SCLM rifting & regional shearing in the Superior Craton

– deformation & mineralization in a non-plate tectonic Archaean Earth; implications for tectonic reconstructions

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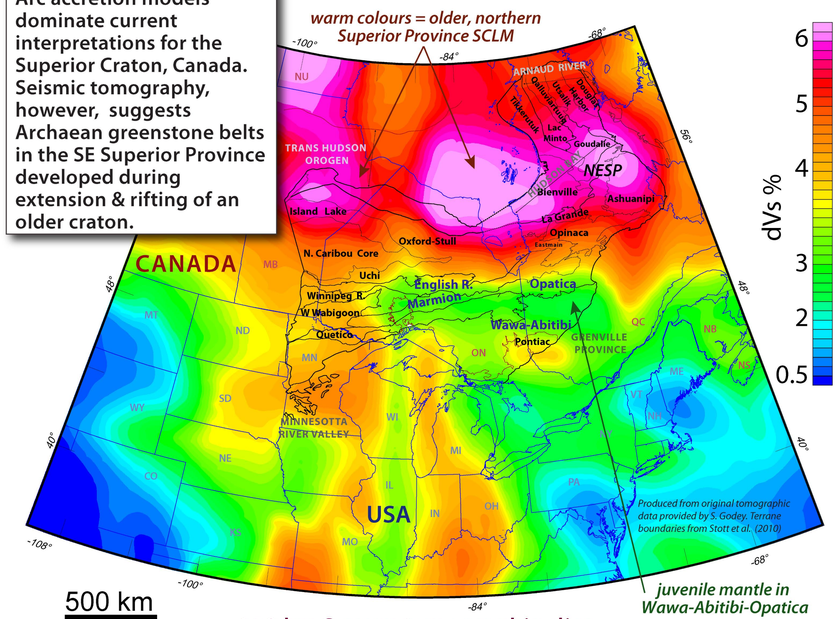
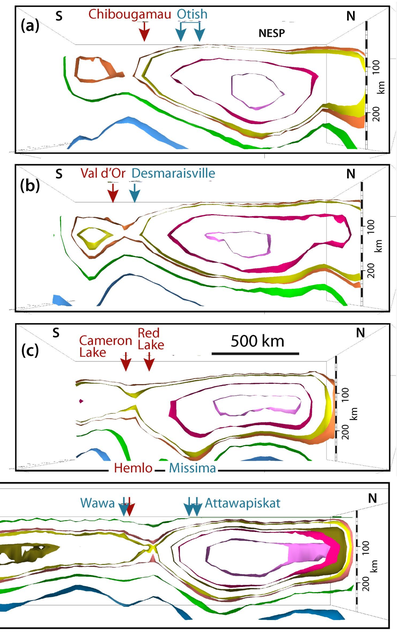
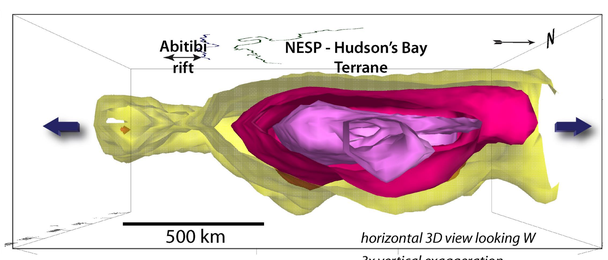
Arc accretion models dominate current interpretations for the Superior Craton, Canada. Seismic tomography, however, suggests Archaean greenstone belts in the SE Superior Province developed during extension & rifting of an older craton.

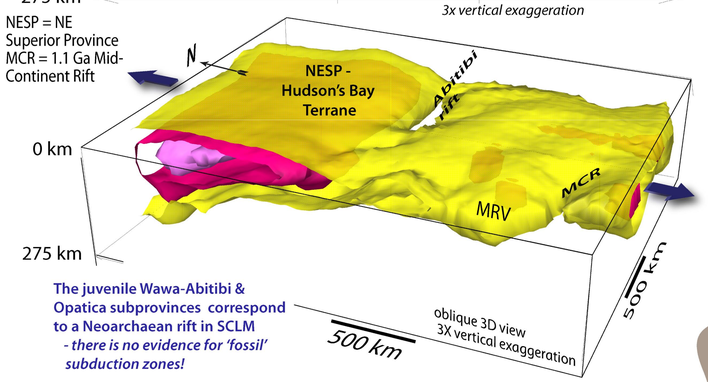


150 km S-wave tomographic slice

Seismic tomographic evidence for Archaean rifting of sub-continental lithospheric mantle (SCLM) in the southern Superior Craton

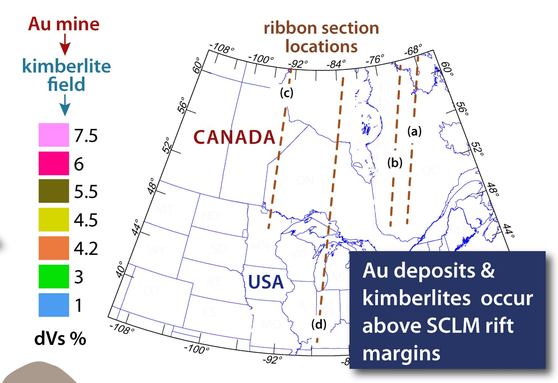






The juvenile Wawa-Abitibi & Opatica subprovinces correspond to a Neoarchaean rift in SCLM
- *there is no evidence for 'fossil' subduction zones!*

3D isosurfaces illustrate necking & separation

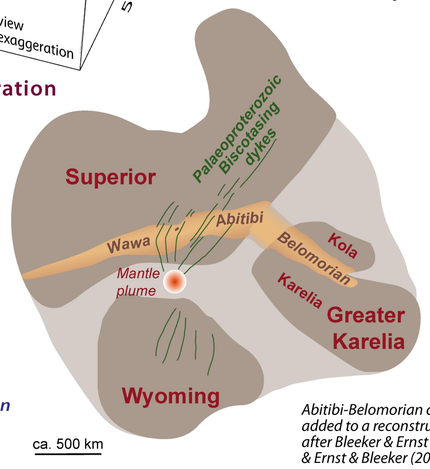


Au deposits & kimberlites occur above SCLM rift margins

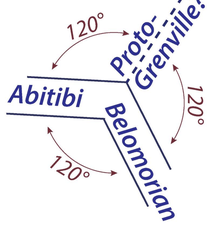
Tectonic reconstruction

Superior, Greater Karelia (Baltica) & Wyoming cratons prior to Palaeoproterozoic breakup

The Belomorian belt (Baltica), placed against the SE Superior Province in tectonic reconstructions, likely represents a continuation of the Abitibi.

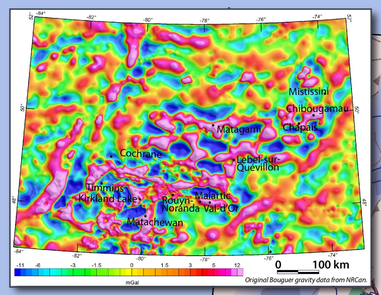


Neoarchaean rifts define a triple point

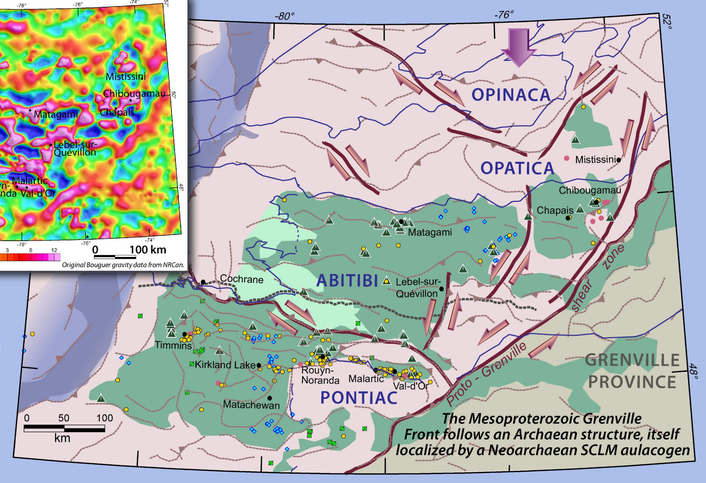


Abitibi-Belomorian connection added to a reconstruction modified after Bleeker & Ernst (2006) & Ernst & Bleeker (2010)

Regional Folding & Shearing Without Plate Tectonics

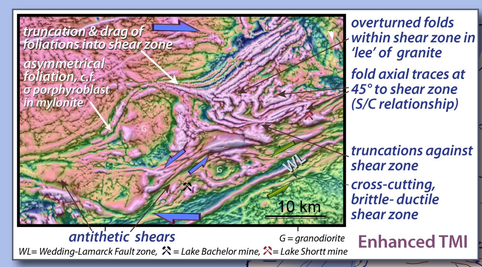


Curvature & offset of positive gravity anomalies & 'worms' in the Grenville Province paraautochthon occurs along Archaean structures sub-parallel to the Grenville Front.

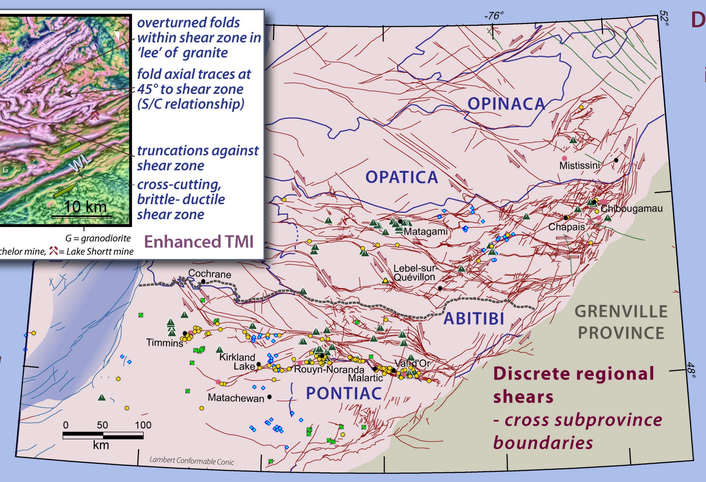


Short wavelength Bouguer gravity shows offset of denser, mafic-dominated domains along regional shear zones

- dense (mafic dominated) crust
- part of displaced block?
- Kapuskasing uplift
- Grenville
- shear zone
- gravity edges/shallow worms
- limit, N & S Abitibi
- terrane boundaries
- Au
- porphyry
- VHMS
- Ni, PGE, Cr
- kimberlite



Enhanced aeromagnetic images portray early ductile shear corridors
- *structures at semi-regional scale resemble those in ultramylonites*

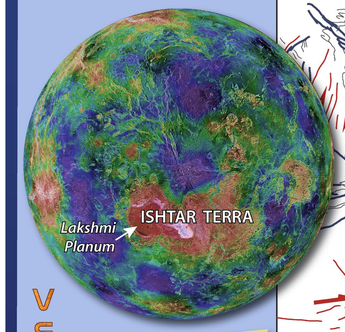


Discrete shears, cutting broad dextral shear corridors, indicate c.a. N-S shortening & indentation of the N Superior proto-craton

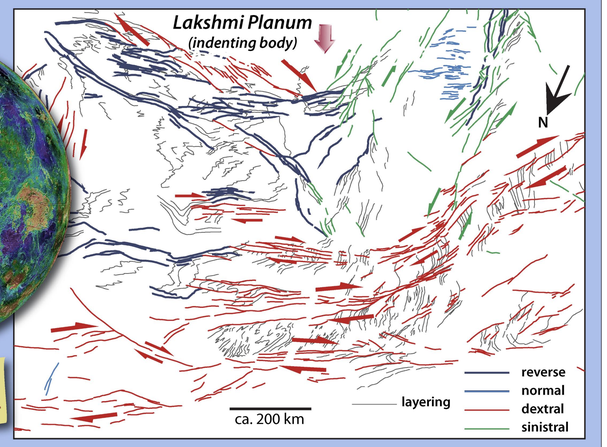
- Superior Province
- Kapuskasing uplift
- Grenville Province
- shear zone
- fault (Kapuskasing Uplift)
- limit, N & S Abitibi
- terrane boundaries
- Mistassini dykes

Compiled from the Geological Map of Quebec (Theriault, 2002), Daigneault (1996), & unpublished aeromagnetic interpretation by L. Harris.

Main mineral deposits from NRCan World Mineral Deposits databases. Kimberlites are from Faure's (2010) World Kimberlites CONSOREM Database.



SEE SEPARATE VENUS POSTER

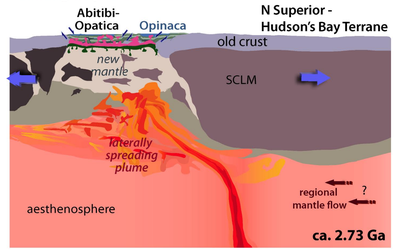


The pattern of shears in W Ishtar Terra, Venus (a planet without plate tectonics) resembles the SE Superior Province

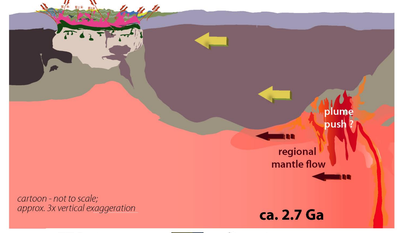
When the shear zone interpretation of western Ishtar Terra, Venus, is rotated & flipped to match the orientation of shears in the SE Superior Province, the resemblance is striking. Shear zones on Venus formed without stresses arising from plate tectonic processes; arc development & accretion in a modern plate tectonic régime is similarly not required for formation & deformation of Archaean granite-greenstone terrains on Earth.

Tectonic model

Rifting of proto-craton



Shortening during displacement of N Superior - Hudson's Bay Terrane due to mantle flow tractions ± plume push on its deep keel



- TTG plutons
- sediments
- volcanics & volcaniclastics
- mafic intrusions
- mafic lower crust