
GEOLOGICAL SURVEY
WESTERN AUSTRALIA
OPEN DAY
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Changing Perspective:

a whole-of-lithosphere approach to mineral discovery

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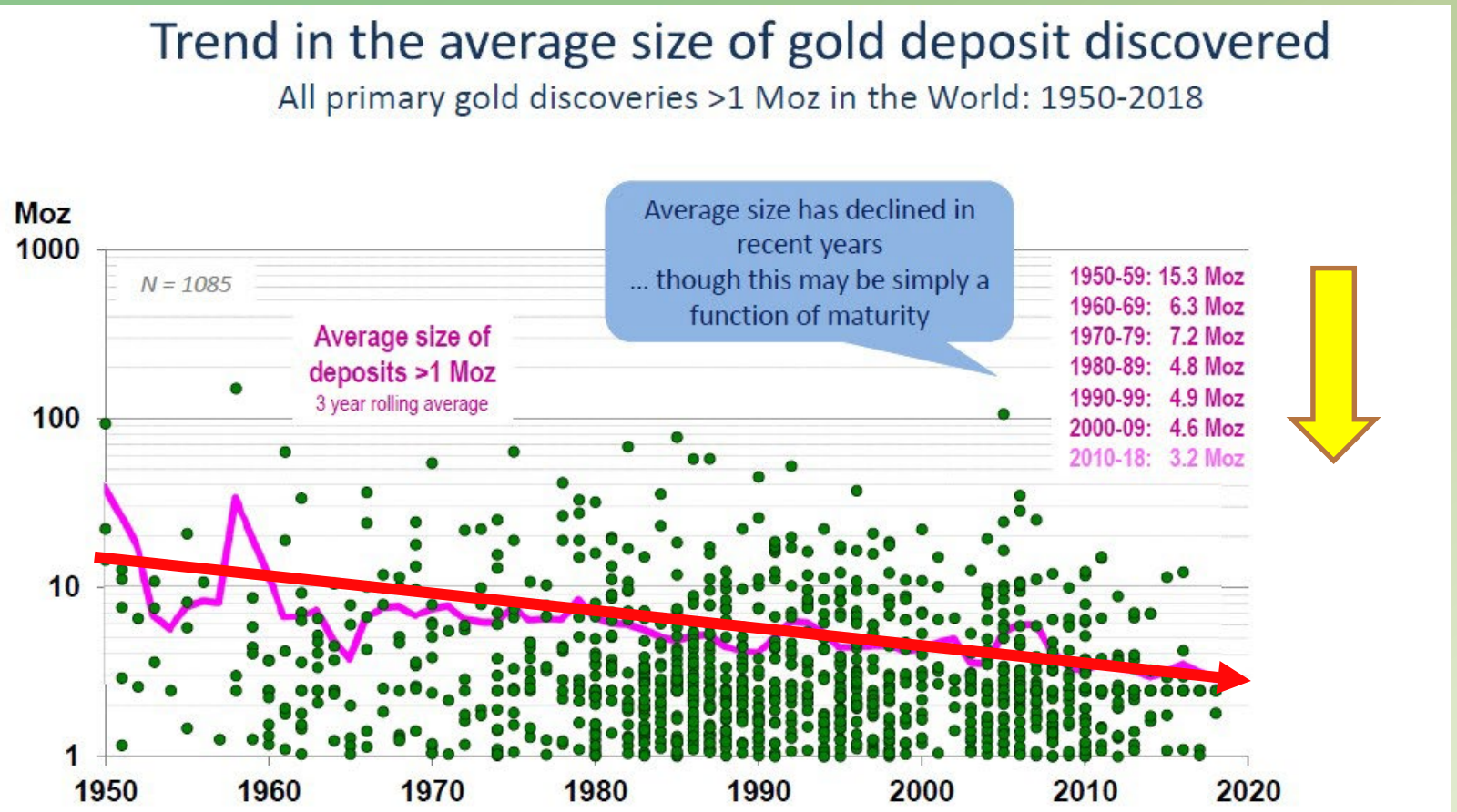
The Age of declining Discoveries: Gold example



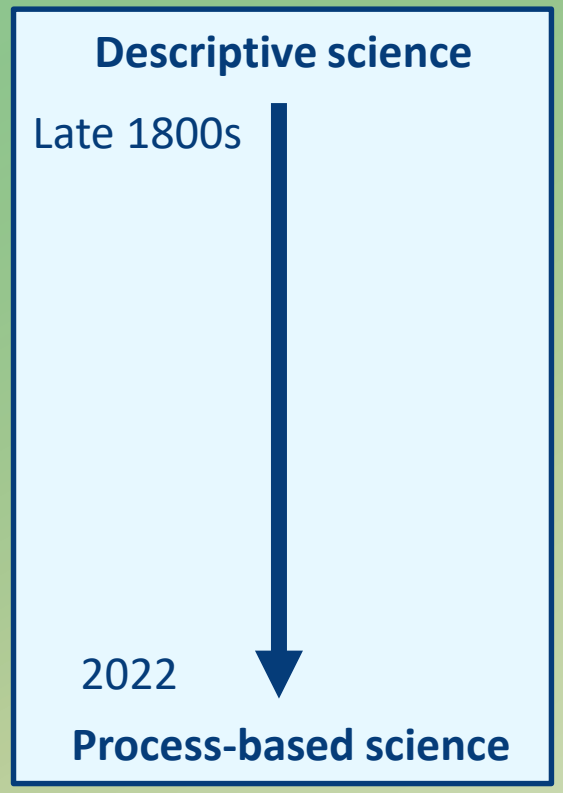
Note: Excludes deposits where gold is a by-product.
No adjustment made for growth in recent discoveries

Source: MinEx Consulting © October 2019

Average discoveries are getting smaller i.e. ***the search space is depleting***

Ore Deposits in the History of Earth Science

Mineral Deposit Science journey



Downward-looking science that began with observations at the outcrop scale
→ ***Ore deposits were discovered via prospecting***

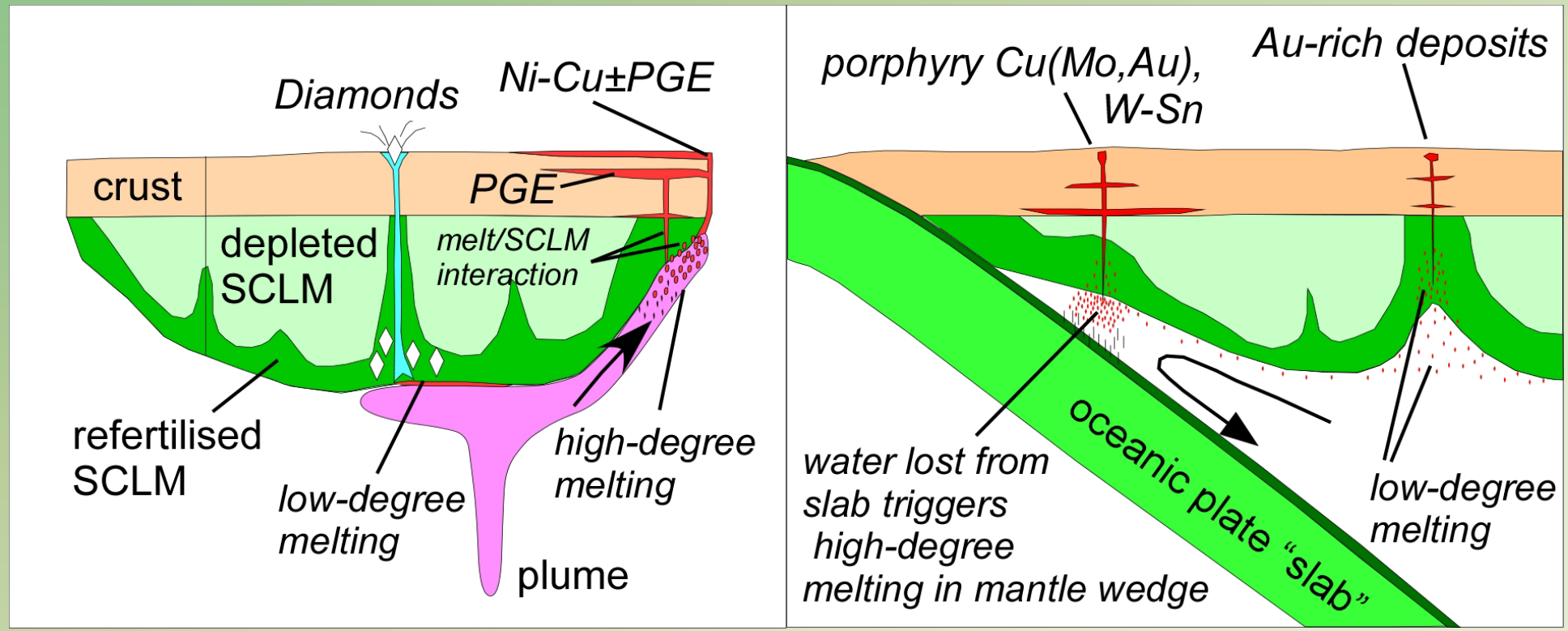
1950s-1970s Plate Tectonics revolution
→ ***ore deposits into a predictive context***

1970s-1990s advances in geochemical & geophysical capability
→ ***improved understanding of deposits and their crustal context***

Mid 1990s - 2020s whole Earth and lithosphere-scale imaging, new geochemical and geochronology methods, GIS and a revolution in processing capability
→ ***unlocked an ability to map the Earth in 4D***

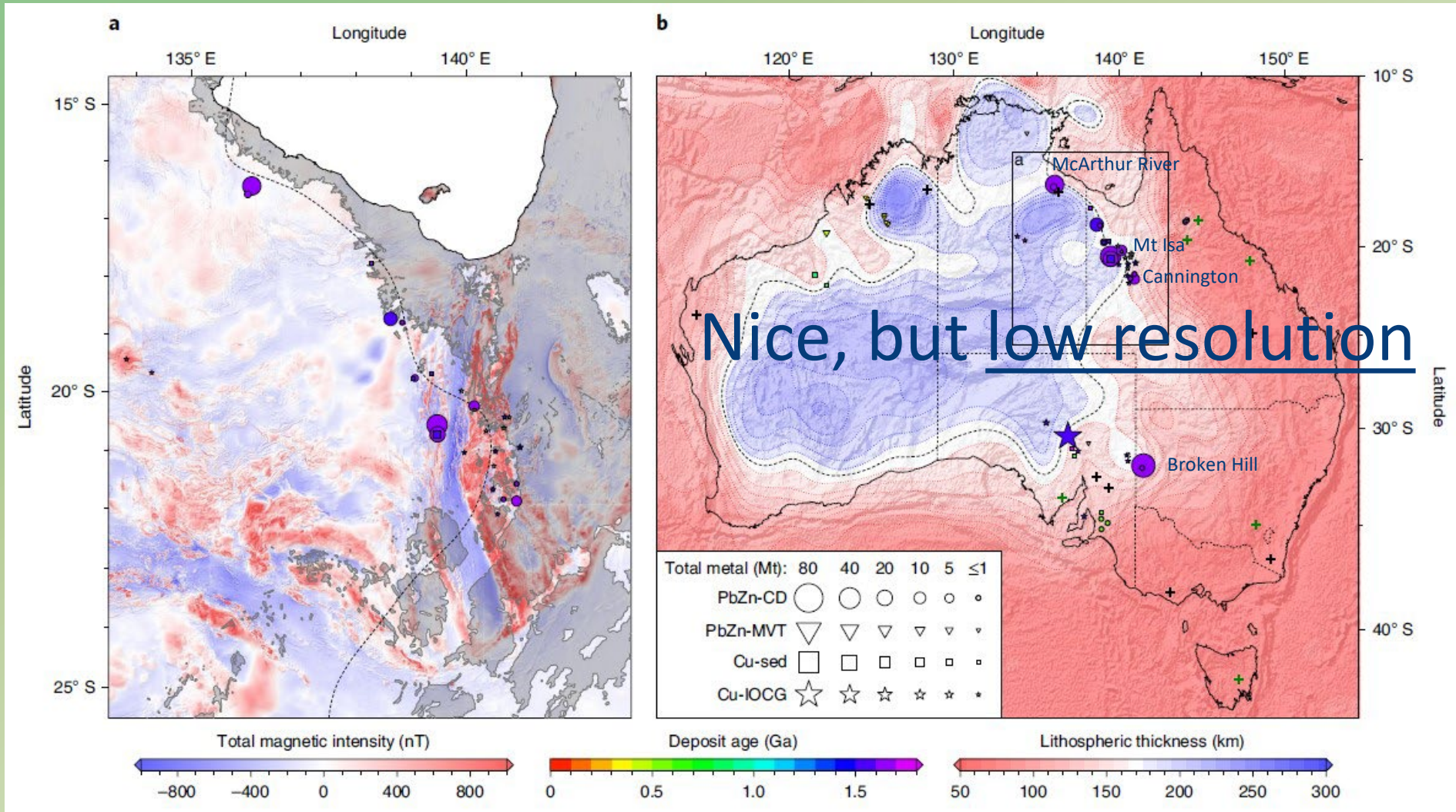
The focus is now on **Mineral Systems**
and is shifting to **Lithosphere scale**
linked to the **Global Geodynamic System**

An unparalleled 4D context for understanding Mineral Systems and their resultant Deposits

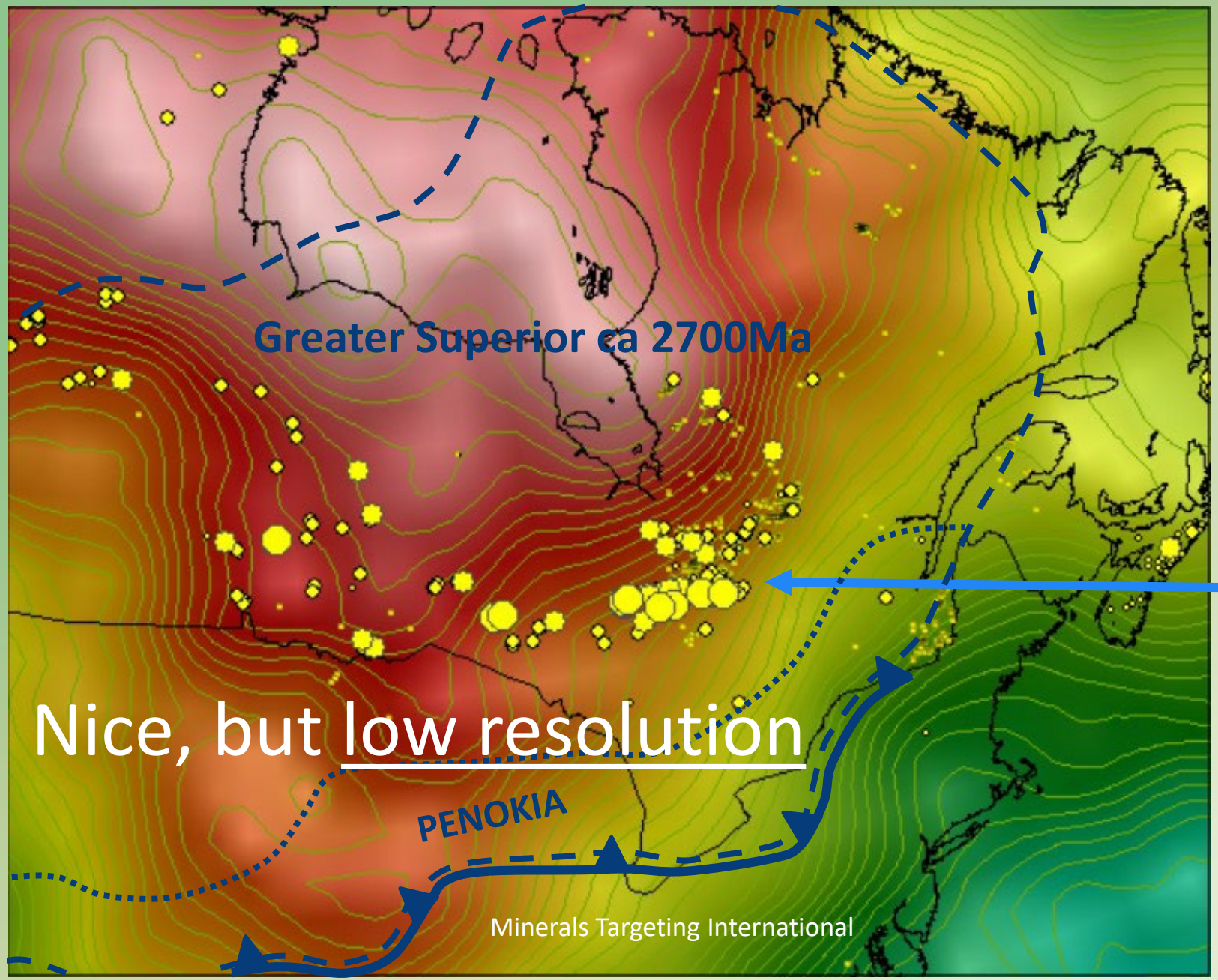


Griffin, Begg & O'Reilly, 2013, Nature Geoscience

Sed-Hosted Base Metals - Edge of thick Lithosphere



Hoggard et al., 2020, Nature Geoscience 13, 504-510

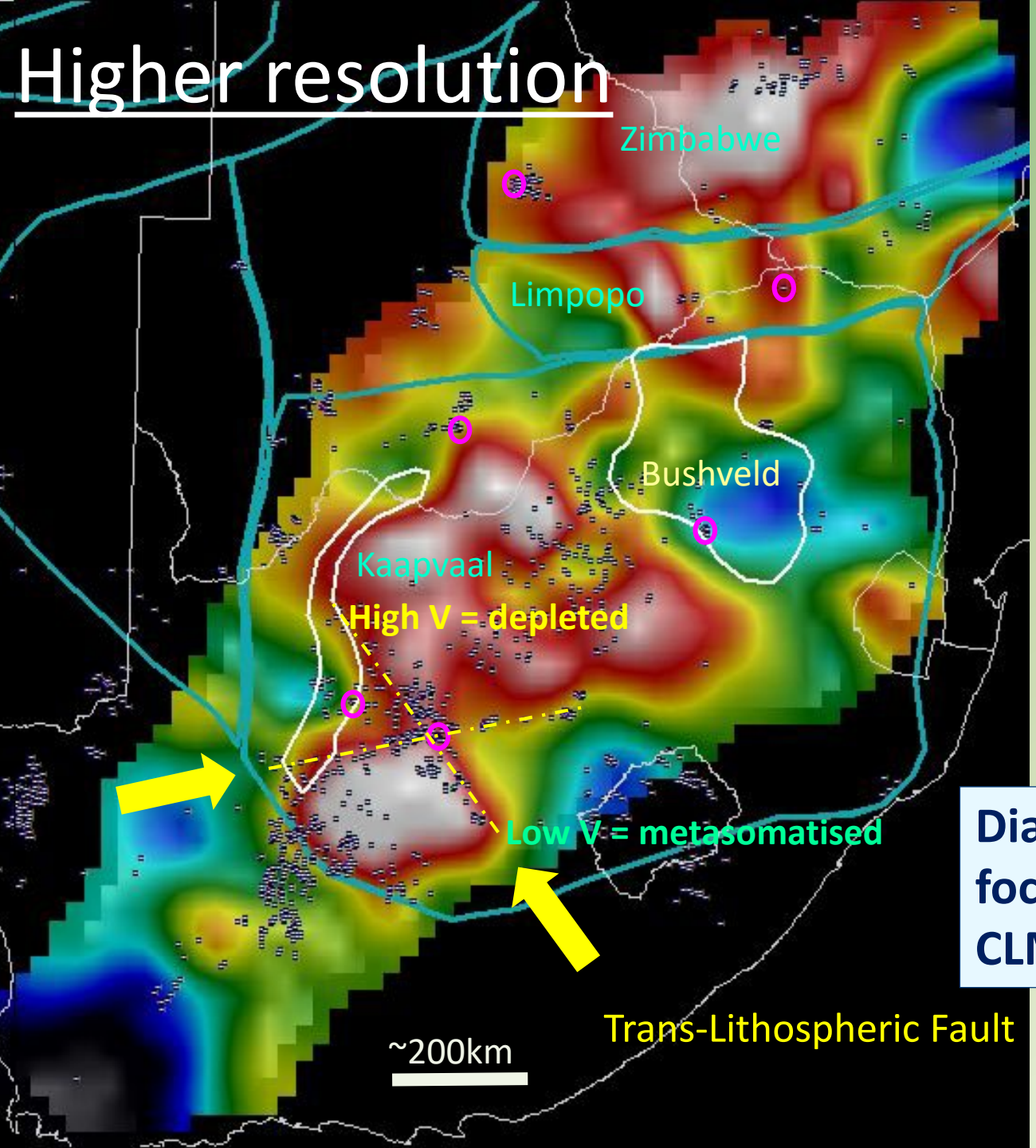


Superior Craton

Seismic tomography 175-250km, & Gold

Overall, gold deposits are in lower velocity zones around the edge of high velocity domains

Southern Abitibi belt in lower velocity zone, consistent with pre-gold rift location



Kimberlites and Diamonds in Vs at 200km

Resolution ~70km

(Carnegie Kaapvaal Experiment; Fouch et al., 2004)

Red = fast

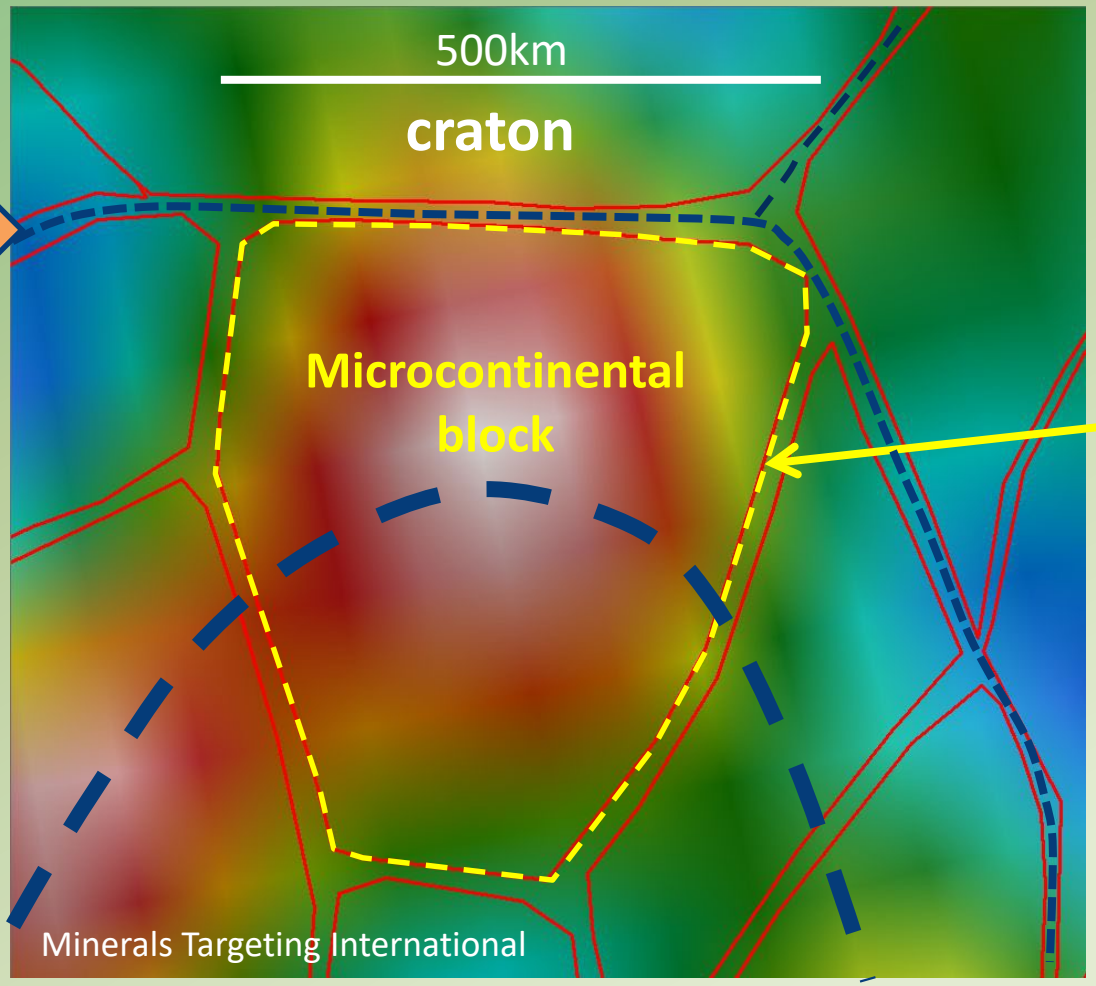
Blue = slow

O Giant Diamond Deposit

Kimberlites from Faure (2006)

Diamondiferous kimberlites focus around edges of depleted CLM (high velocity) regions

Mantle Lithosphere Map at ~100km depth



Sutured former Back-arc

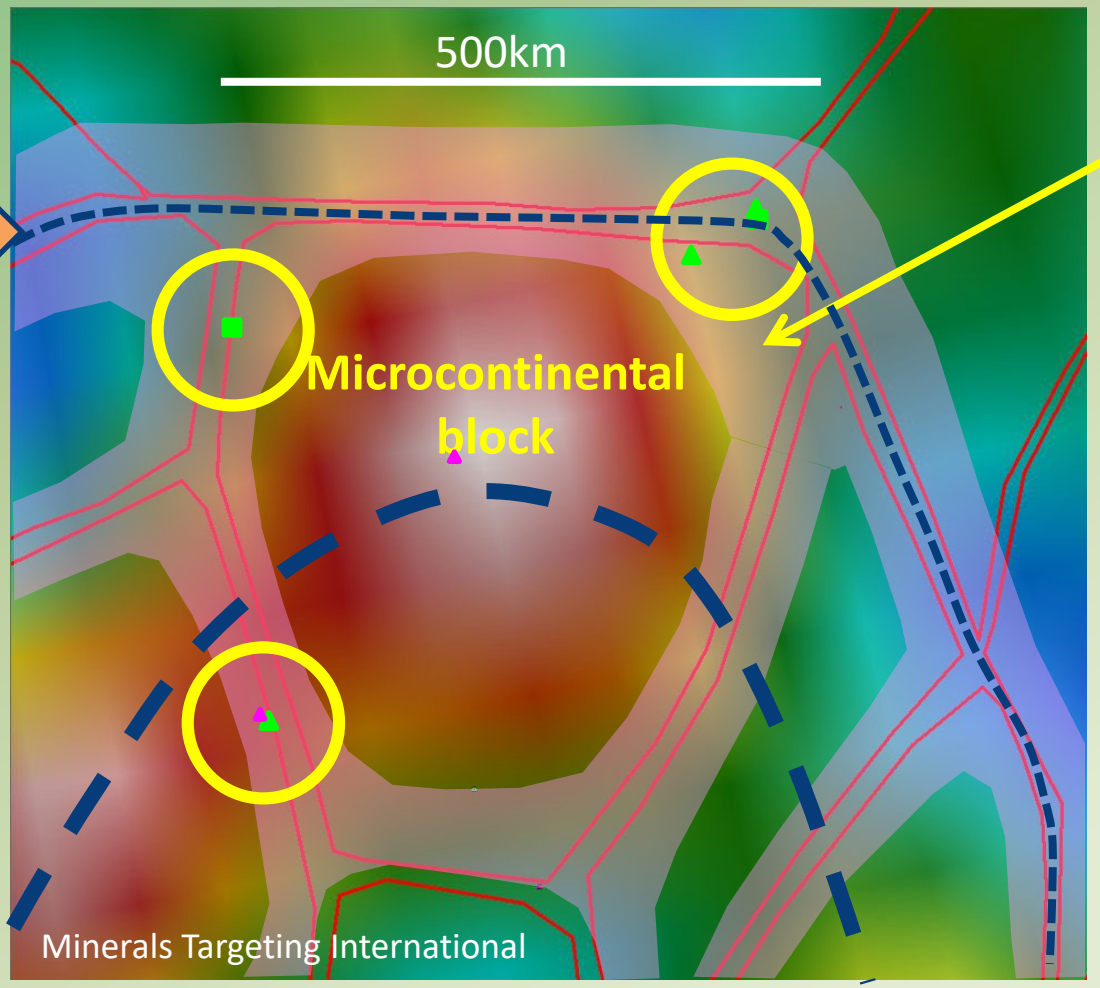
Axis of extinct Arc

Discrete mantle domain* (high Velocity in centre) flanked by major mantle-tapping faults

*Domains mapped using gravity, magnetics, geology, seismic (tomography, reflection, etc), DEM, and more

Lithospheric Mantle Architecture*

& *Gold-rich deposits*



Sutured former Back-arc

Axis of extinct Arc

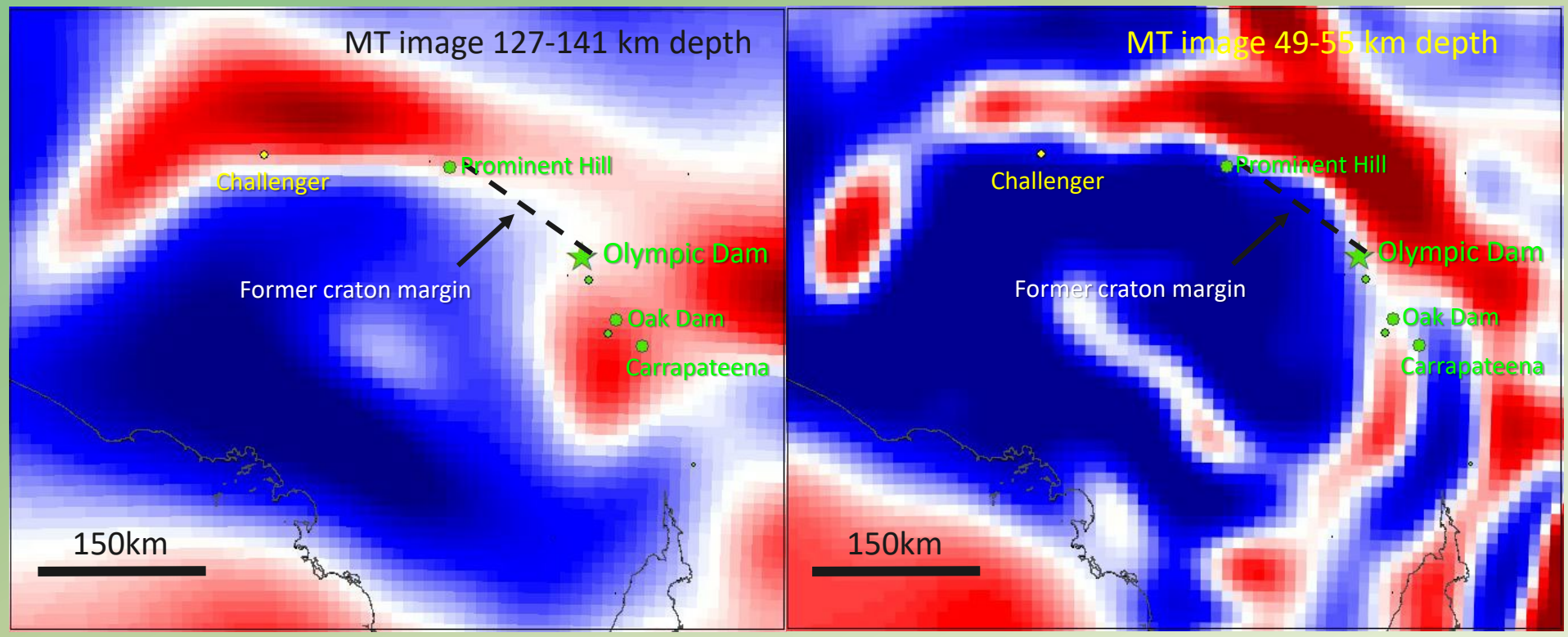
Metasomatized ancient SCLM (Gold source)

Deposits

- Giant >6 Moz
- Major >1 Moz
- Moderate >100 koz

** 2nd order faults not shown (important targeting ingredient)*

Gawler Craton Mantle Conductivity & Cu/Au



South Australia Geol. Survey data, 2018

- Linear zones of conductivity (red) may be zones of refertilised/metasomatized SCLM
- 1.59Ga IOCG deposits triggered by major mantle (plume?) melting event
  (LIP comprising Gawler Range Volcanics & Hiltaba Suite granitoids)
- IOCG association with high T alkaline ultramafic melts (melting of metasomatised SCLM)

Olympic Dam - MT reveals the whole mineral system

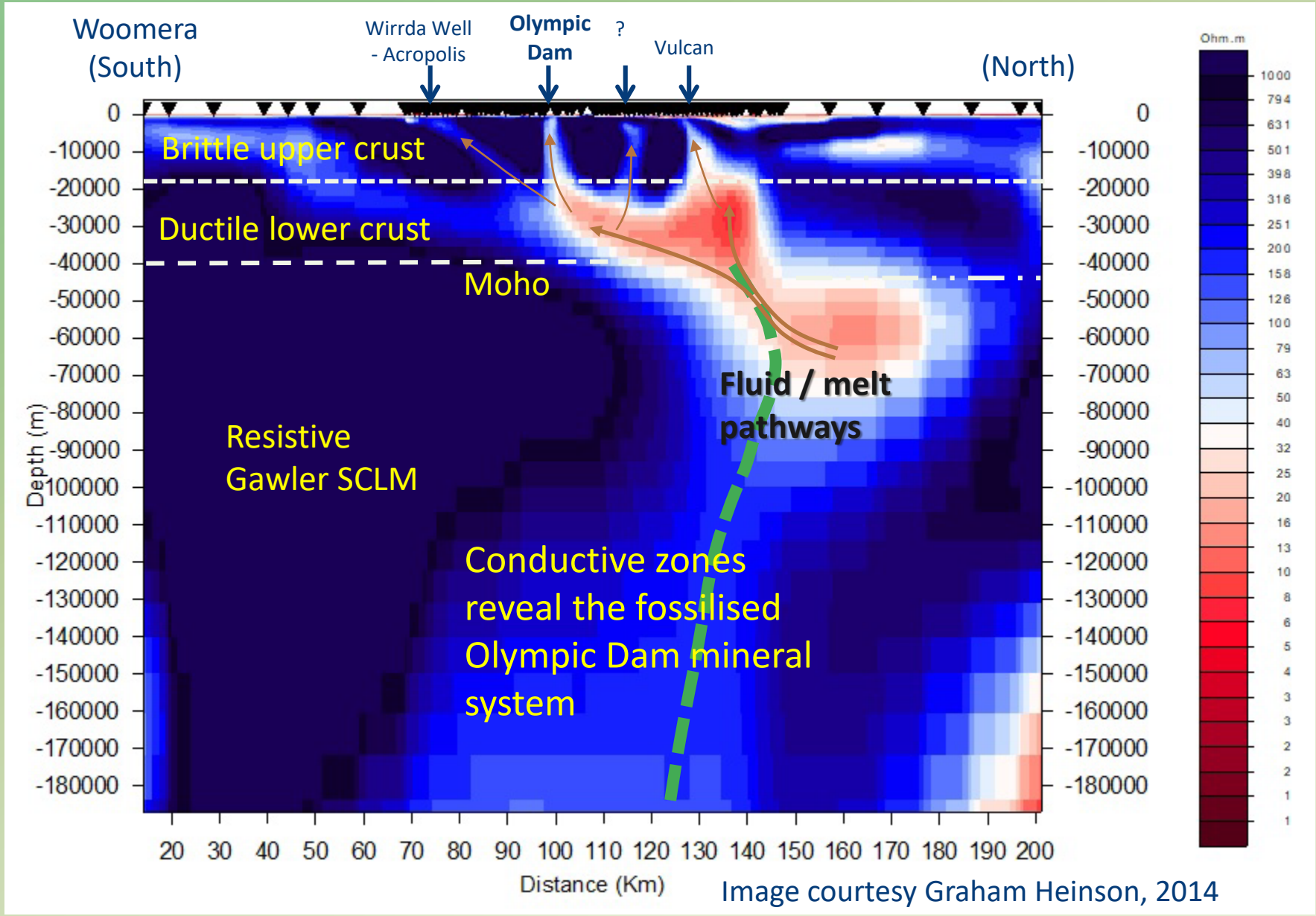
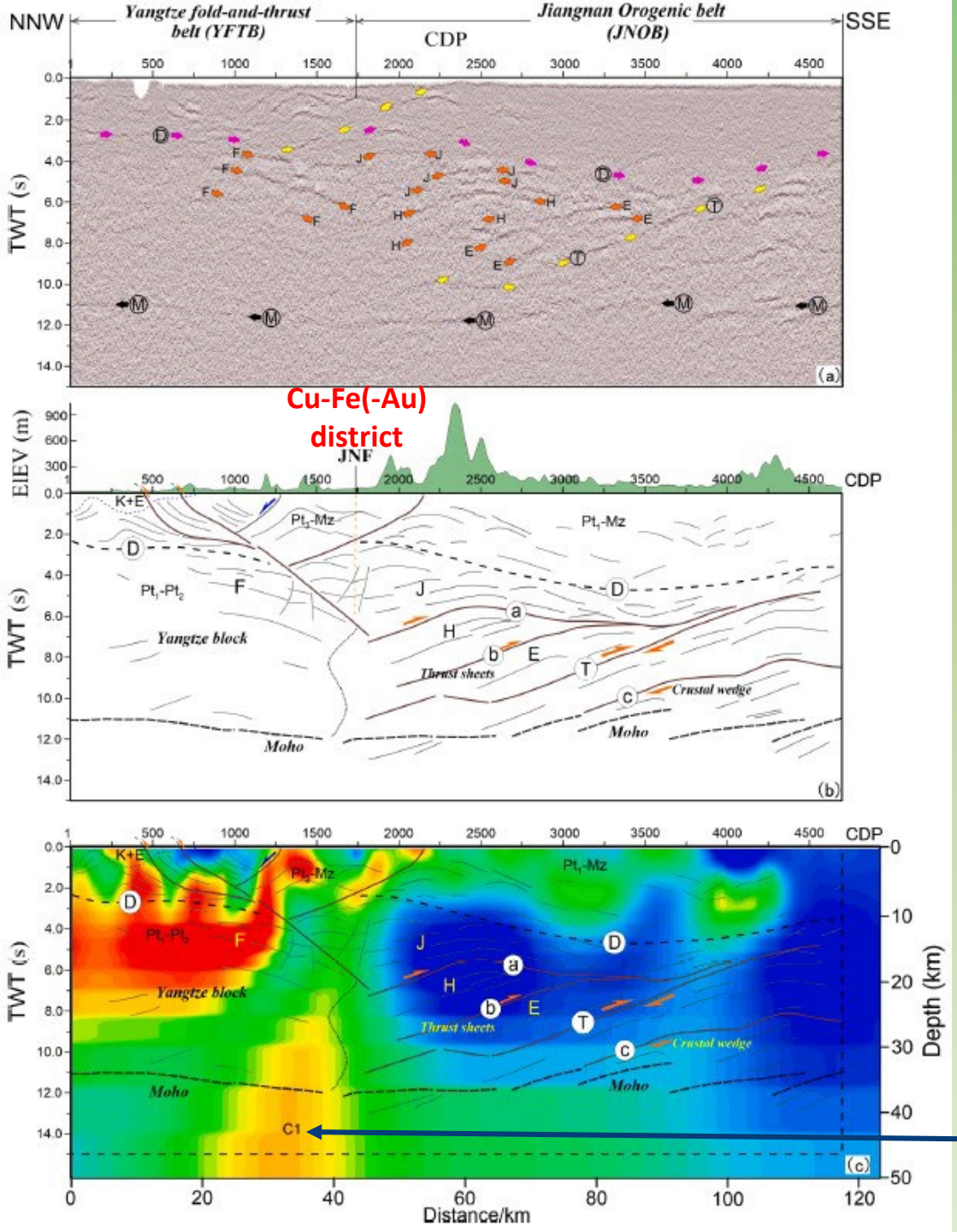


Image courtesy Graham Heinson, 2014

Lithospheric-scale Mineral Systems: Lower Yangtze Metallogenic Belt



Ca 140Ma Porphyry skarn Cu-Fe(-Au) deposits along trend of the JiangNan Fault (JNF)

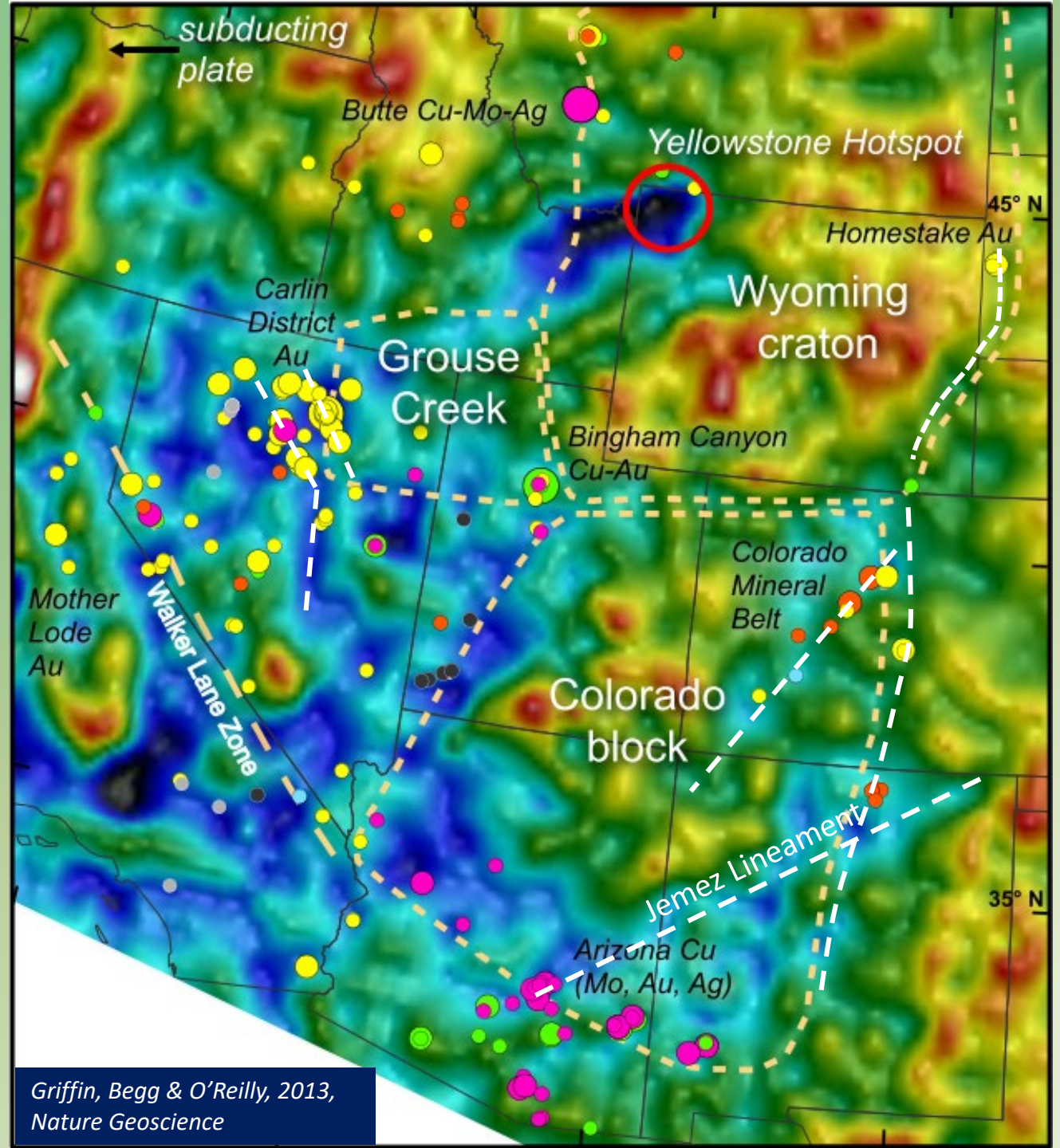
Seismic and MT data demonstrate linkage between mantle and upper crust

- Crustal architecture shows bivergent pattern from superposed extension & compression, ***focused at craton-microcontinent boundary***
- Moho offset consistent with mantle lithospheric boundary is also associated with strong mantle conductor
- Conductor continues into overlying crust as a subvertical feature
- Magmas dominantly follow vertical Trans-Lithospheric Faults
- Fluids may divert laterally along dipping crustal structures and domal culminations

Mantle conductor at craton boundary

Lu et al 2021, Ore Geology Reviews 132, 103989

W USA
90km depth Velocity



Griffin, Begg & O'Reilly, 2013, Nature Geoscience

Deposit size (supergiant, giant, major) & dominant metals:

yellow, Au
green, Cu-Au-Mo
pink, Cu-Mo-Ag-Au
orange, Mo
light blue, REE
light grey, W(-Sn)
dark grey, Fe

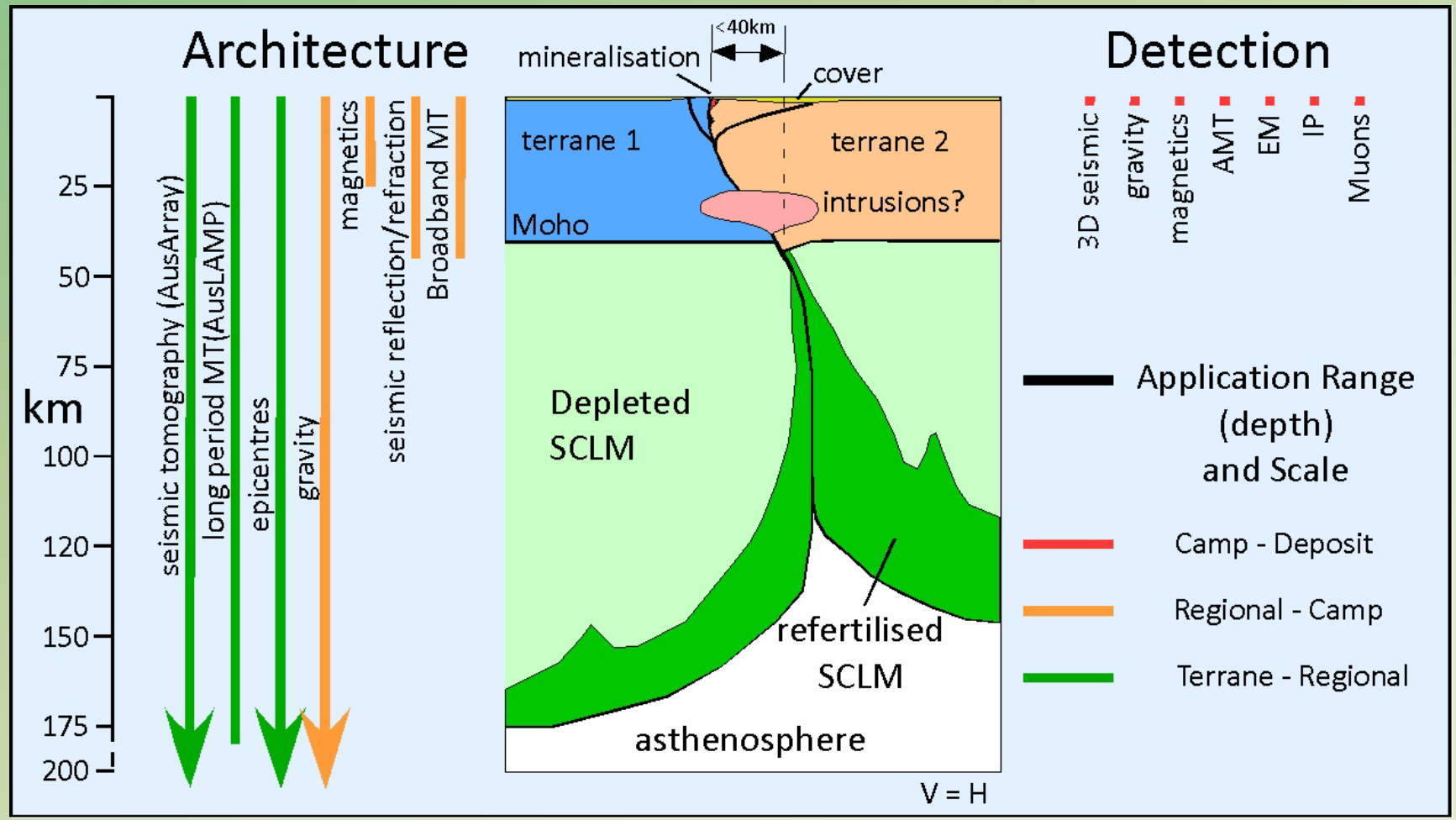
Big deposits concentrate along prominent trans-lithospheric structures, particularly in lower-velocity regions (blue) or on the flanks of highs

There is abundant evidence of widespread Archean lithosphere

WA Array

- 40km spaced passive seismic array will reveal velocity structure of the continental mantle and crust
  - More detailed than US Array
- MT acquisition (variable spacing; some at 40km)
- The Opportunity: Combine these with the extensive and detailed existing data over WA to create the world's most detailed 3D understanding of full lithosphere architecture
- Focus the search for new deposits and camps

Whole-of-Lithosphere Approach to Exploration



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