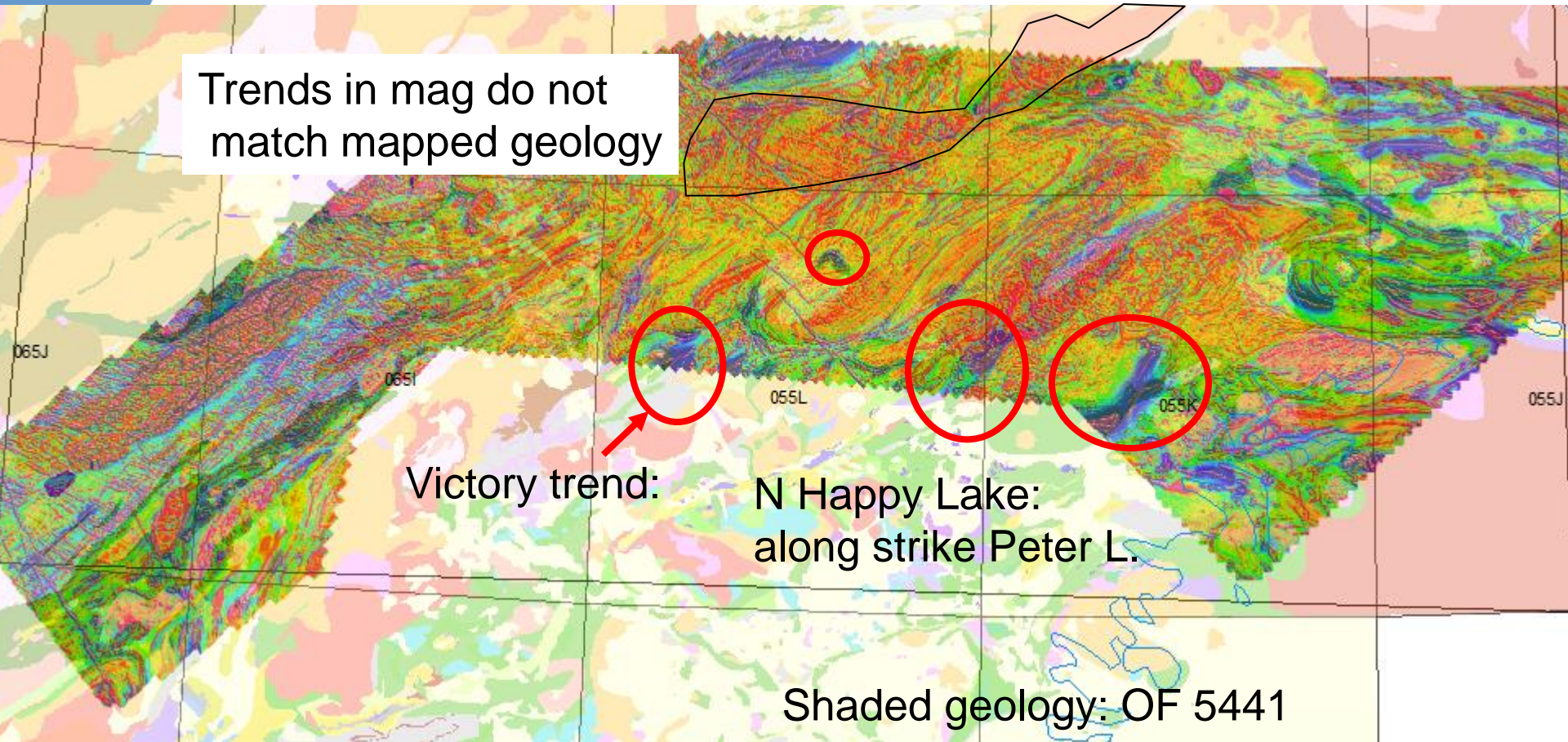


Greatly increased definition  
in all three block areas





Trends in mag do not match mapped geology



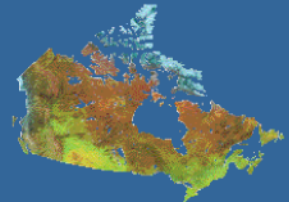
Victory trend:

N Happy Lake:  
along strike Peter L.

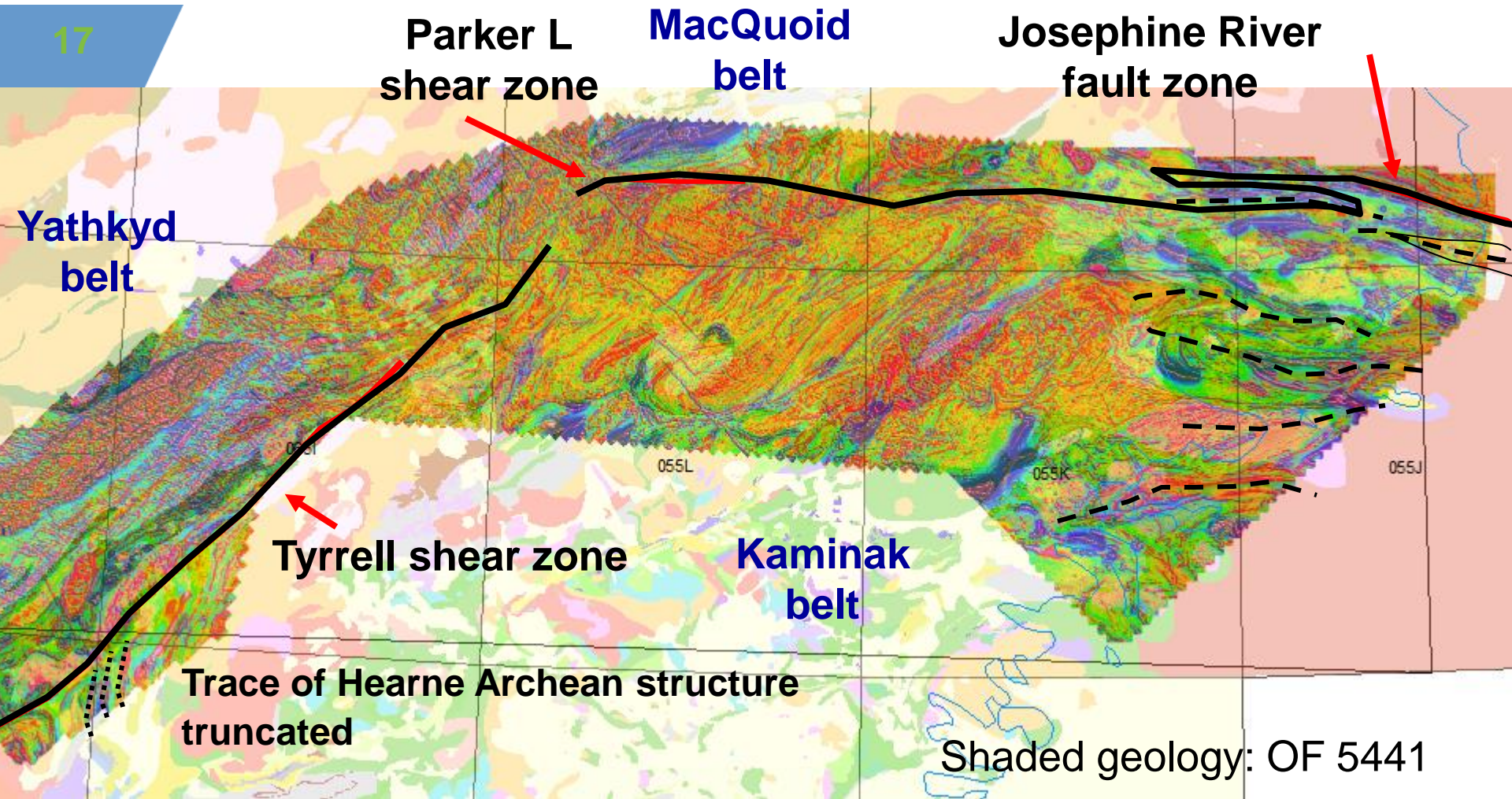
Shaded geology: OF 5441



## Snowbird tectonic zone?

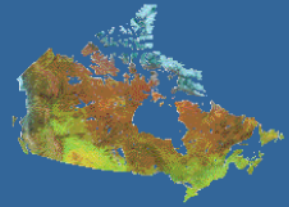


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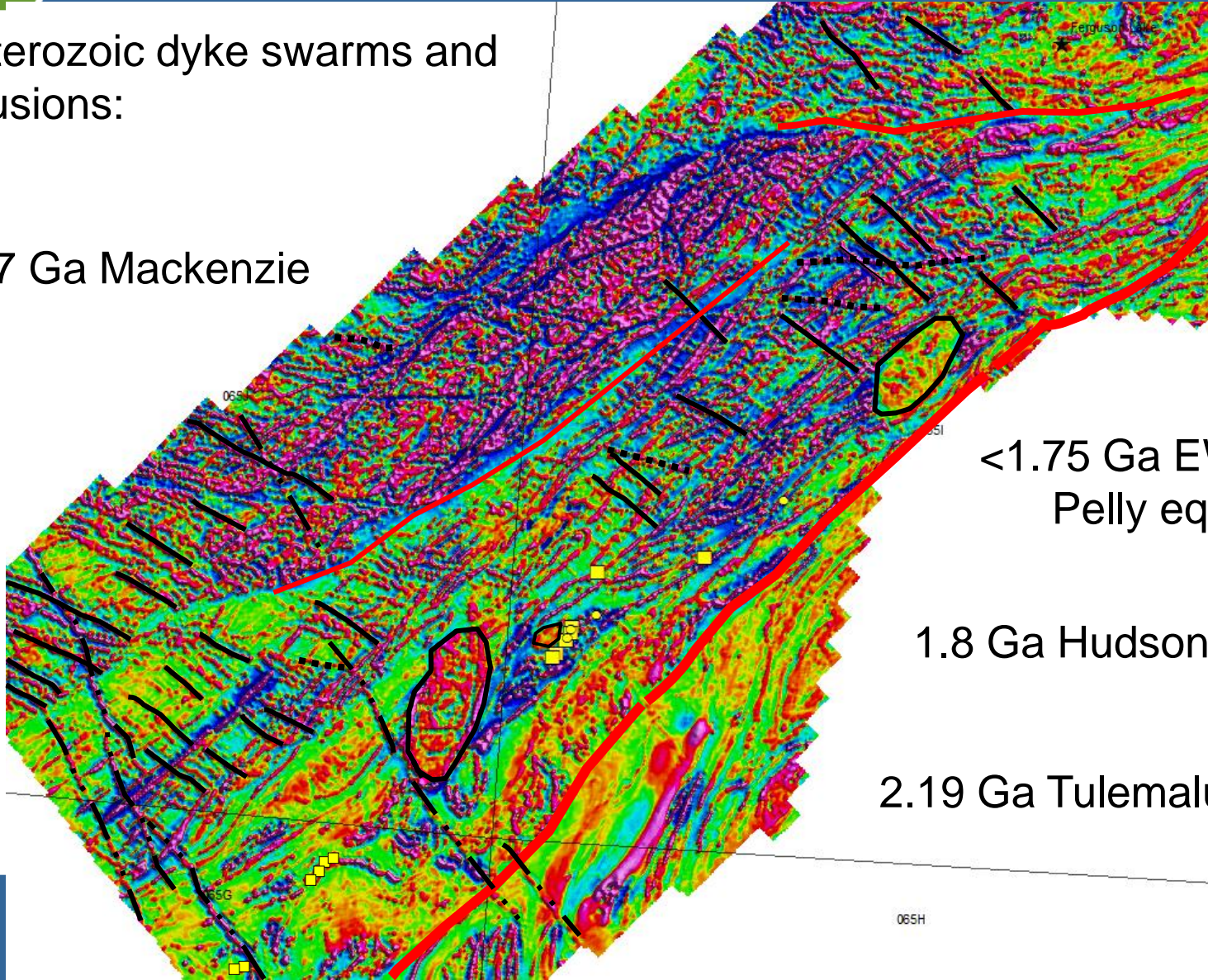


## West block: Yathkyd greenstone belt



1 Proterozoic dyke swarms and  
Intrusions:

1.27 Ga Mackenzie



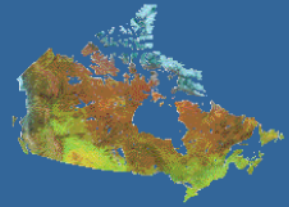
<1.75 Ga EW dykes  
Pelly equivalent?

1.8 Ga Hudson granites

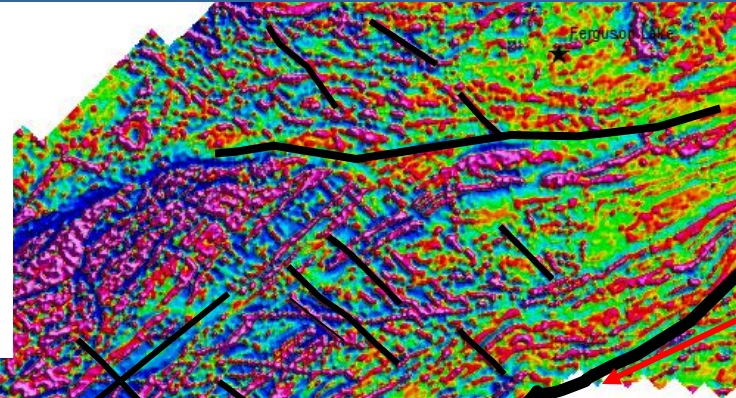
2.19 Ga Tulemalu dykes



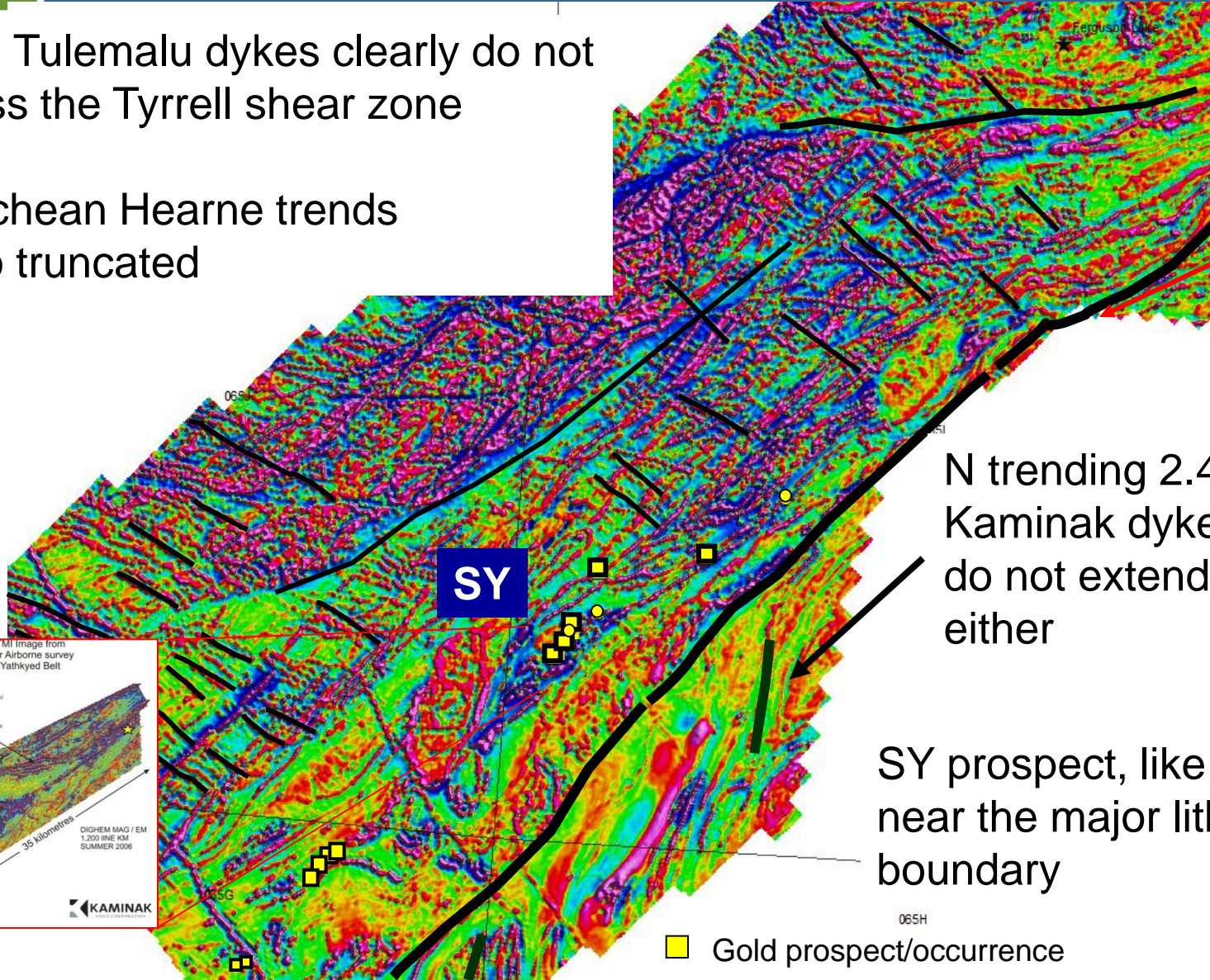
## Tyrrell shear zone: Trace of the Snowbird zone?



- SE Tulemalu dykes clearly do not cross the Tyrrell shear zone
- Archean Hearne trends also truncated



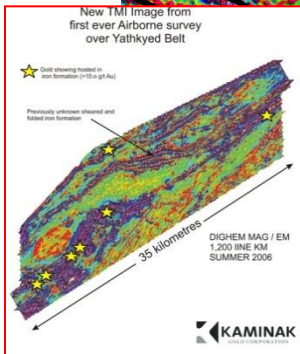
Tyrrell Shear zone



N trending 2.45 Ga Kaminak dykes do not extend across either

SY prospect, like Meliadine near the major lithosphere boundary

Gold prospect/occurrence





**Unit Amm of Eade, 1975**

**NE trending > 2.5 Ga < 2.68 Ga  
'amphibolite'**

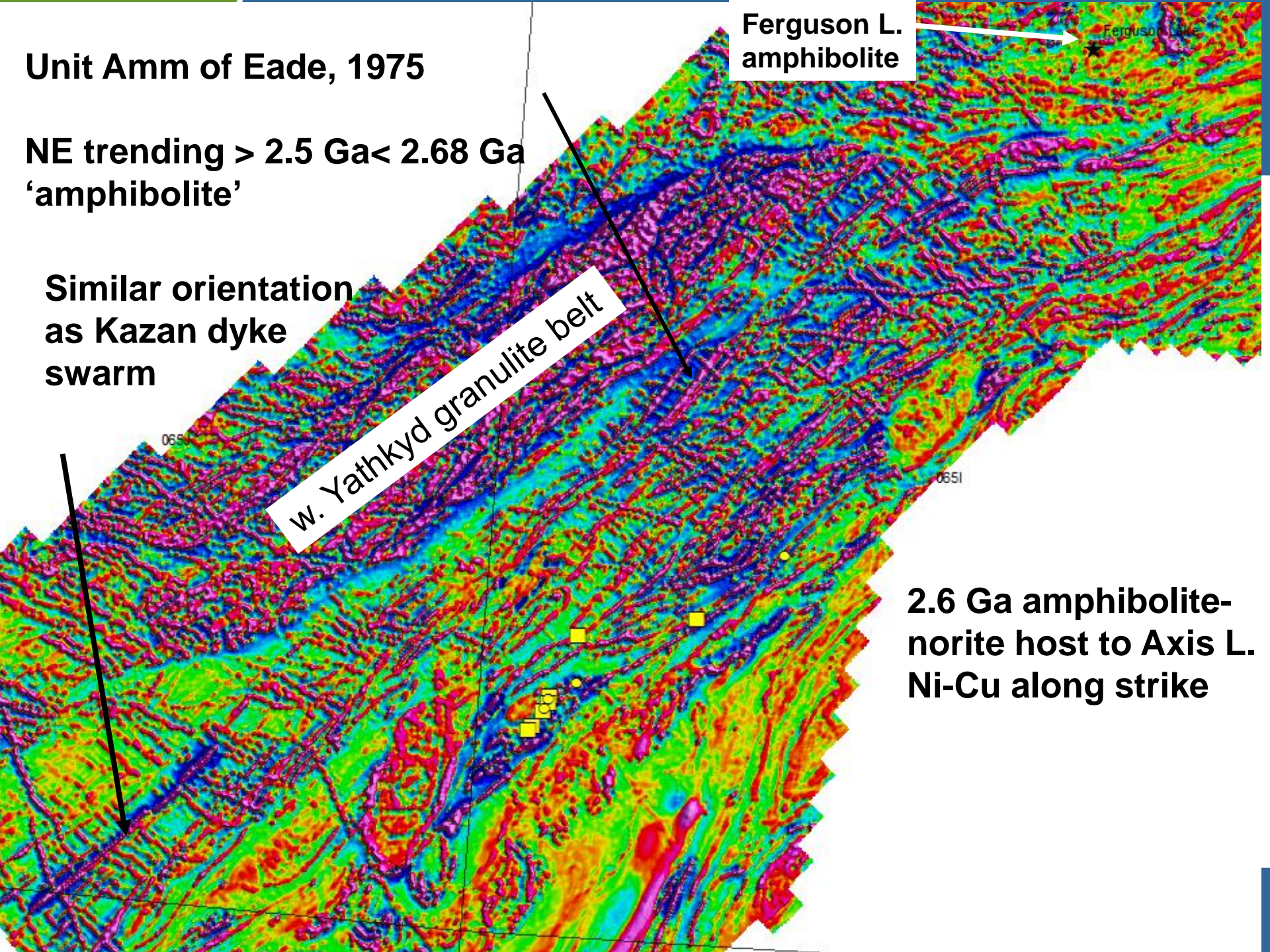
**Similar orientation  
as Kazan dyke  
swarm**

**w. Yathkyd granulite belt**

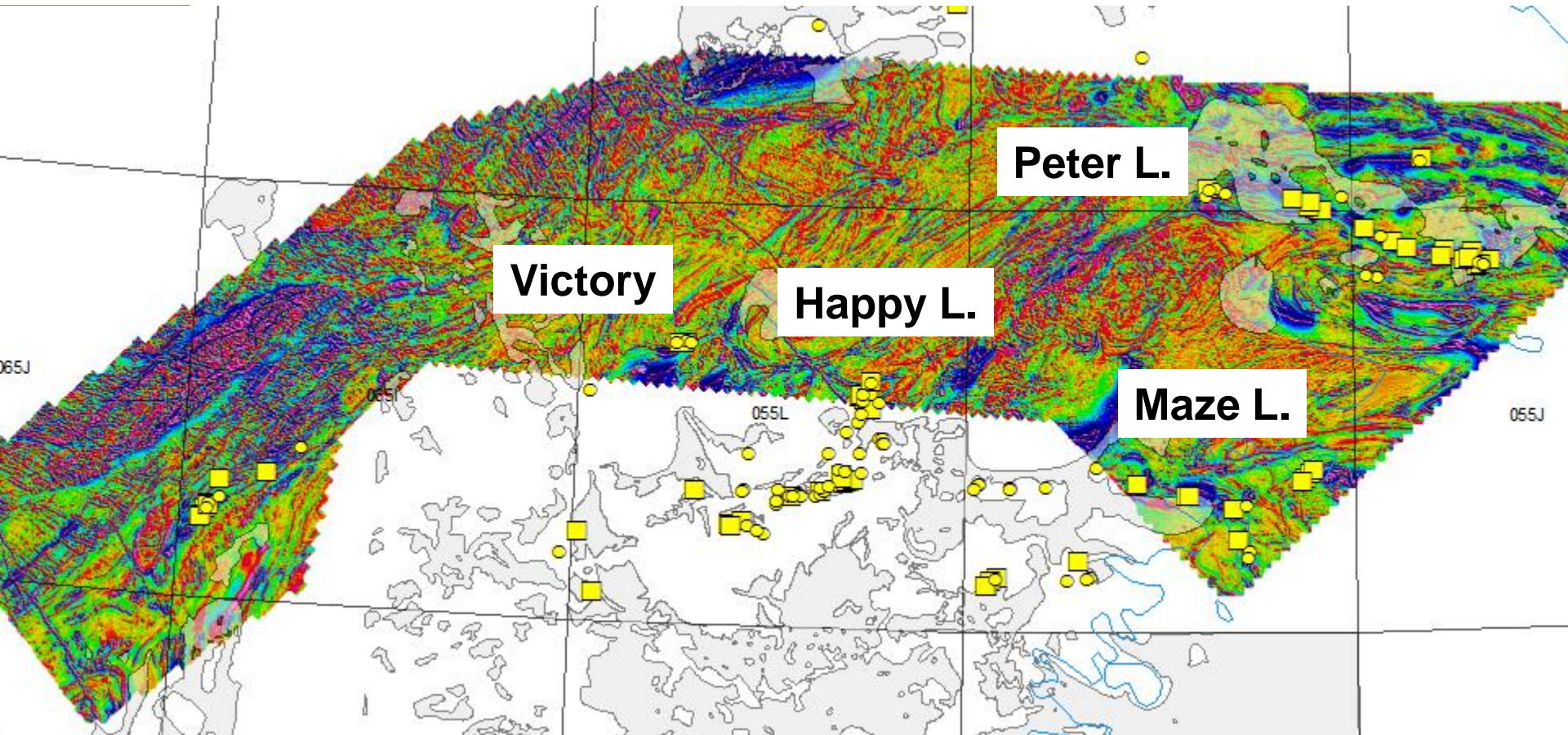
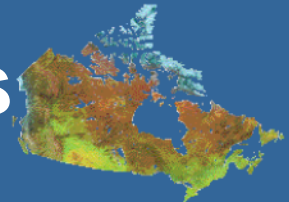
**Ferguson L.  
amphibolite**

Ferguson Lake

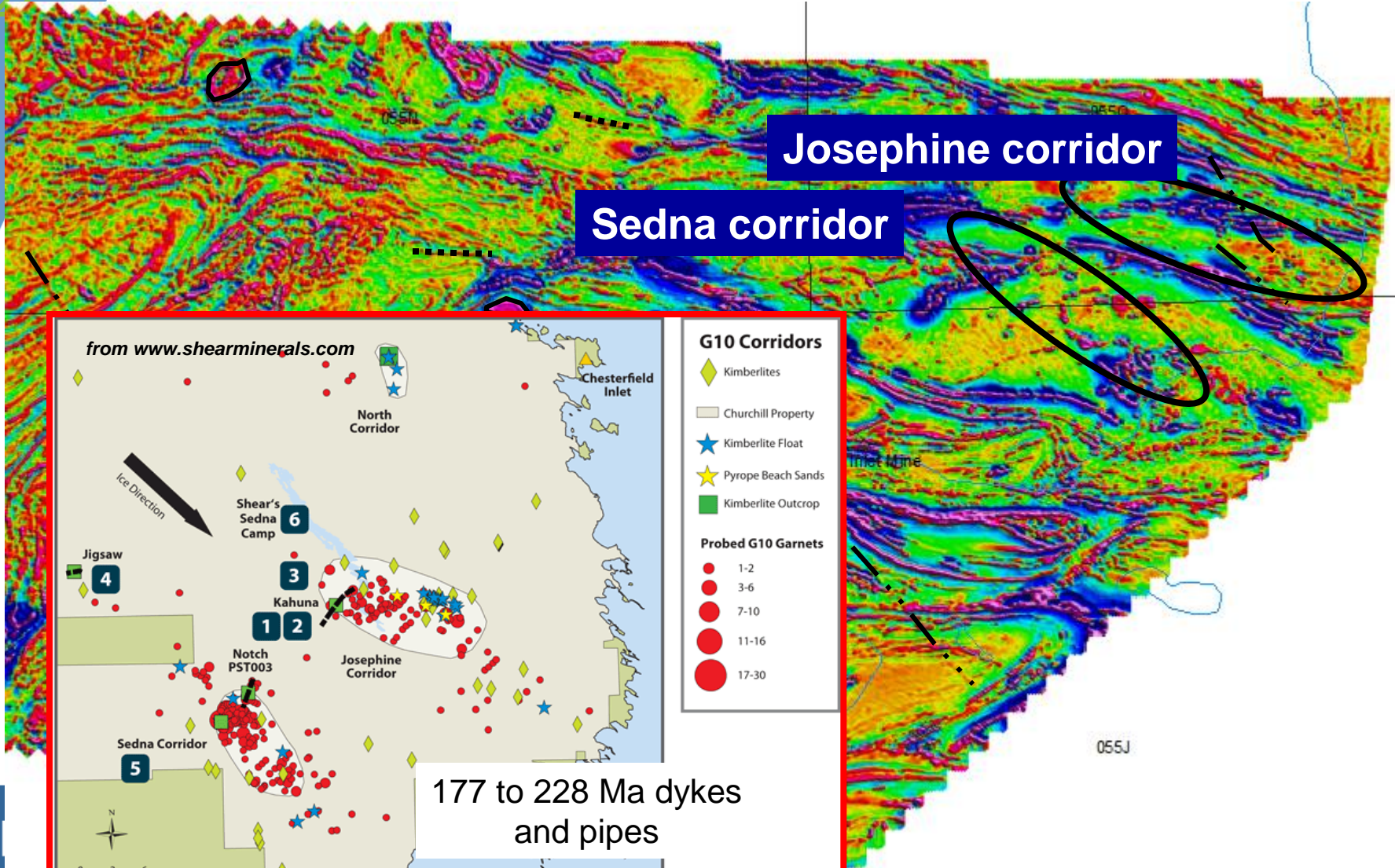
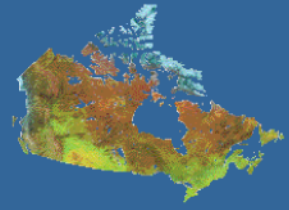
**2.6 Ga amphibolite-  
norite host to Axis L.  
Ni-Cu along strike**









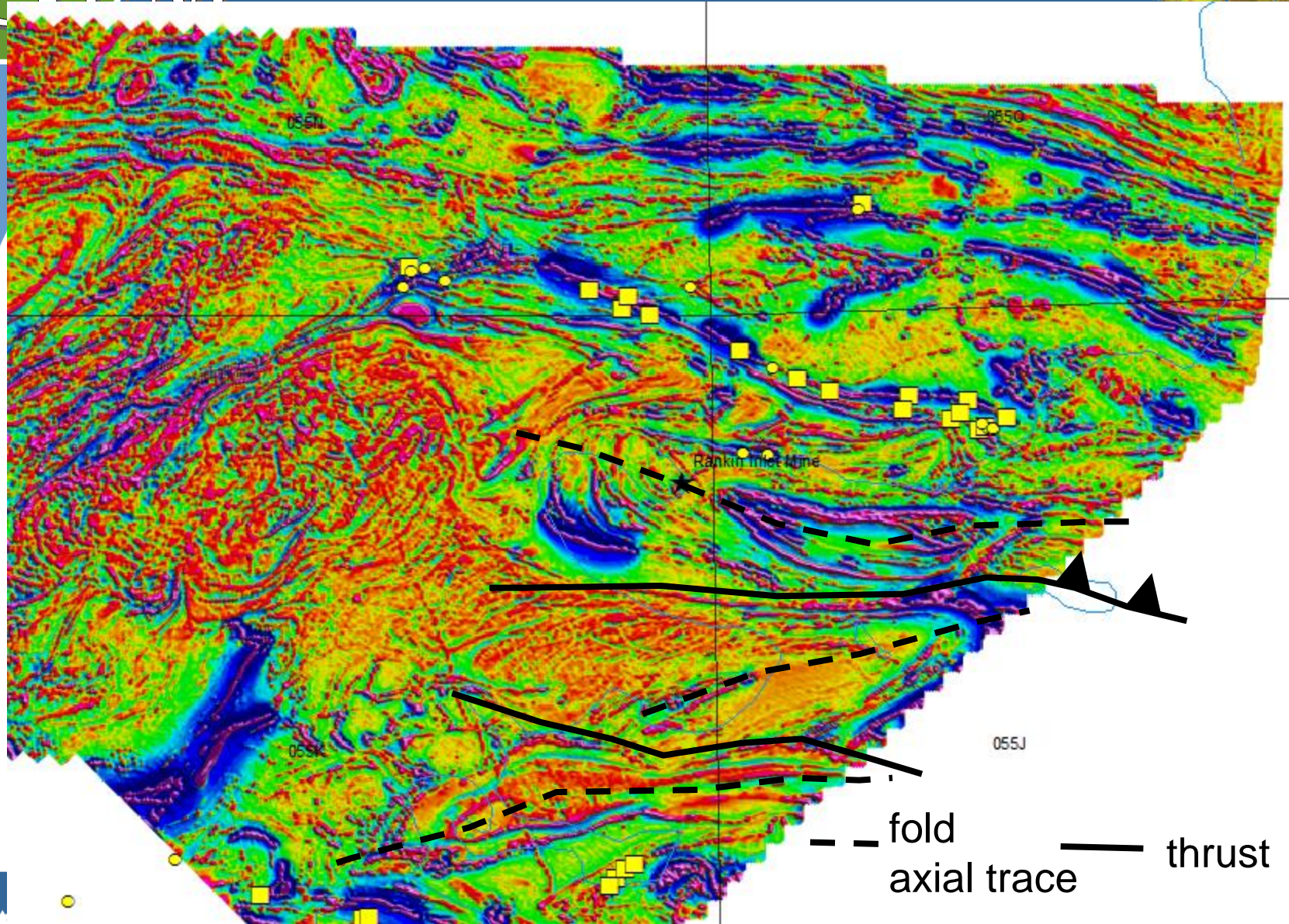




## Au hosting unit trajectory?



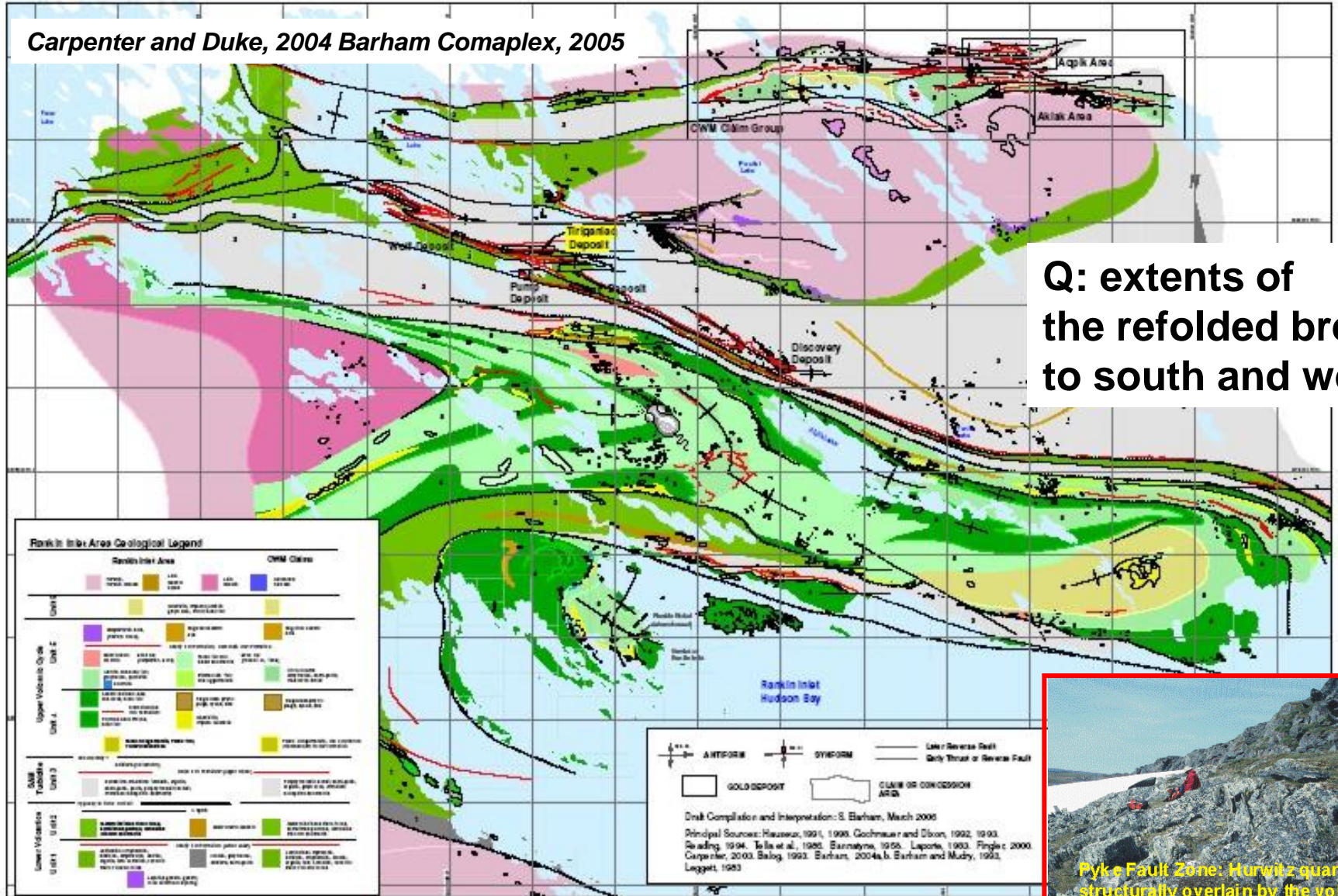
23



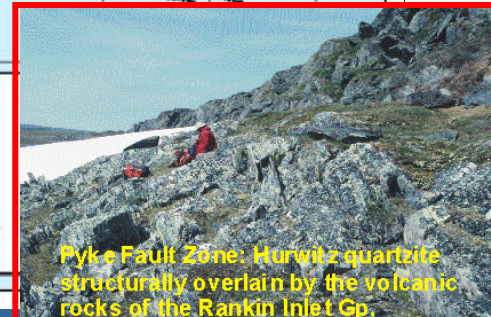


# Meliadine deposit: Thrust Archean and Paleoproterozoic sequences adjacent to a major crustal break Mineralization/dextral reactivation ca. 1.85 Ga

Carpenter and Duke, 2004 Barham Complex, 2005



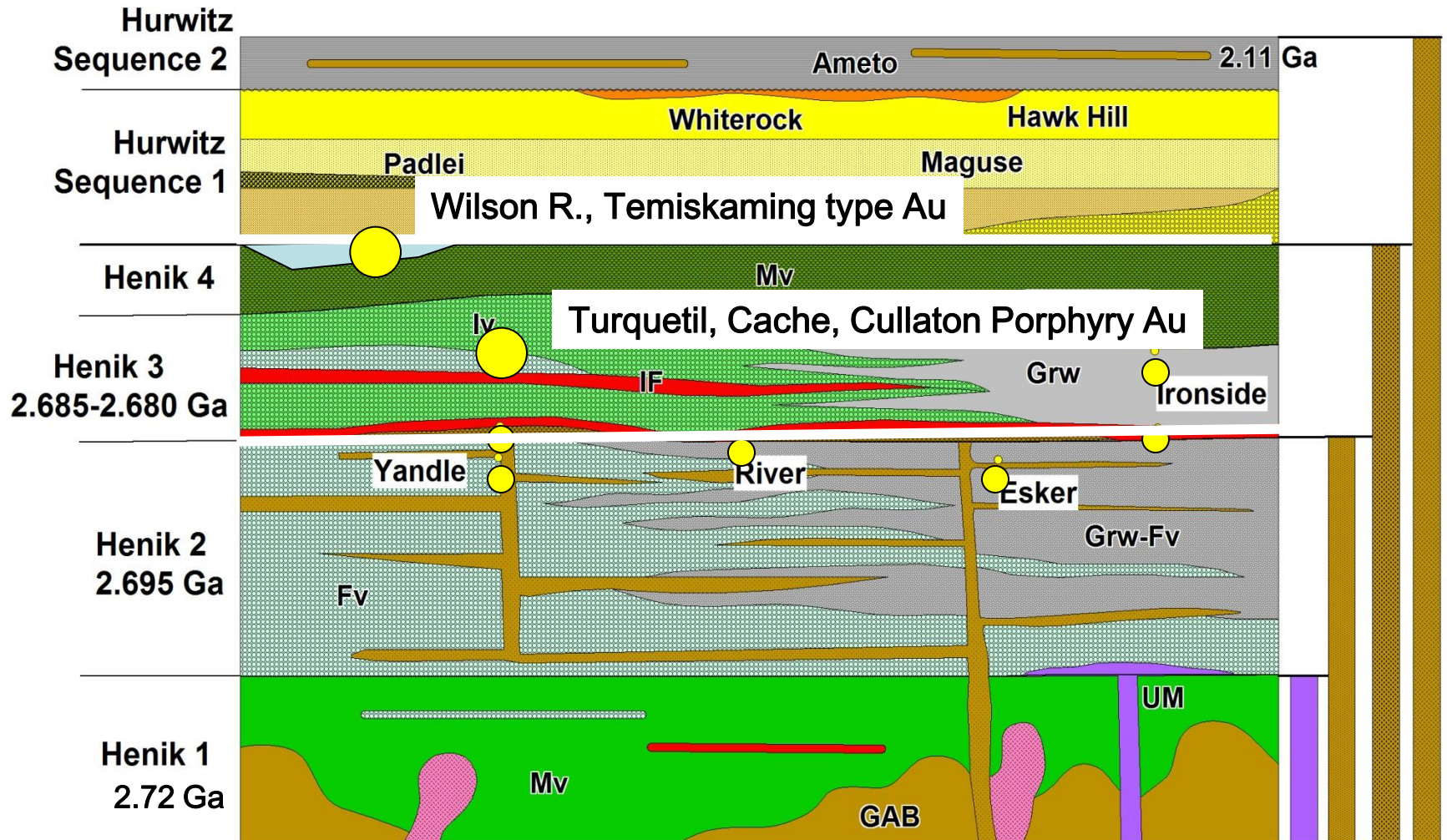
Q: extents of the refolded break to south and west





# Kinga Lake

# Henik Lake



Correlation Chart

Ultramafic  
"Henik"  
Kaminak  
Mackenzie

**Gold hosting sequences in the Hearne;  
what is the Meliadine host? Rae or Hearne?**

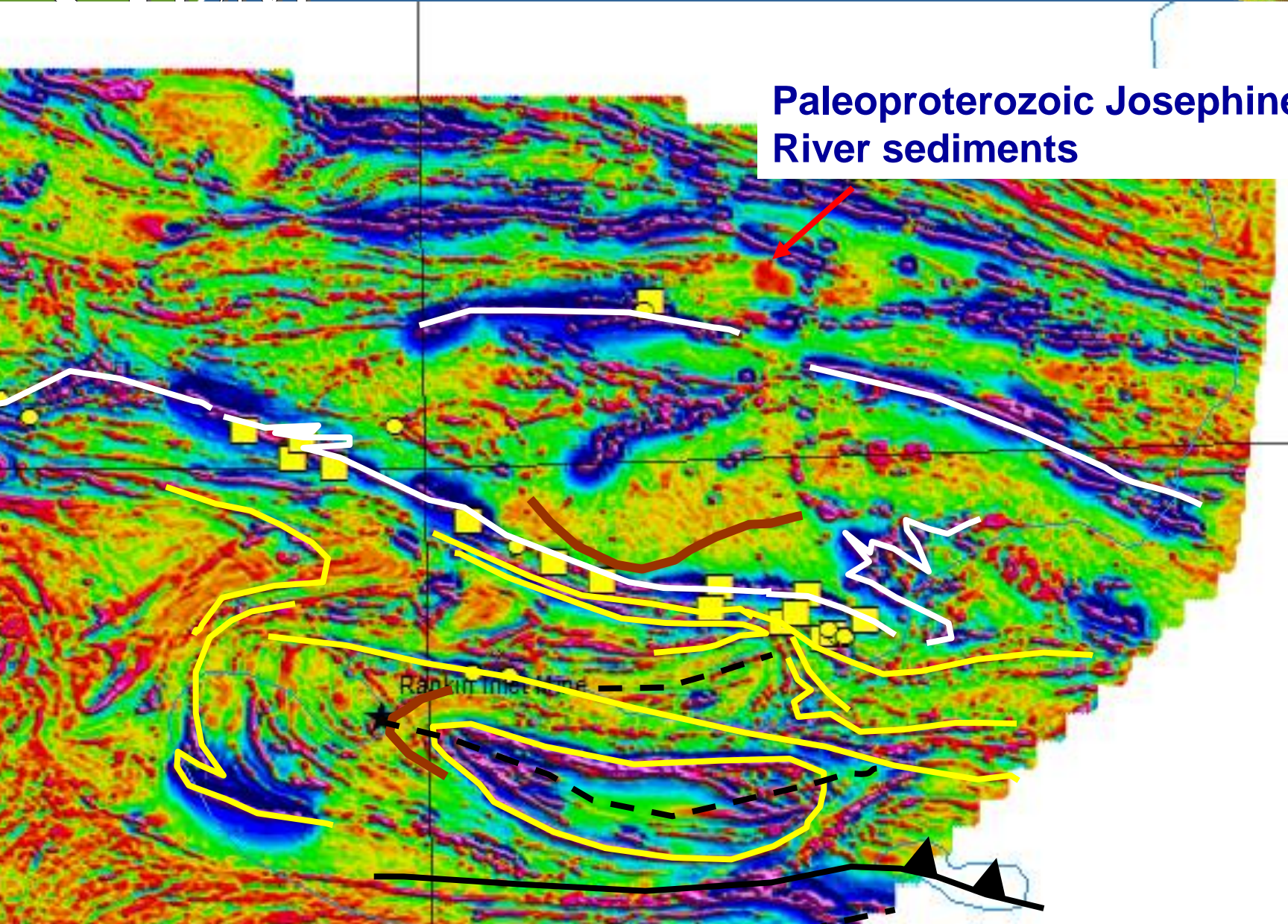
Courtesy Barham, 2004, Comaplex Min.

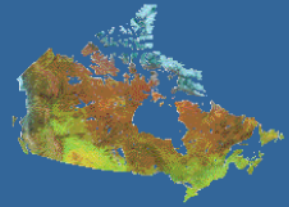


## Where does Meliadine go?



**Paleoproterozoic Josephine River sediments**

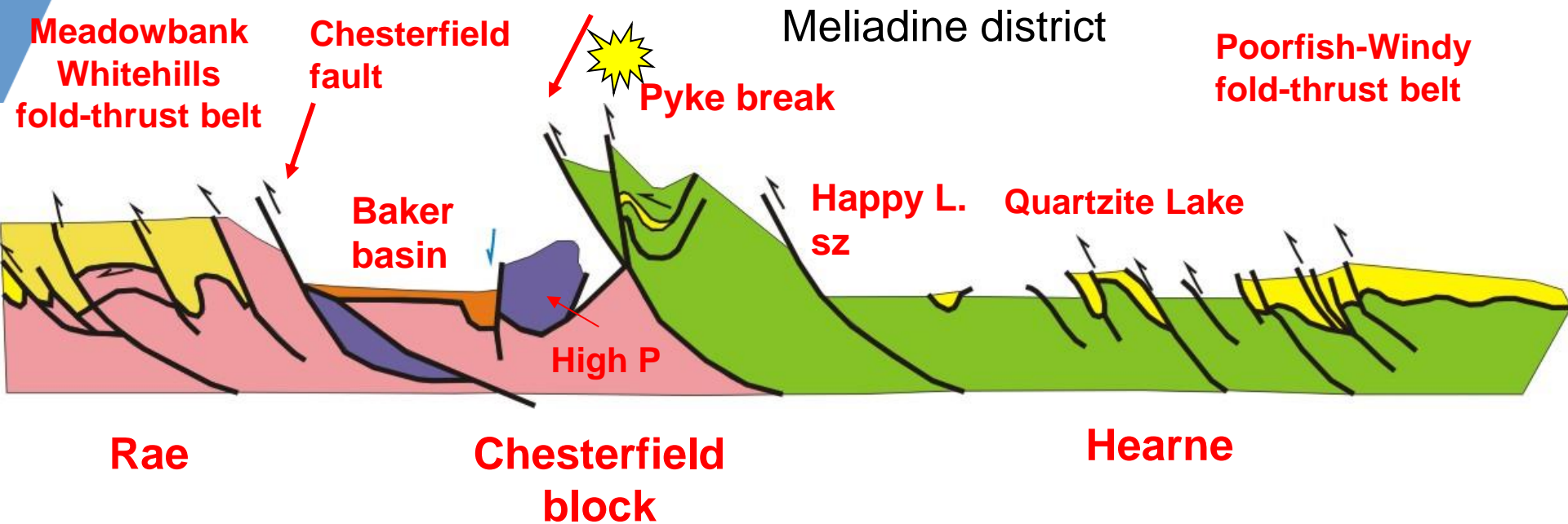




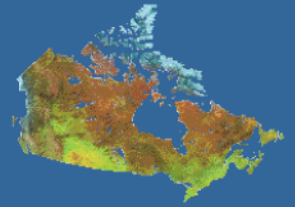
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Is there a relationship between focusing of world class gold mineralization and the nearby lithosphere boundary?

Is the Rankin Inlet area host to rocks of both cratons that are Interthrust in a suture zone?







Katherine Sigurdson, GIS  
John Kerswill, Au occurrence compilation  
Doug Oneschuk: Geophysics  
Subhas Tella and Warner Miles, consultation



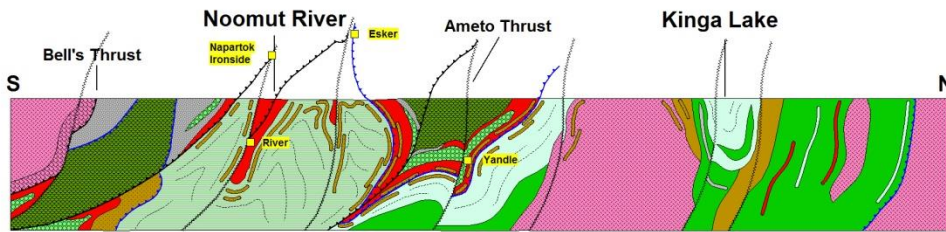
Contact:

Sally Pehrsson; GSC Ottawa  
[pehrsson@nrcan.gc.ca](mailto:pehrsson@nrcan.gc.ca)



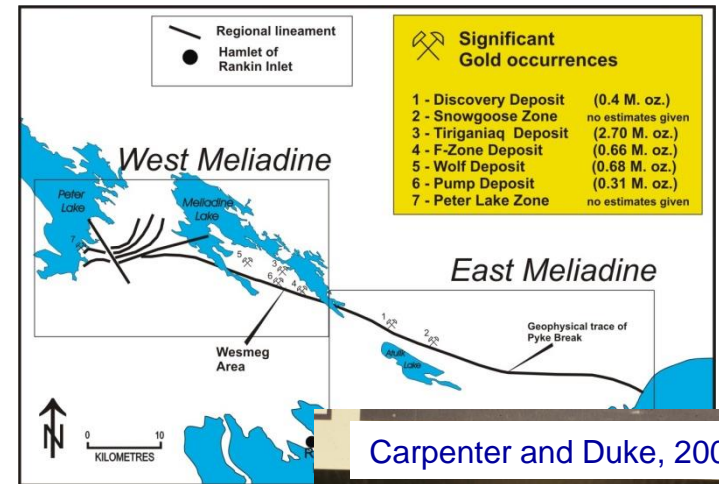
# Alternative models: What localizes Archean vs Proterozoic gold?

1. Proterozoic reactivation of Archean structures involving specific fertile tectonostratigraphy



Barham, 2004; Comaplex Min.

2. Superior-style breaks that introduce new gold



Carpenter and Duke, 2004.

2a. Late syn-orogenic gold related to TransHudson orogen (Sherlock et al., 2005, Davies et al., 2010 Committee Bay)

