Implications for regional energy and mineral systems of the GOMA survey

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Australian Government
Geoscience Australia

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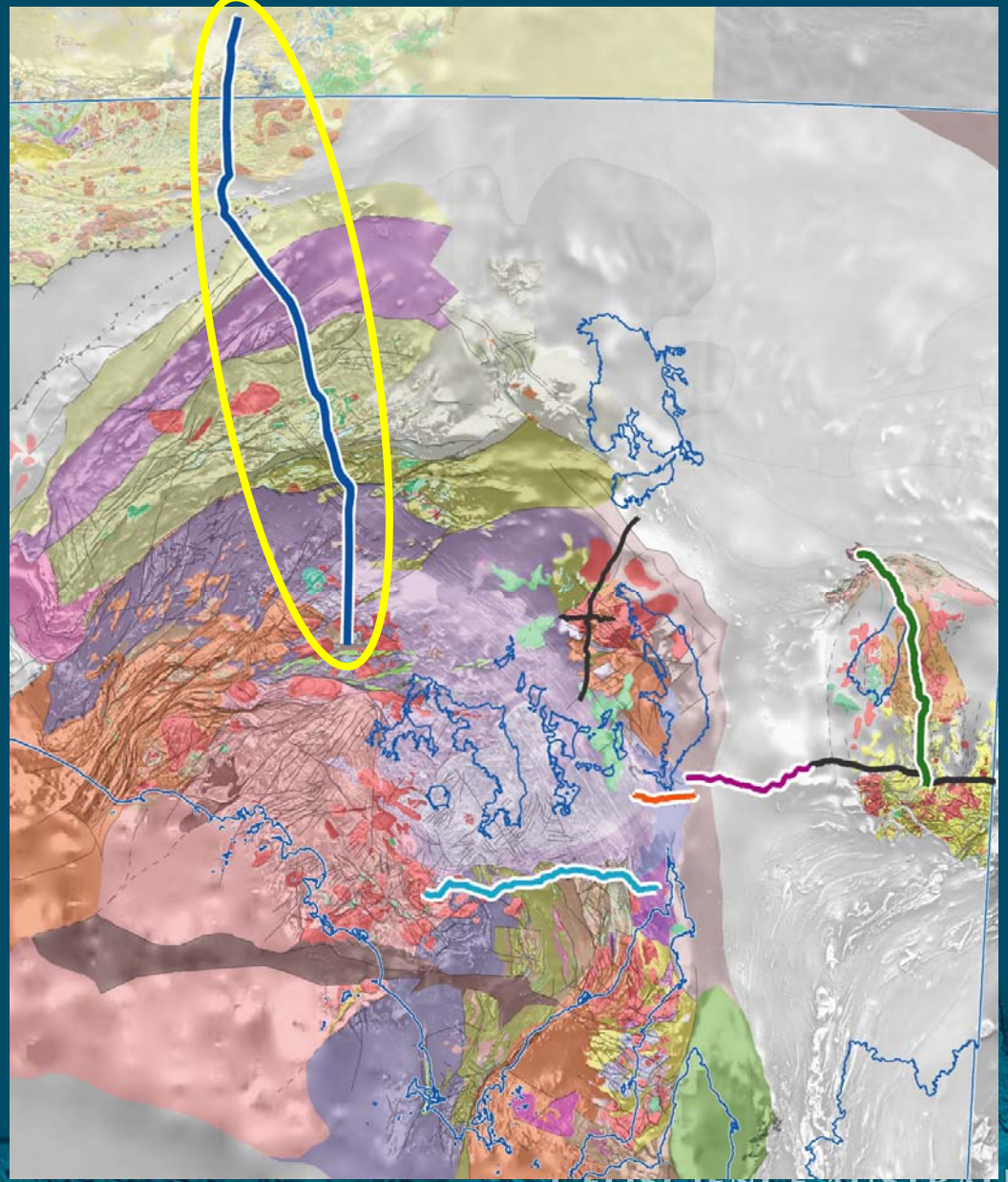
Primary Industries and Resources SA

AuScope

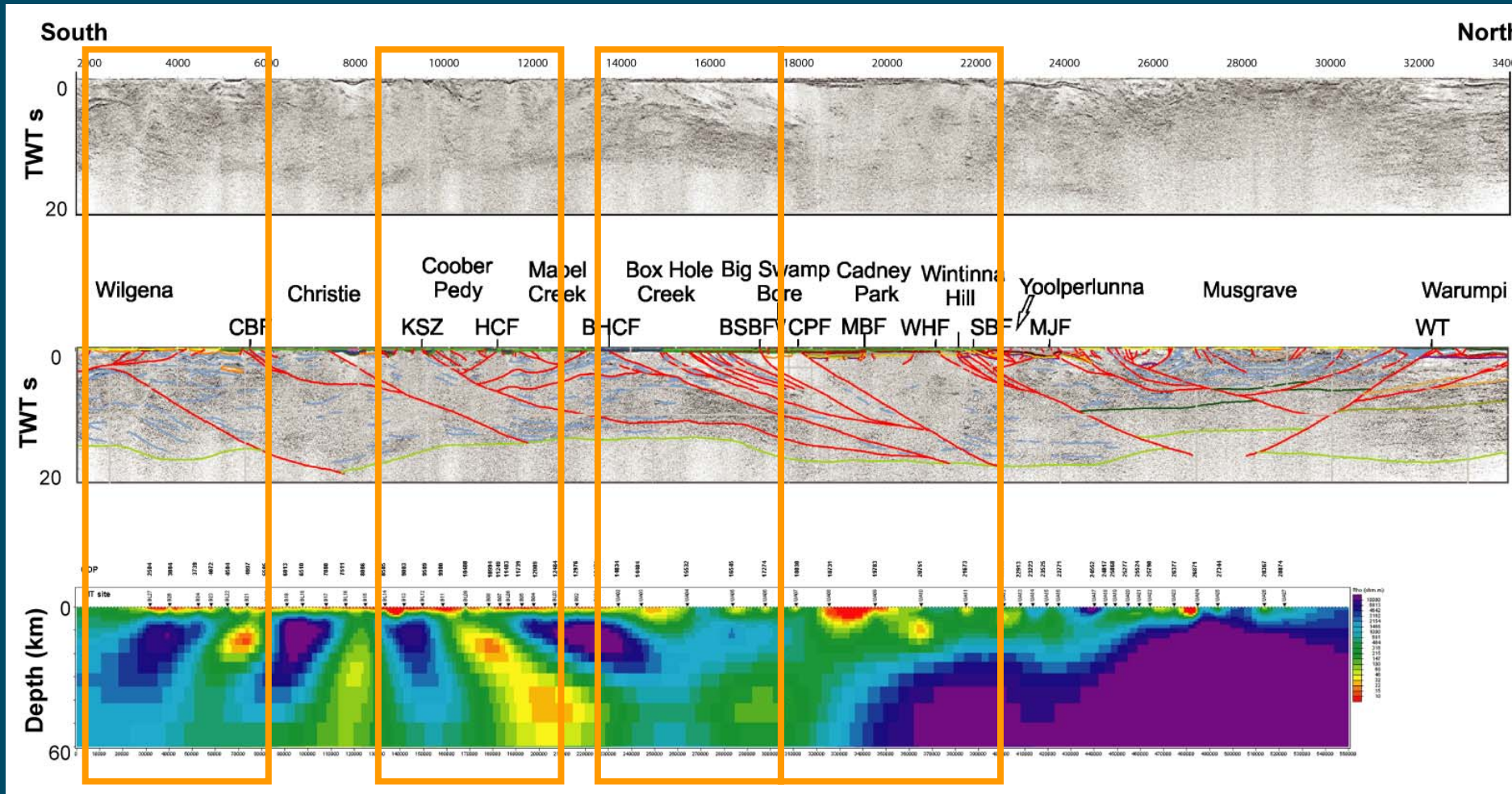
Northern Territory Government

Energy drivers for the GOMA Seismic & MT data

- Image the crustal architecture of the Officer and Amadeus Basins → petroleum.
- Compare the crustal architecture of the northern Gawler Craton to the Olympic iron oxide copper-gold (IOCG) Province.
- Identify crustal geometries with a high mineral and energy potential.
- Refine the northern extension of the South Australian Heat Flow Anomaly → geothermal.
- Improve understanding of the geodynamic evolution of the region.

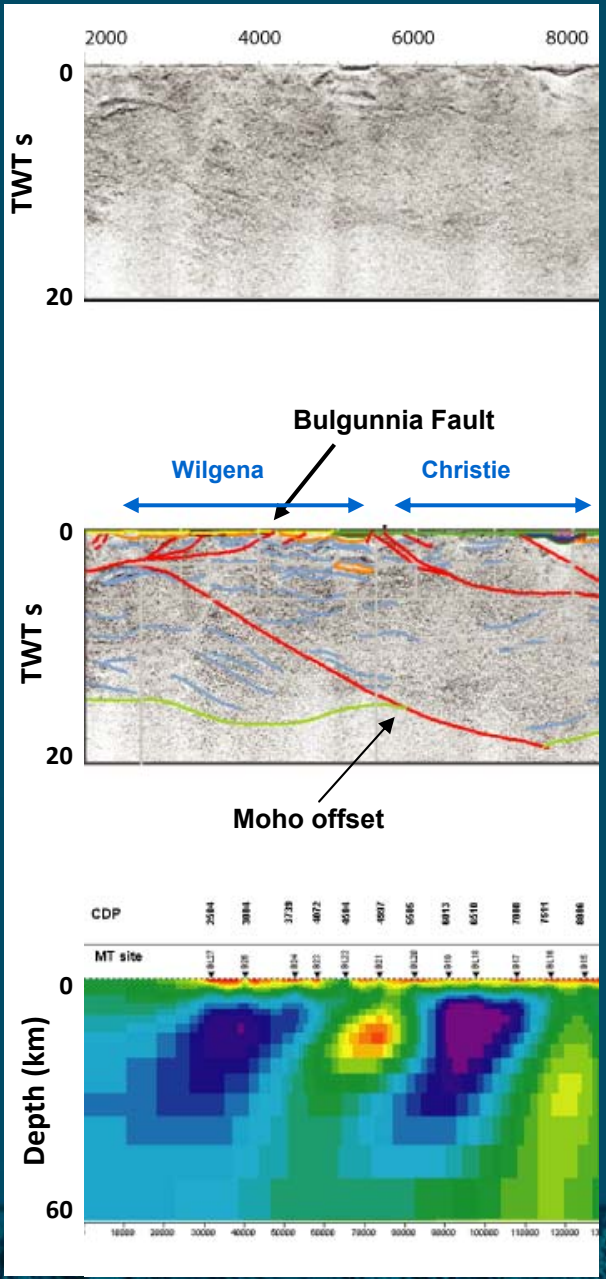


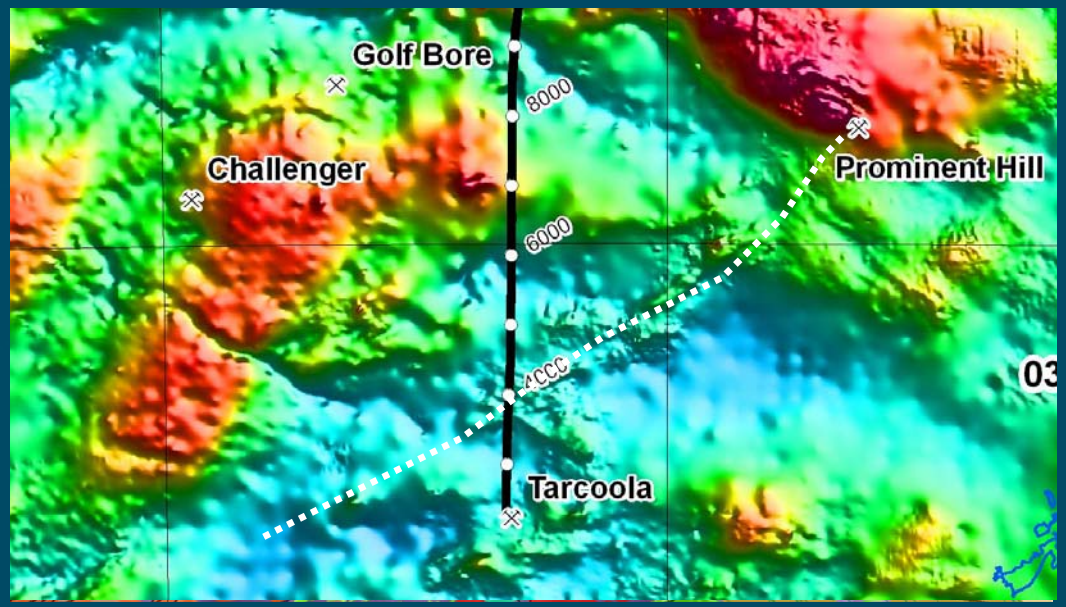
Energy drivers for the GOMA Seismic & MT data

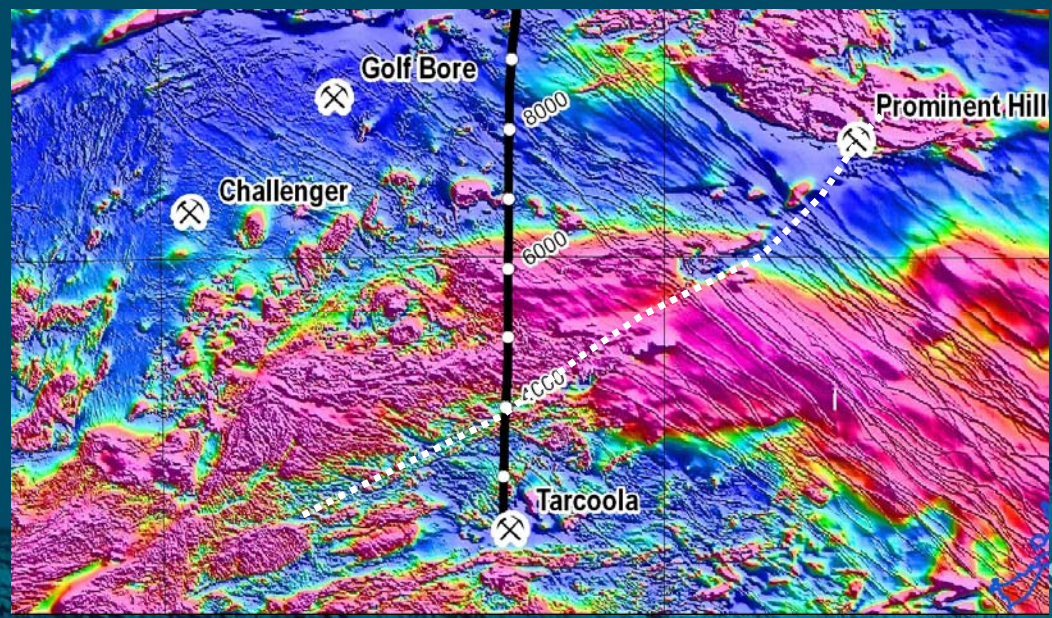


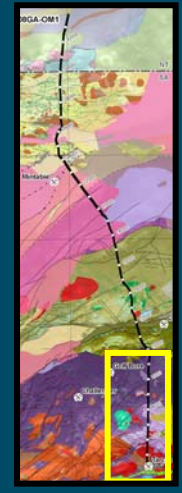
Bulgunnia Fault IOCG systems Load Au Fluid migration

Bulgunnia Fault

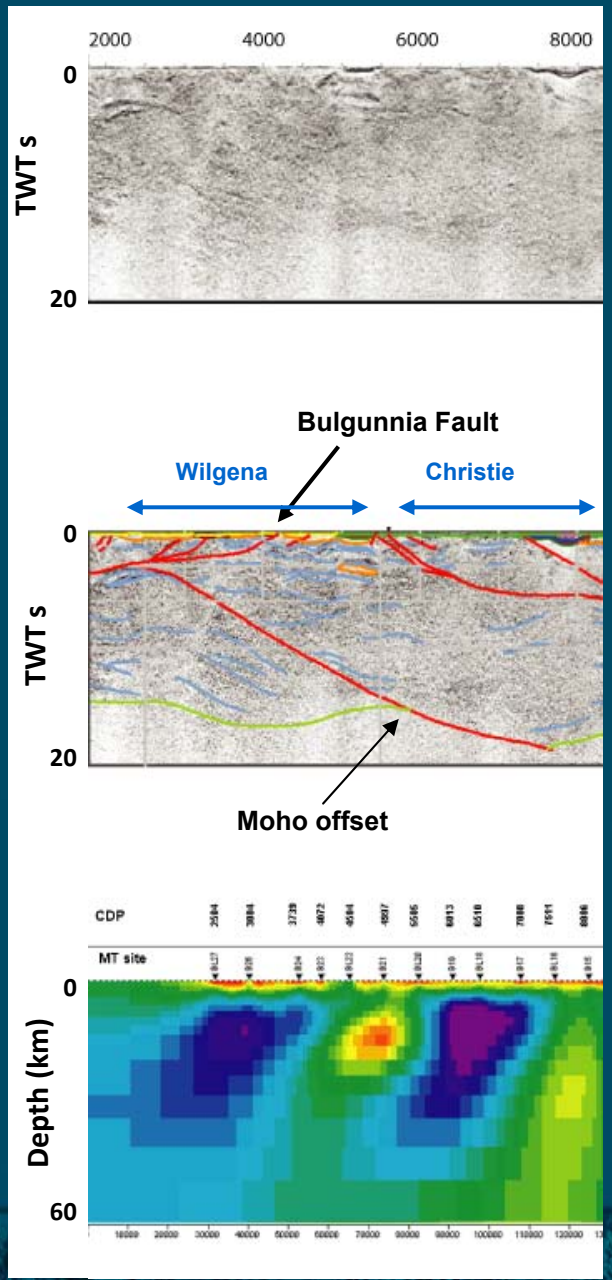








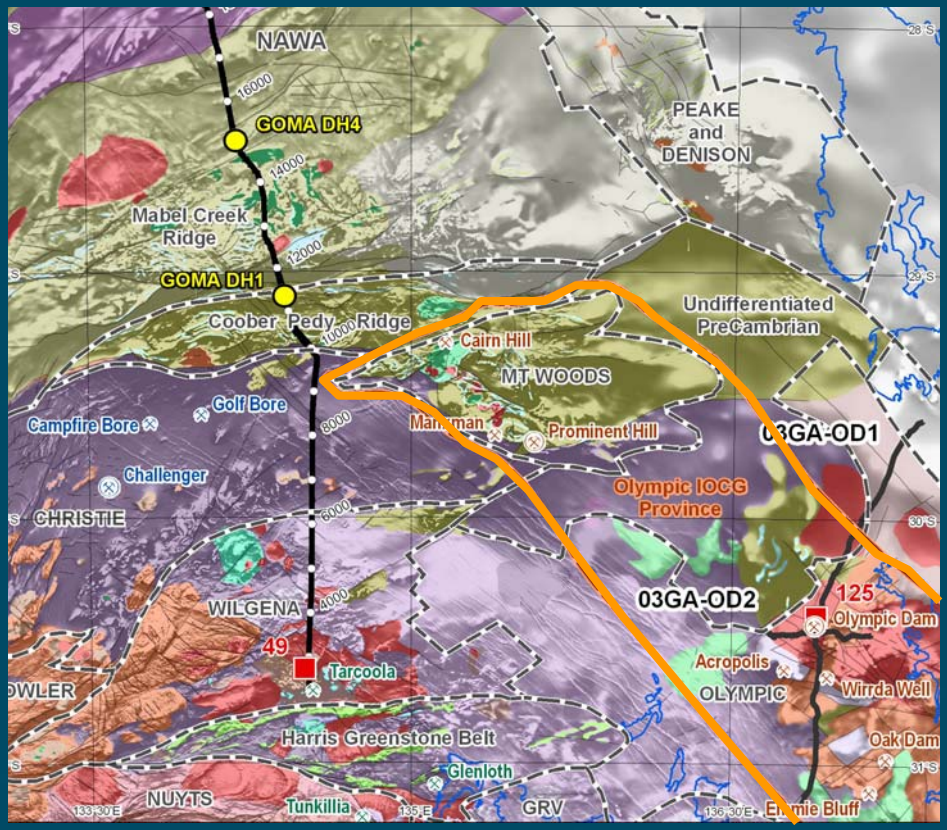
Bulgunnia Fault

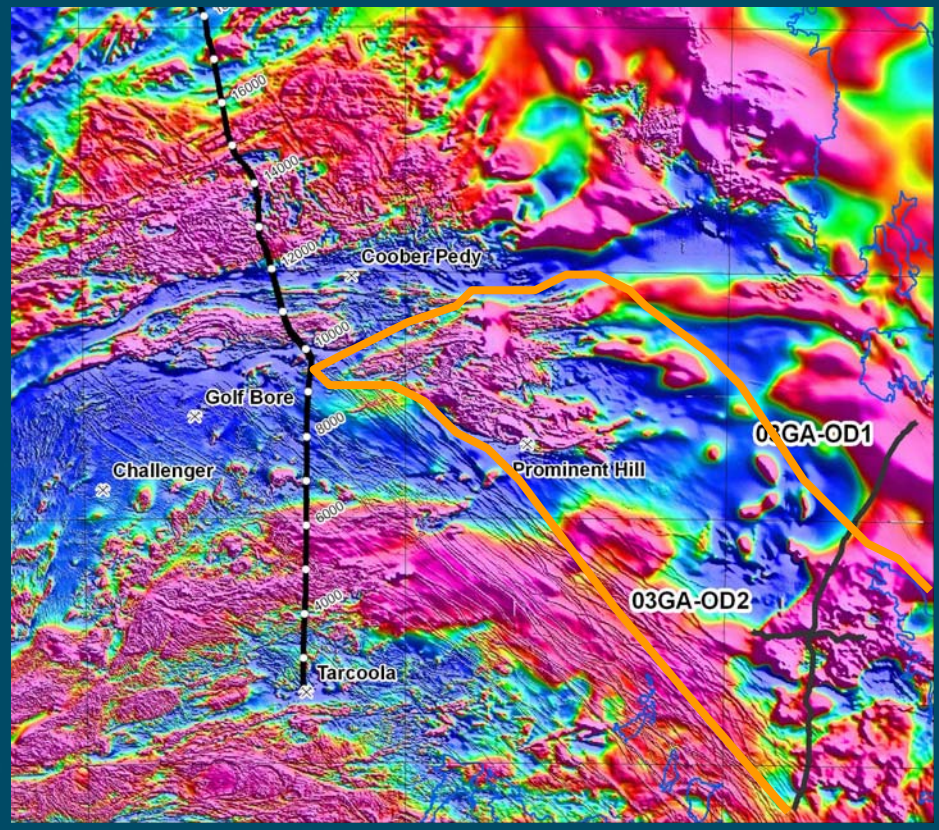


- BF is a relatively shallow south-dipping fault, which intersects a crustal-scale north-dipping structure at ~6km depth.
- The crustal-scale fault offsets the Moho with an extensional geometry, and corresponds to a zone of higher conductivity compared to surrounding crust.
- Tarcoola goldfield located near the intersection of these faults. Here Au mineralisation associated with 1580 Ma mantle-derived magmatism.

→ Zone associated with the Bulgunnia Fault many be prospective for gold (± copper) systems ?

GOMA and the Olympic IOCG±U Province

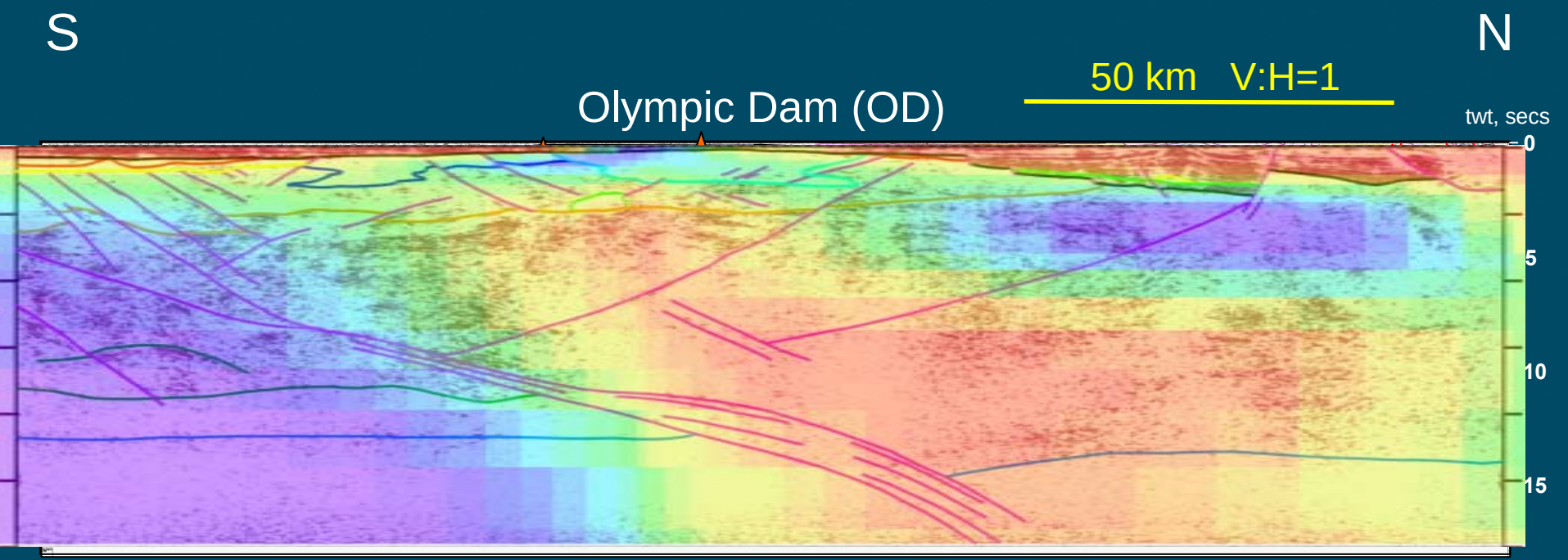




- Olympic IOCG Province defined by regions recording early Mesoproterozoic IOCG±U hydrothermal systems and associated geological features.
- In the northern Gawler Craton ~ Olympic Domain, Mt Woods Domain and Undifferentiated Precambrian areas.

? Inclusion of Coober Pedy Domain and Mabel Creek Domain

Crustal architecture - Olympic Dam (OD)



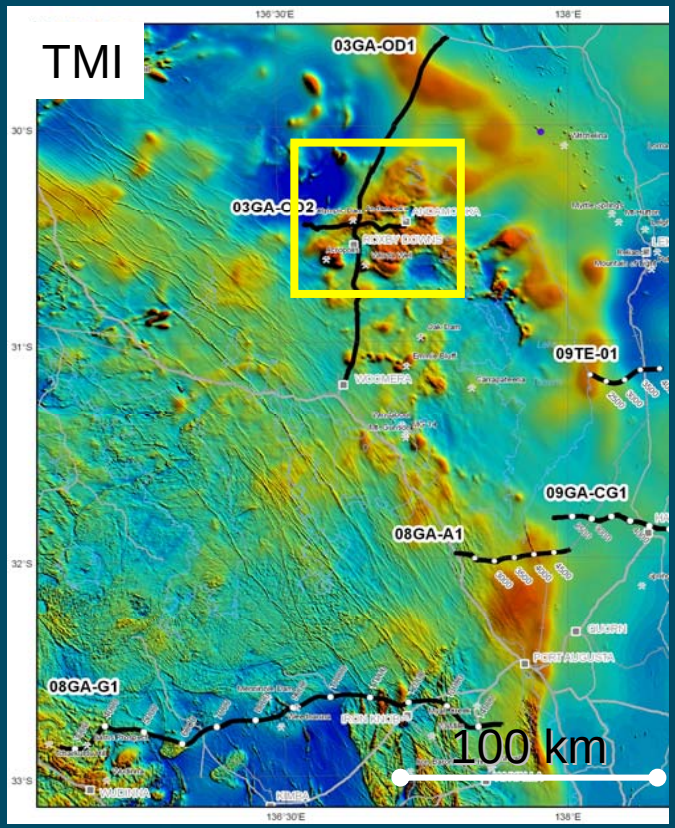
Seismic and magnetotellurics

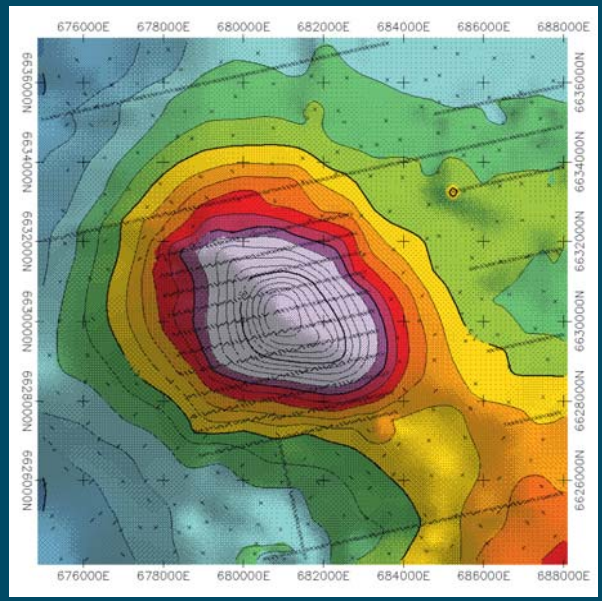
(Lyons and Goleby, 2005; Heinson et al., 2006)

Major crustal architectural ingredients, OD sits above:

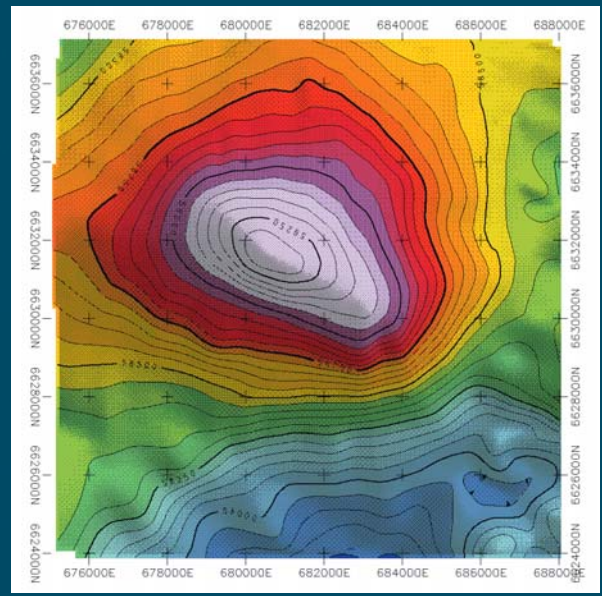
- **Seismically non-reflective crustal ('bland zone')**
- **Crustal-scale structure (Elizabeth Creek Fault) – extension implied, OD in hangingwall**
- **Two different crustal blocks (seismic character)**
- **Magnetotellurics (MT) = conductive zone → deep alteration system?**

Other characteristics of IOCG systems





Bouguer Gravity



Aeromagnetics data

Hanneson (2003)

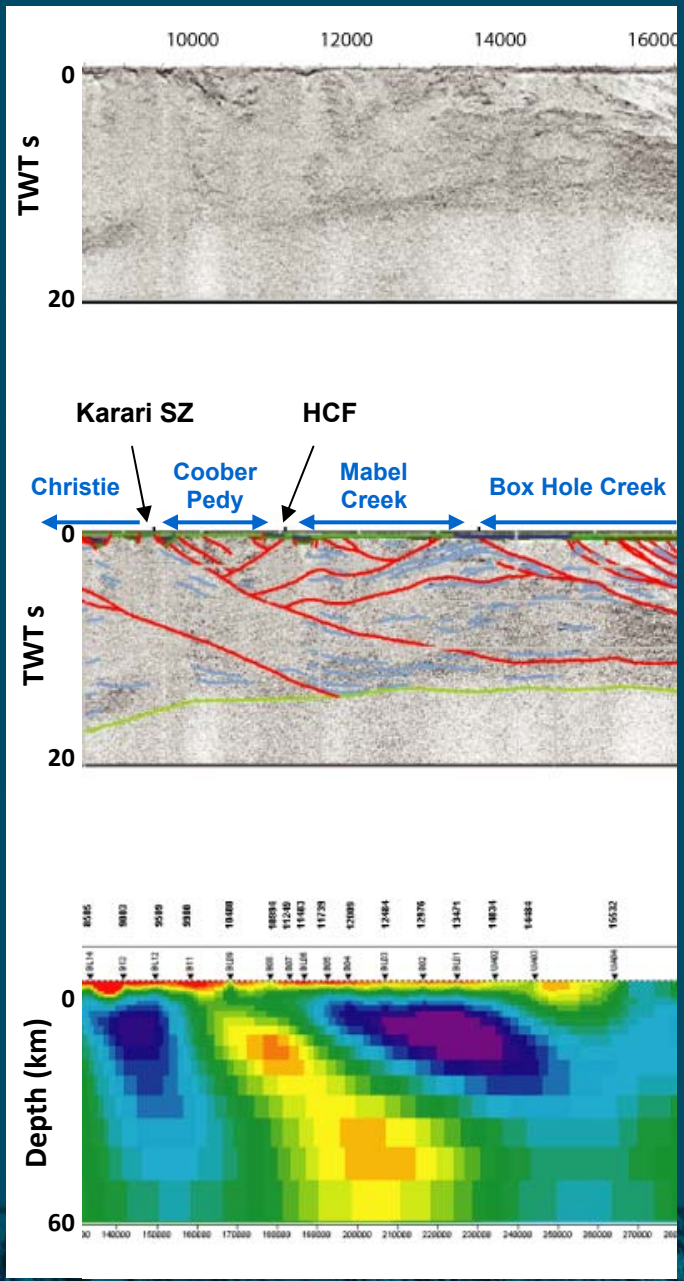
Geophysical characteristics:

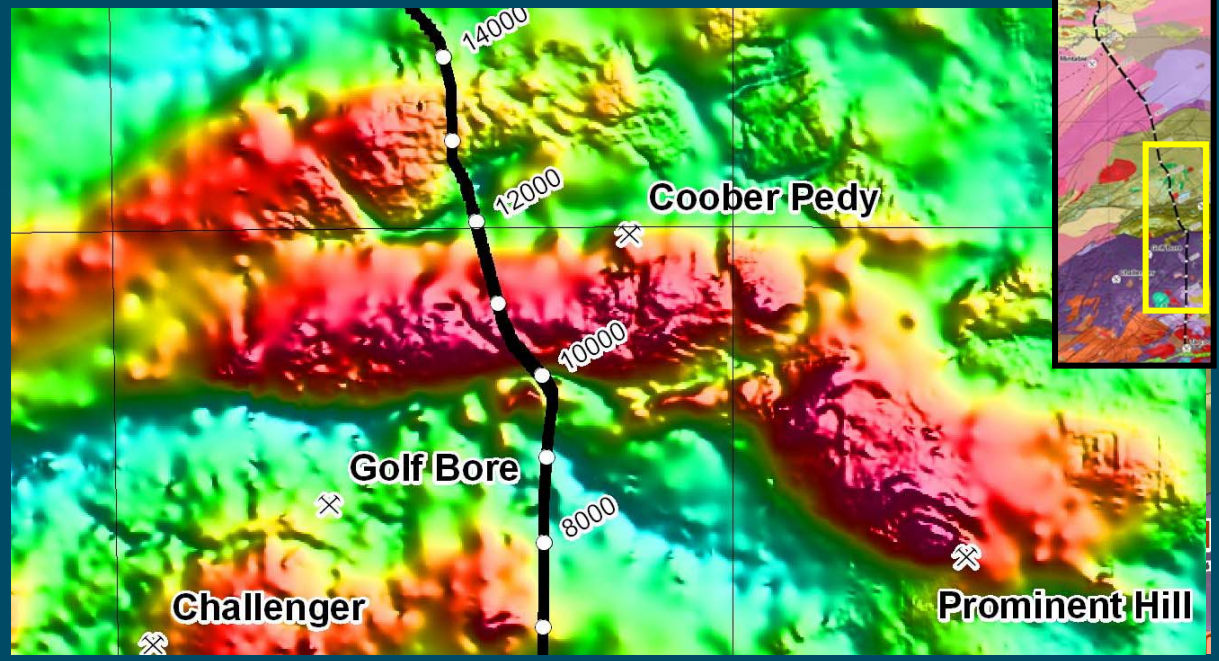
- Huge magnetic and gravity anomaly.
- In detail off-set between magnetic and gravity high.

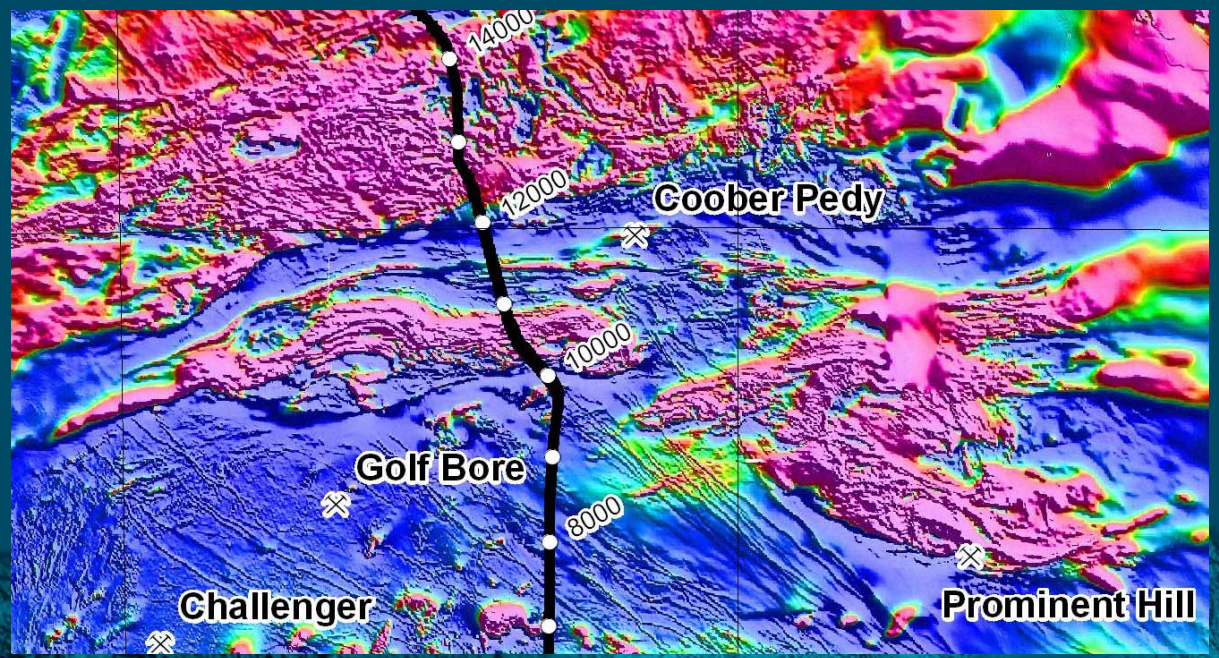
Alteration characteristics:

- Hematite-rich alteration style (e.g. Olympic Dam, Prominent Hill)
- Magnetite-rich alteration style (e.g. Cairn Hill, Manxman)

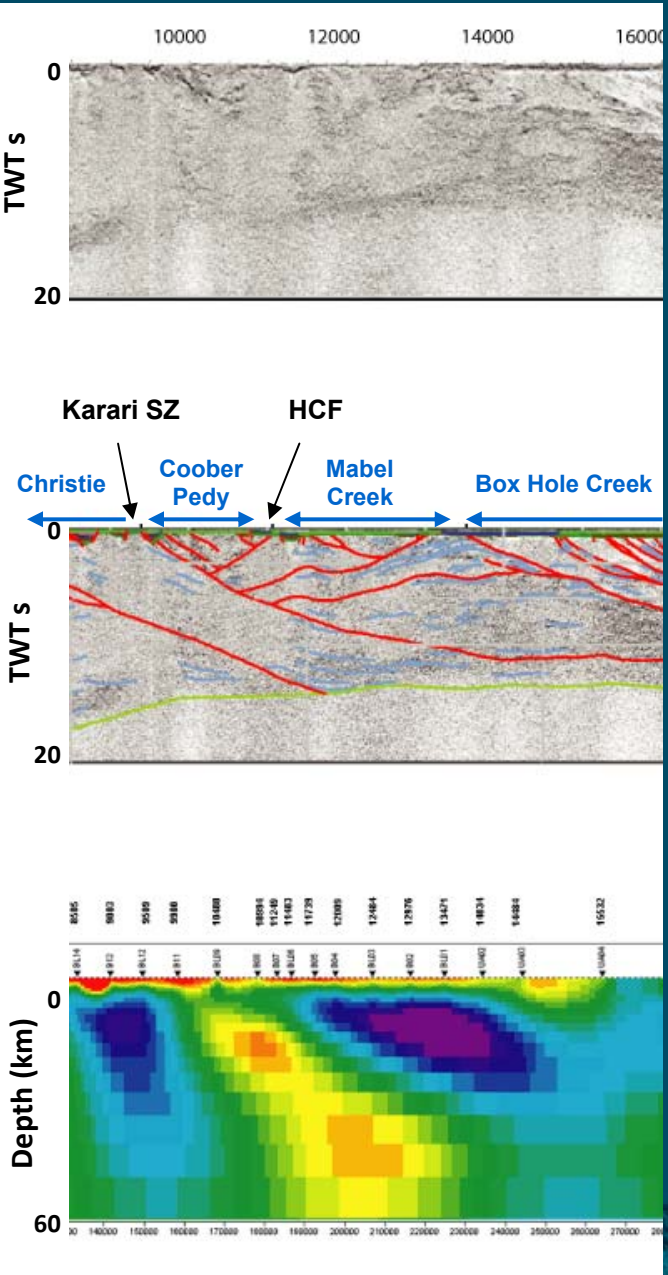
Karari SZ & the Olympic IOCG±U Province







Karari Shear Zone & the Olympic IOCG±U Province



- KSZ separates Neoarchean high-grade metamorphic rocks from ~1595 Ma high-grade metamorphic rocks.
- KSZ is a north-dipping crustal-scale structure which soles at depth onto the Moho.
- Deep crust beneath the KSZ corresponds to an area of higher conductivity - modified by fluids?
- Regional magnetic data → KSZ is a major east-west structure which is intersected by ~northeast-southwest faults.

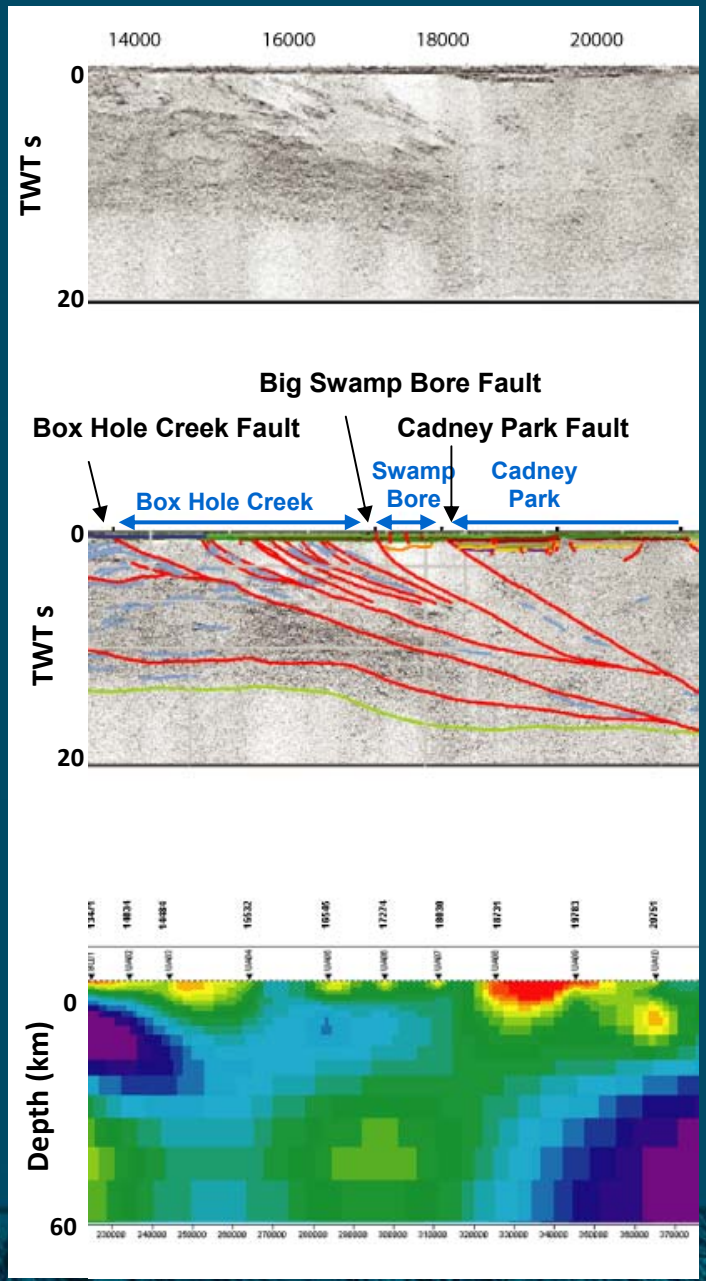
☑ Intersecting major fault systems

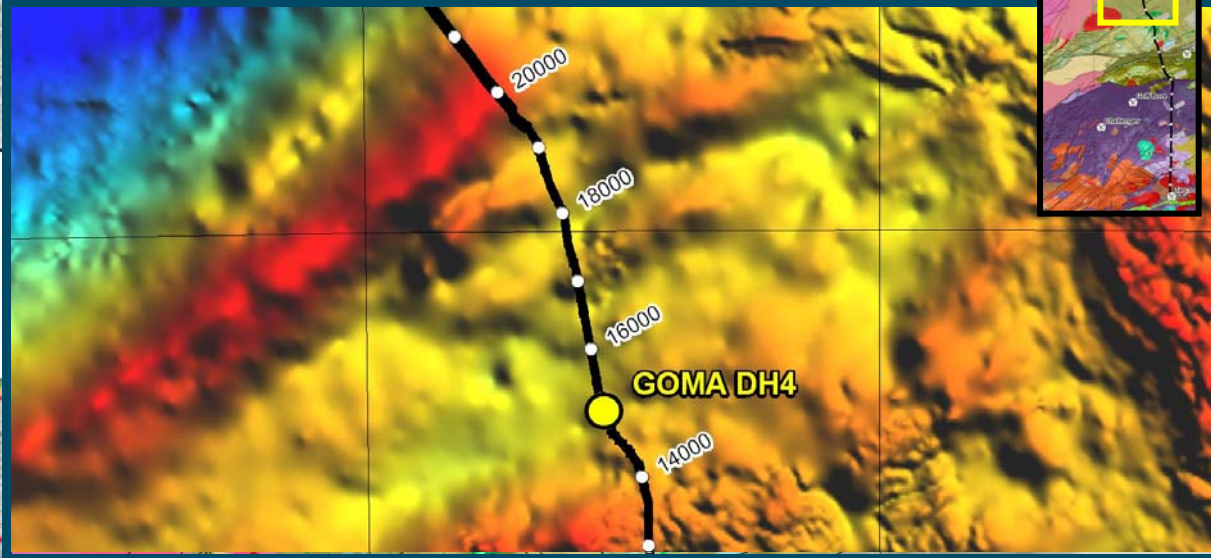
☑ Juxtaposition of Archean + Proterozoic terranes

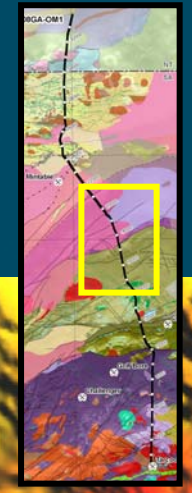
☒ No Hiltaba Granites/Gawler Range Volcanics preserved → uppermost crust not preserved.

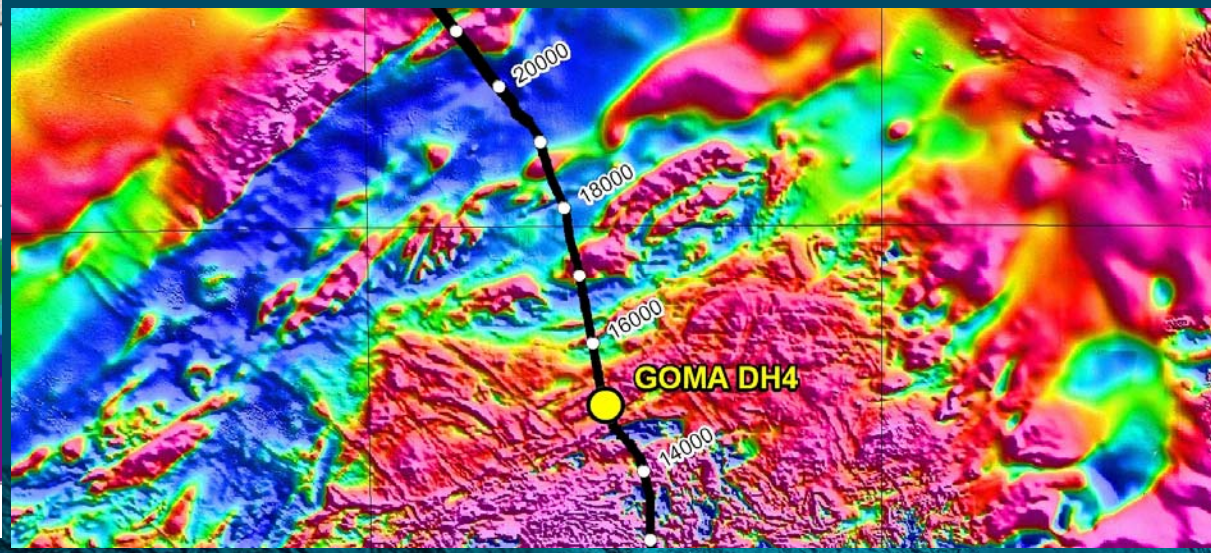
→ IOCG systems may be high temperature magnetite-rich Cu-Au style rather than hematite-rich and uranium-bearing systems.

Lode Gold potential

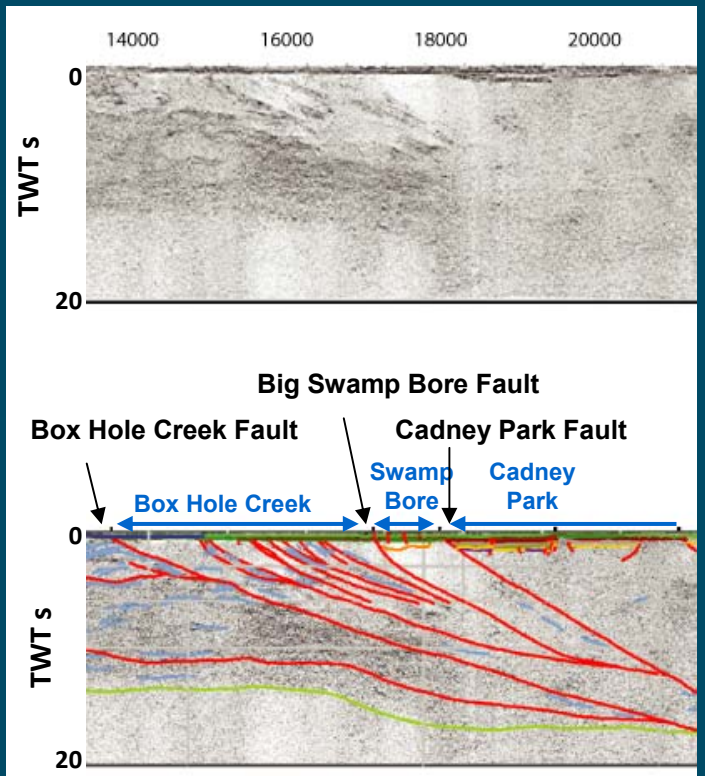






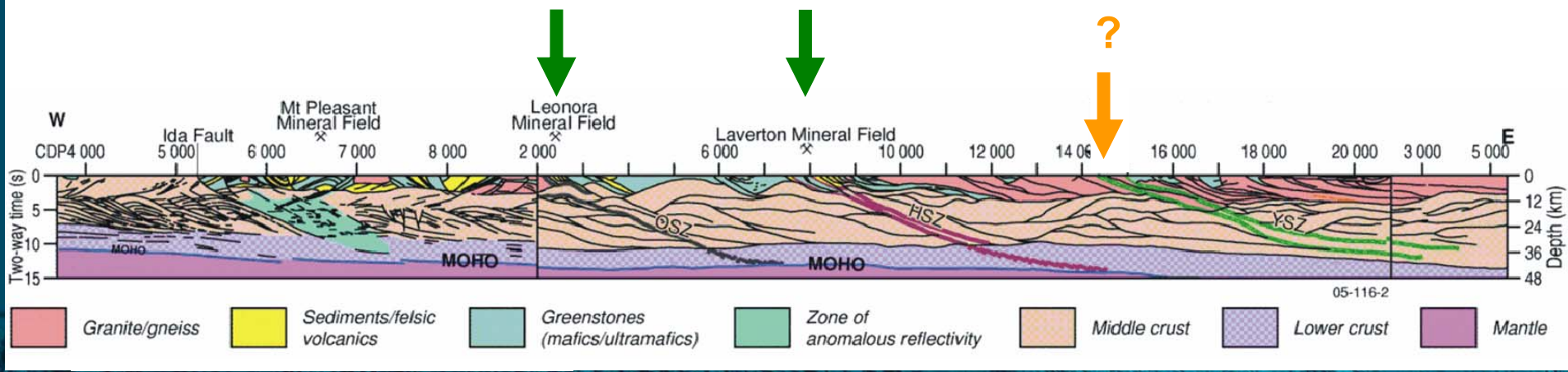


Lode Gold potential

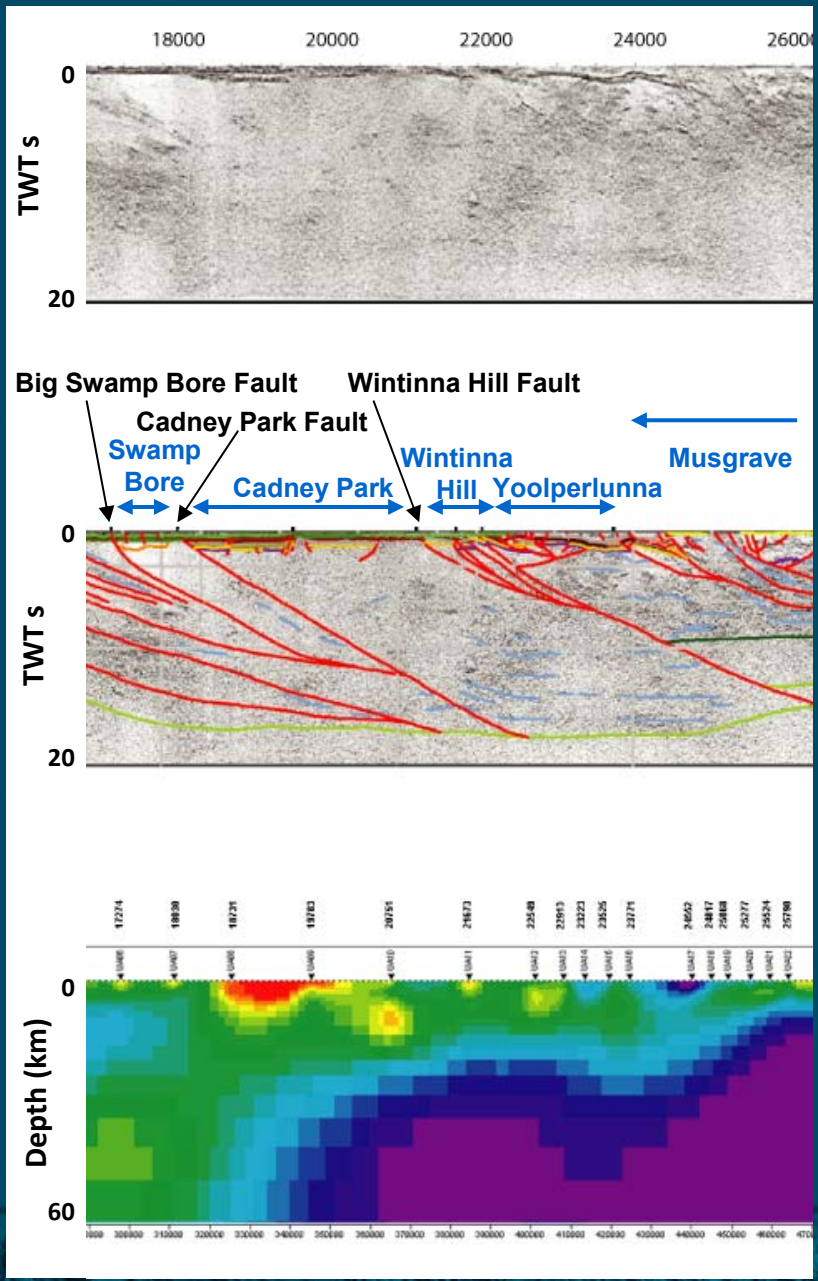


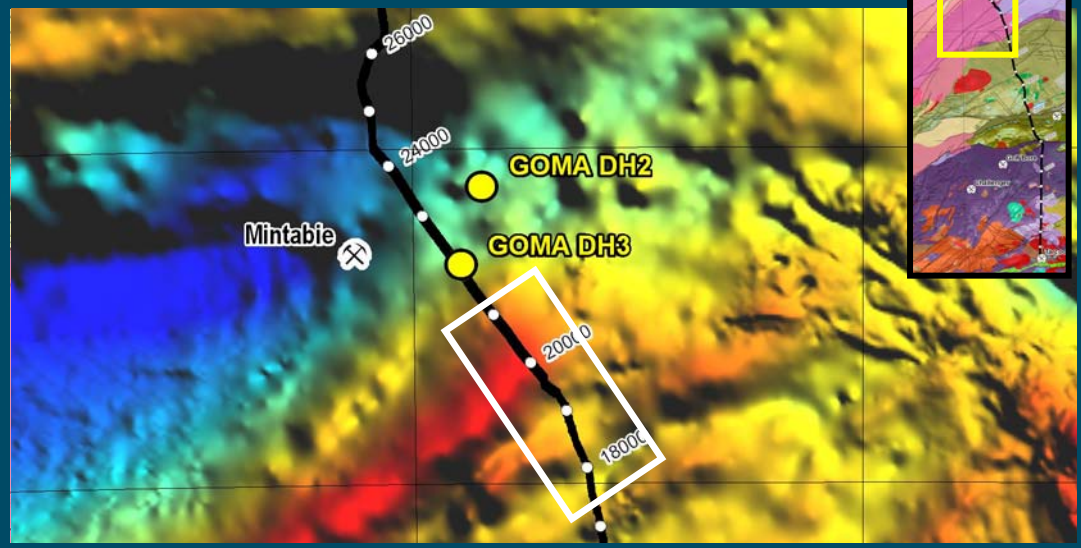
- Seismic data identify series of north-dipping, structures which sole out onto the crustal-scale Big Swamp Bore and Box Hole Creek Faults.
- Within this region, GOMA DH4 intersected Neoarchean orthogneisses & ~1523 Ma metamorphism.
- Similar crustal geometry to crust penetrating shears in Eastern Goldfields, Yilgarn Craton.

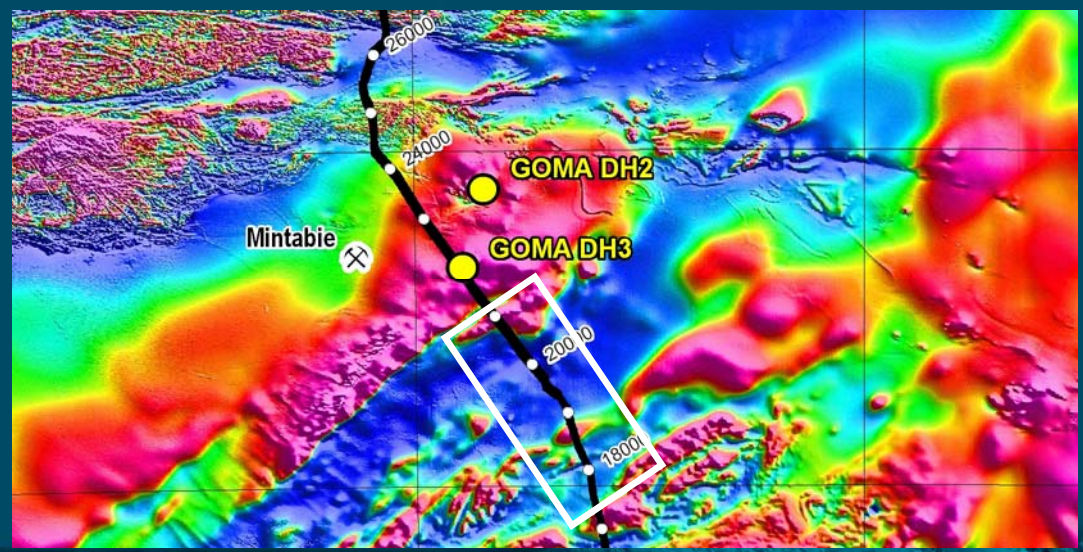
→ Potential for lode-Au systems in this region?



Fluid migration







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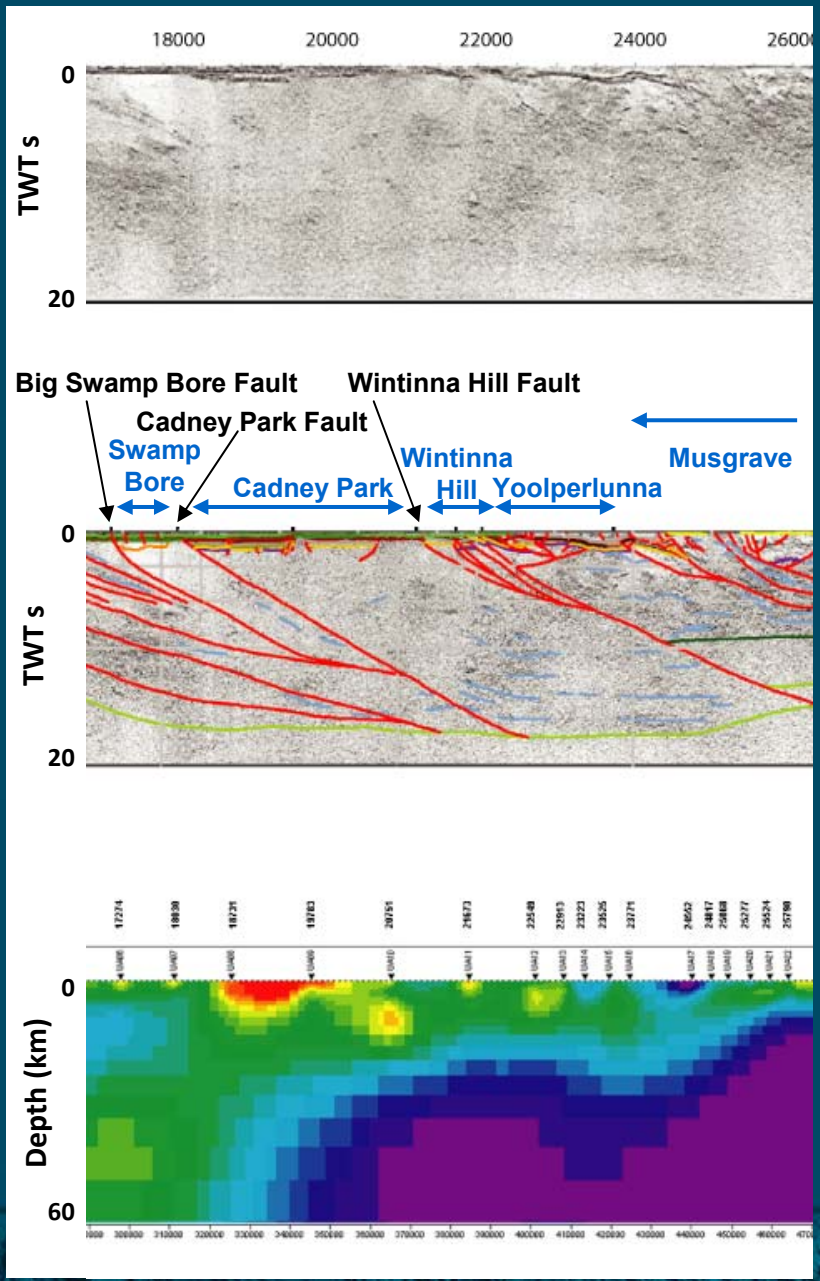
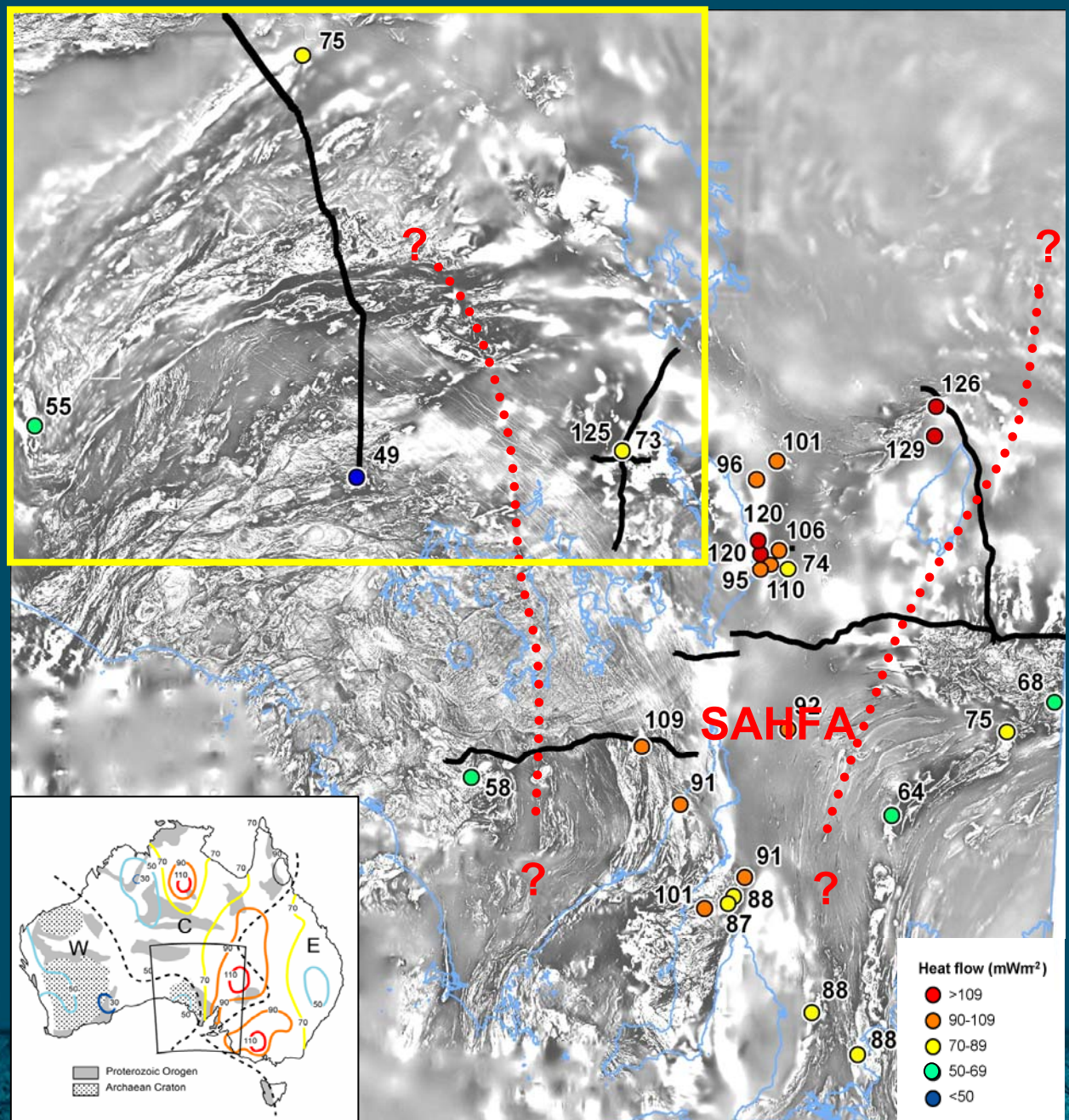


- Big Swamp Bore and Cadney Park Seismic subdomains = low seismic reflectivity throughout the crust, and a slightly deeper Moho.
- Both boundaries defined by north-dipping crustal-penetrating faults.
- Wintinna Hill Fault offsets the Moho.
- Subdomain boundaries correlate to strong gravity and magnetic gradients.
- MT data shows a more conductive region in the mid crust associated with the Cadney Park Fault.

→ zones of major fluid migration?

South Australian Heat Flow Anomaly (SAHFA)



- Proterozoic Australia has high surface heat flow.
- Only 2 heat flow values along GOMA transect
- SAHFA = high heat flow due to high heat-producing granites.

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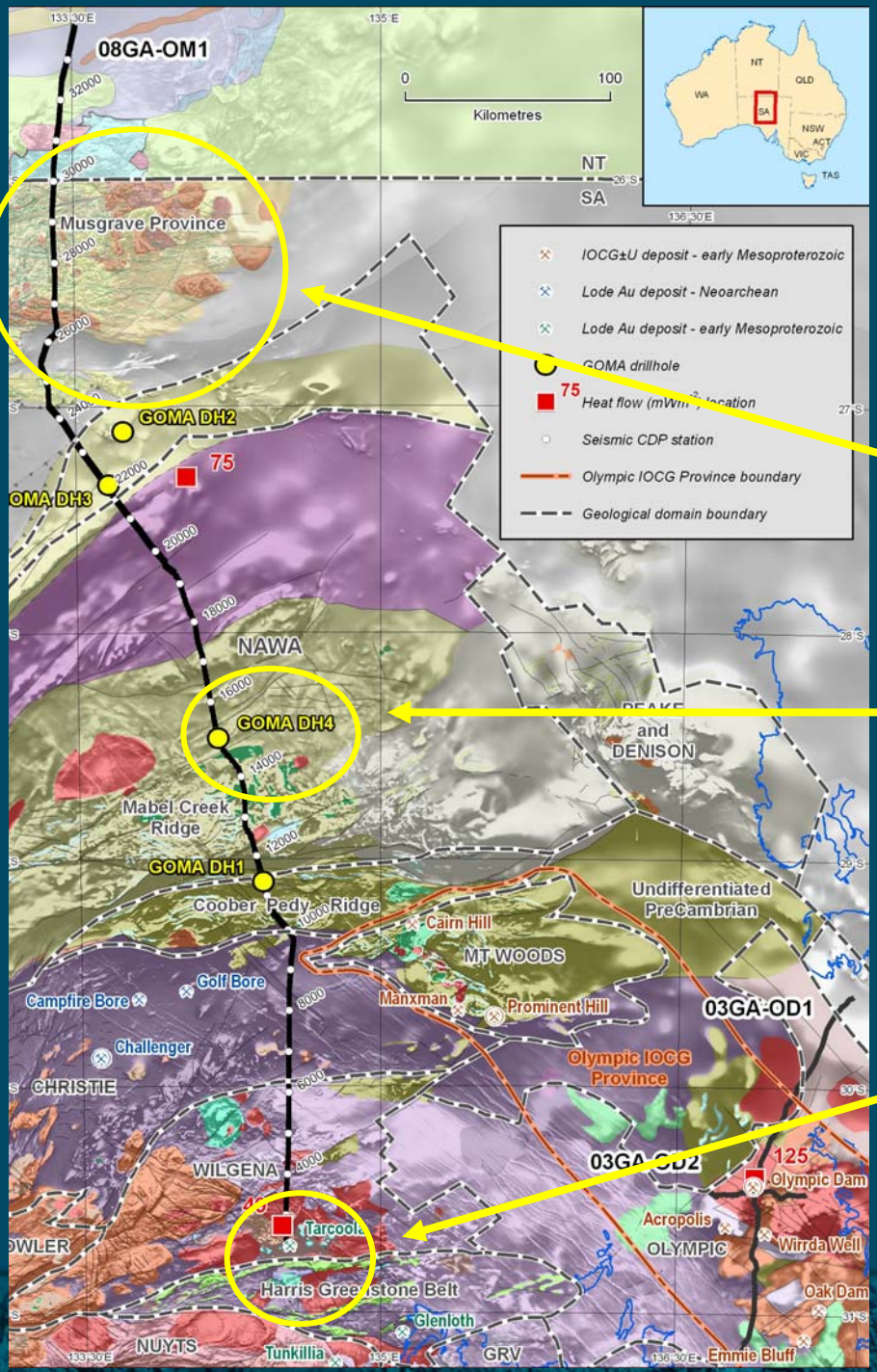
GOMA and heat-producing granites



Average global granite heat production ~2.5µWm^{-3}

Heat production for granites from the Musgrave Province ~2.5 to 5µWm^{-3} (Wyborn et al., 1998).

Heat production for granites and monzogranite dykes from GOMA DH4 ~5 to 8µWm^{-3} (Dutch et al., 2010).

Heat production for Hiltaba Granites from the Wilgena Domain ~5µWm^{-3} (Stewart and Foden, 2003).

Conclusions

- OESP seismic and allied geophysical acquisition improved understanding of the architecture of the Gawler-Officer-Musgrave-Amadeus region.
- Identification of major crustal boundaries
  - Lode Au
  - IOCG±U
- For U resources:
  - favourable regions along strike from Prominent Hill, which share some of the key architectural ingredients of IOCG systems.
- For geothermal resources:
  - heat flow data limited, but there are areas of high heat-producing granites.
  - up to ~4km thick sedimentary successions of the Officer and Arckaringa Basins.