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Geodynamic implications of the GOMA deep seismic reflection line (08GA-OM1)

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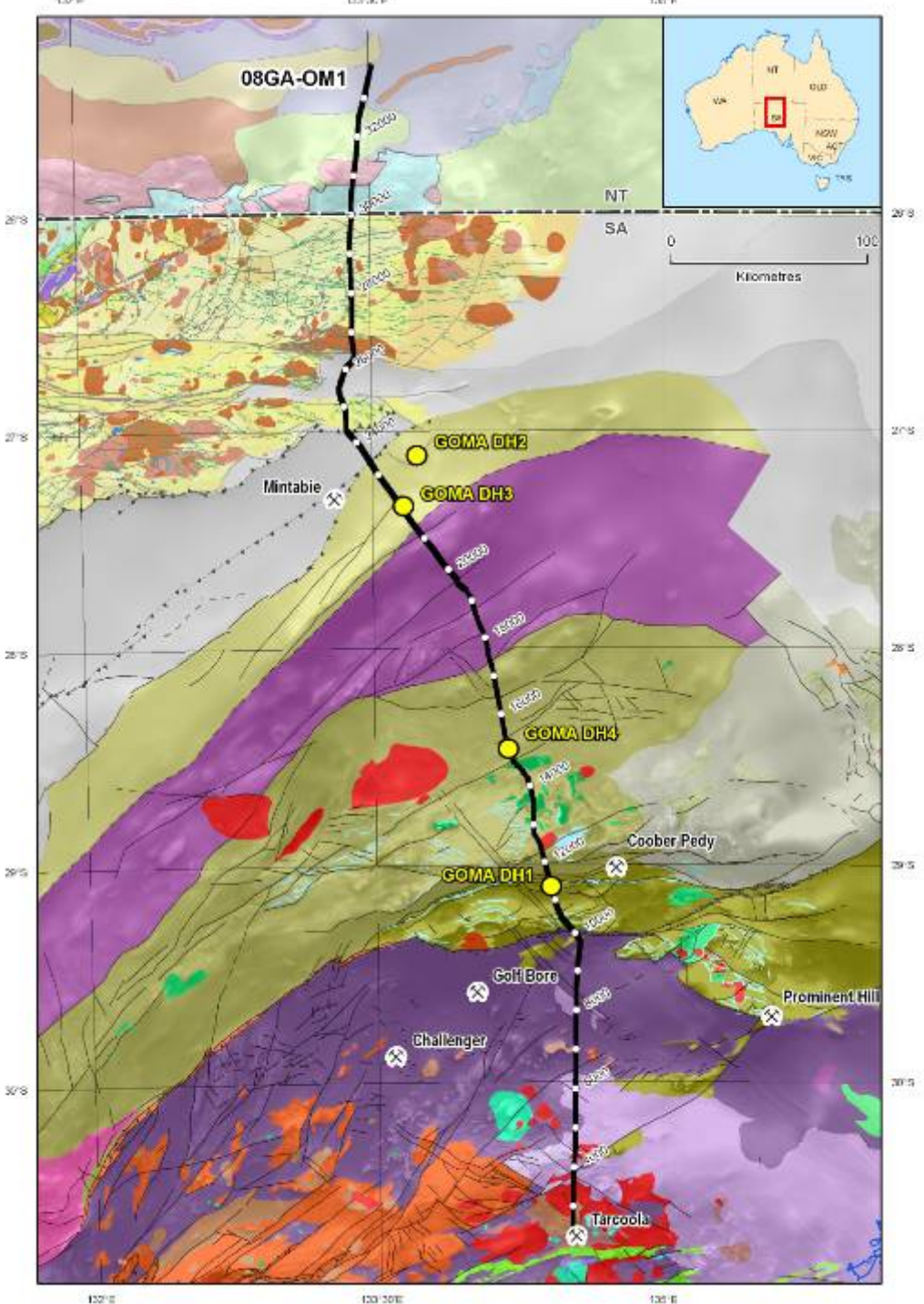
[1]Geoscience Australia, [2]U.Adelaide, [3]ANU, [4]GSGA, PIRSA, [5]Monash U.

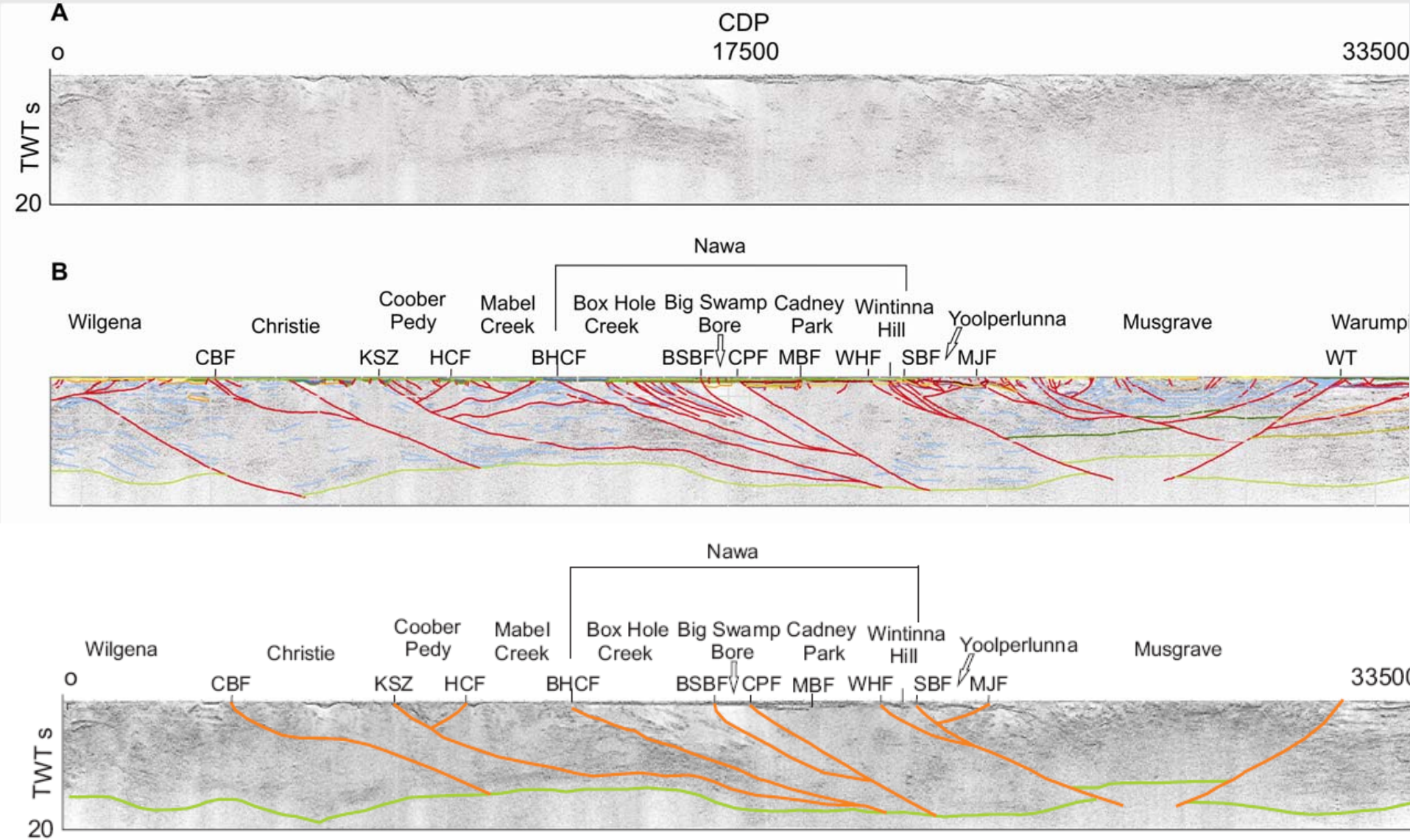


Seismic interpretation

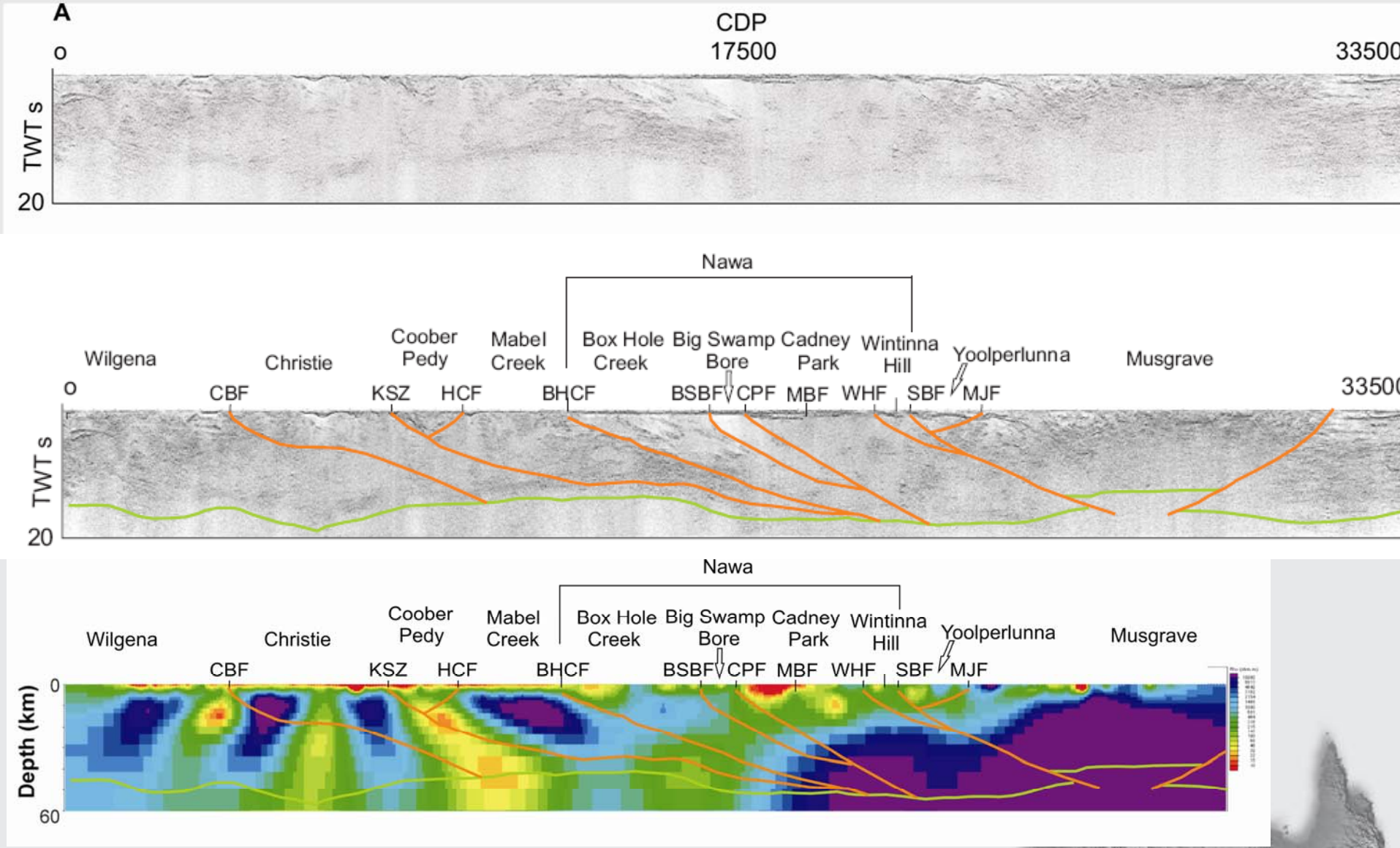
Series of discrete basement crustal blocks

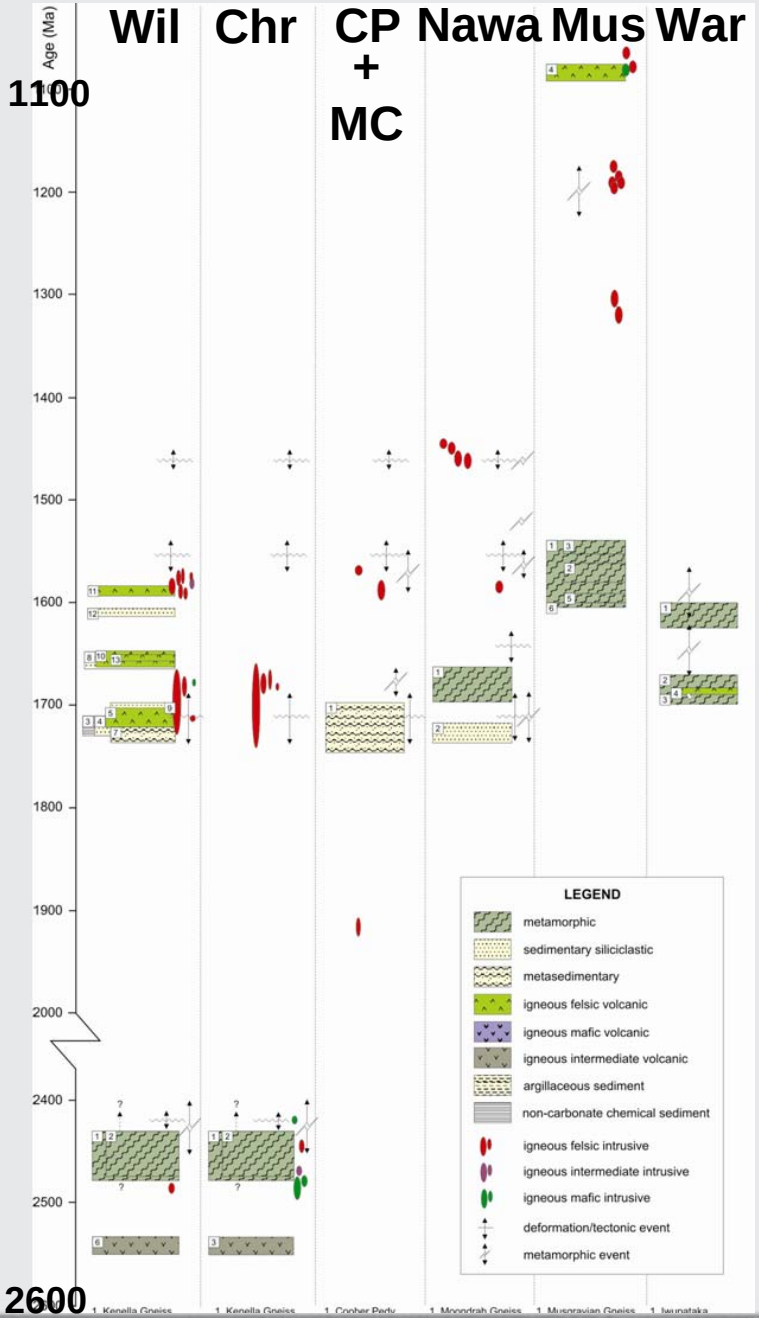
Speculations on the geodynamic evolution of the region (poor geological constraints)

GOMA seismic line – Provinces and domains



GOMA seismic and MT profiles

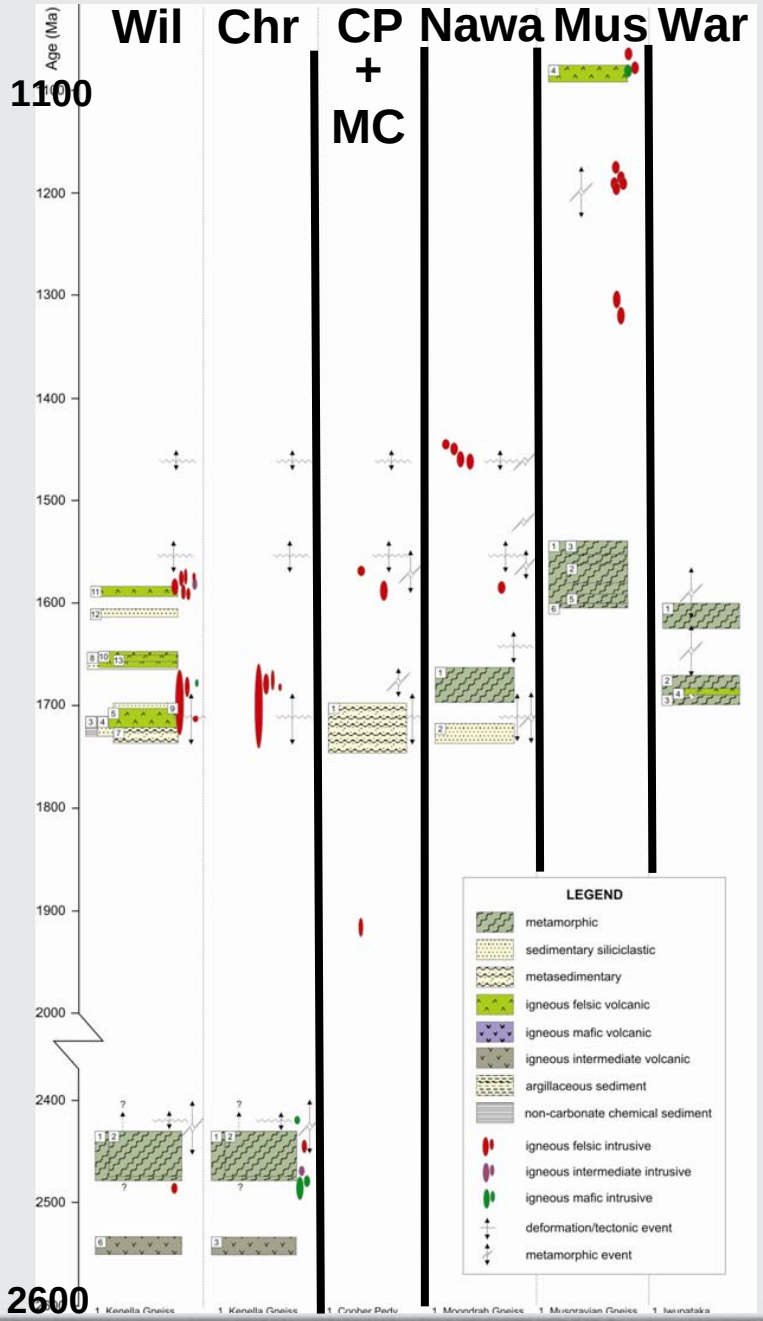




Time-space plot
(GA's digital PROV and EVENTS database)

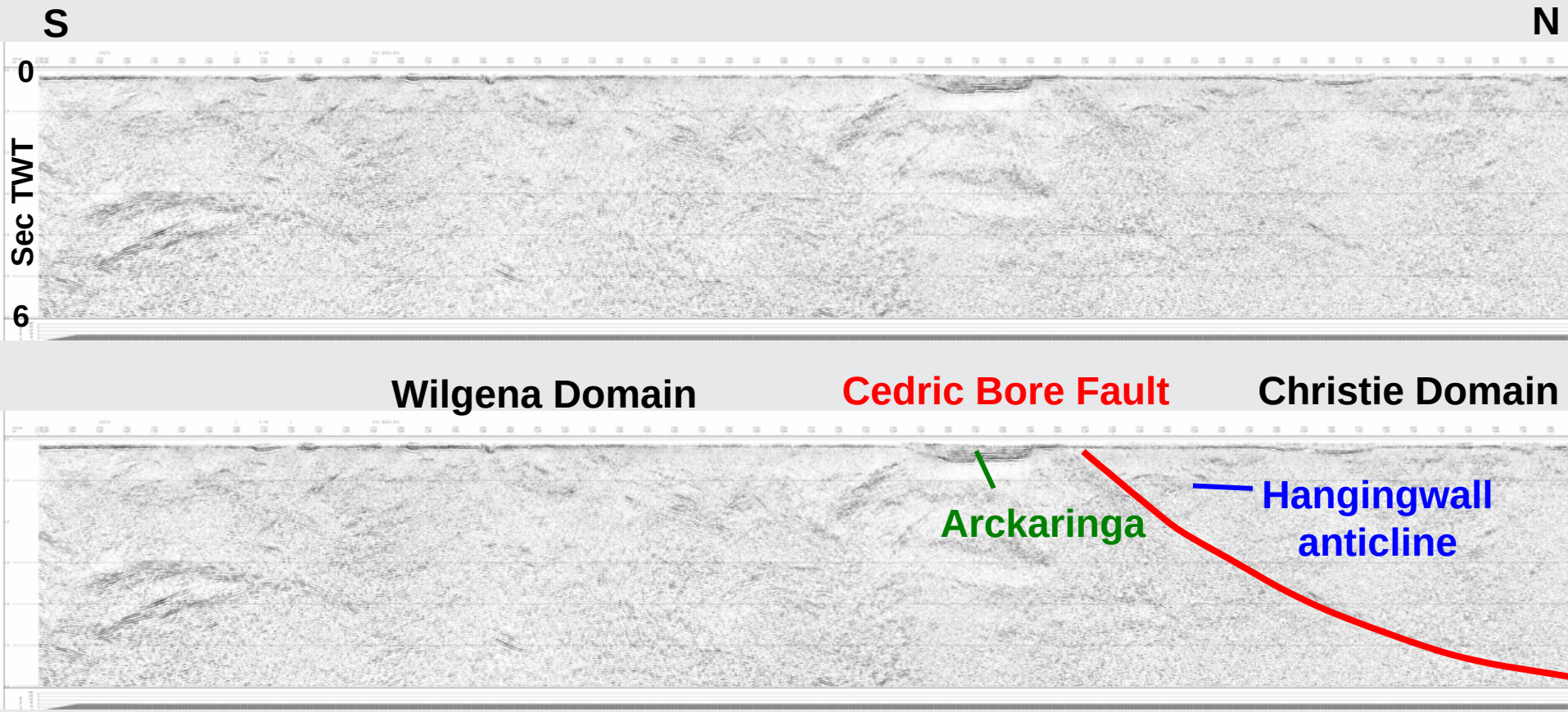
Comparison of provinces and domains

- Different geological histories
- Different seismic reflective character



Key province and domain boundaries

Wilgena to Christie Domains

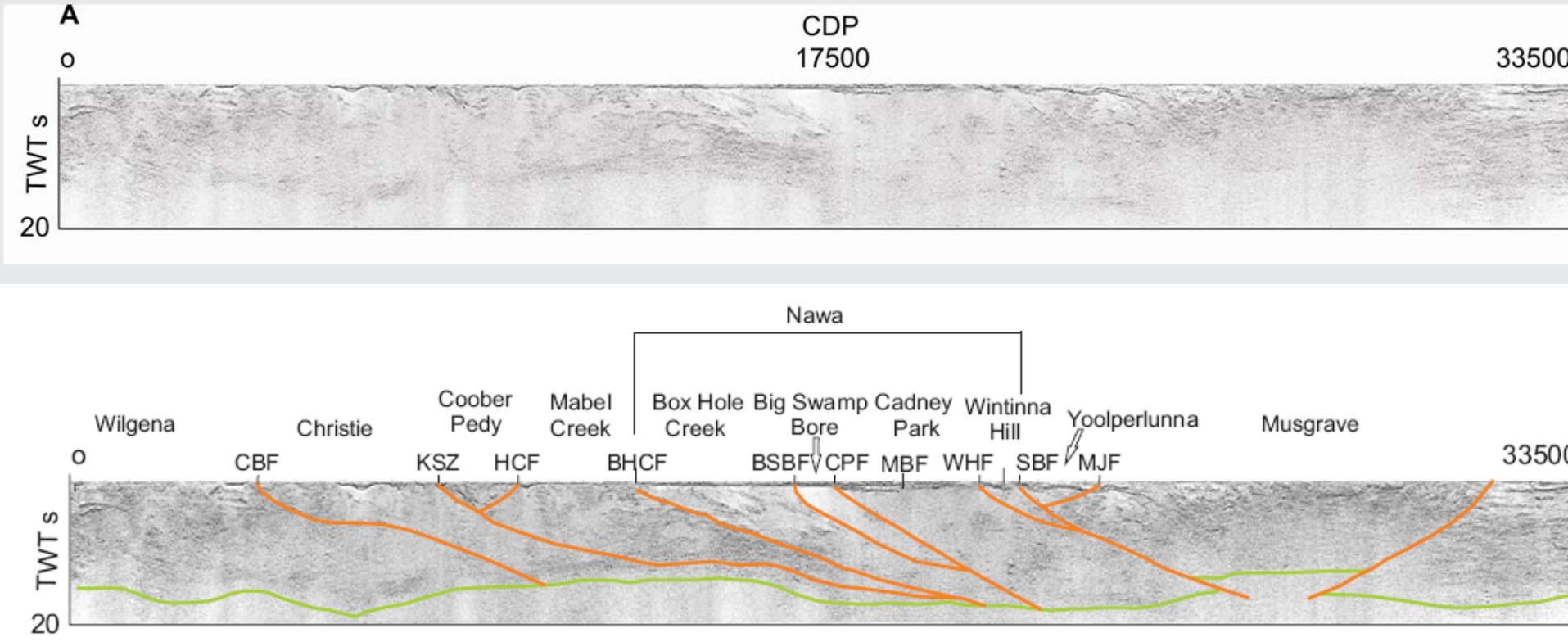


Similar reflectivity between Wilgena and Christie Domains

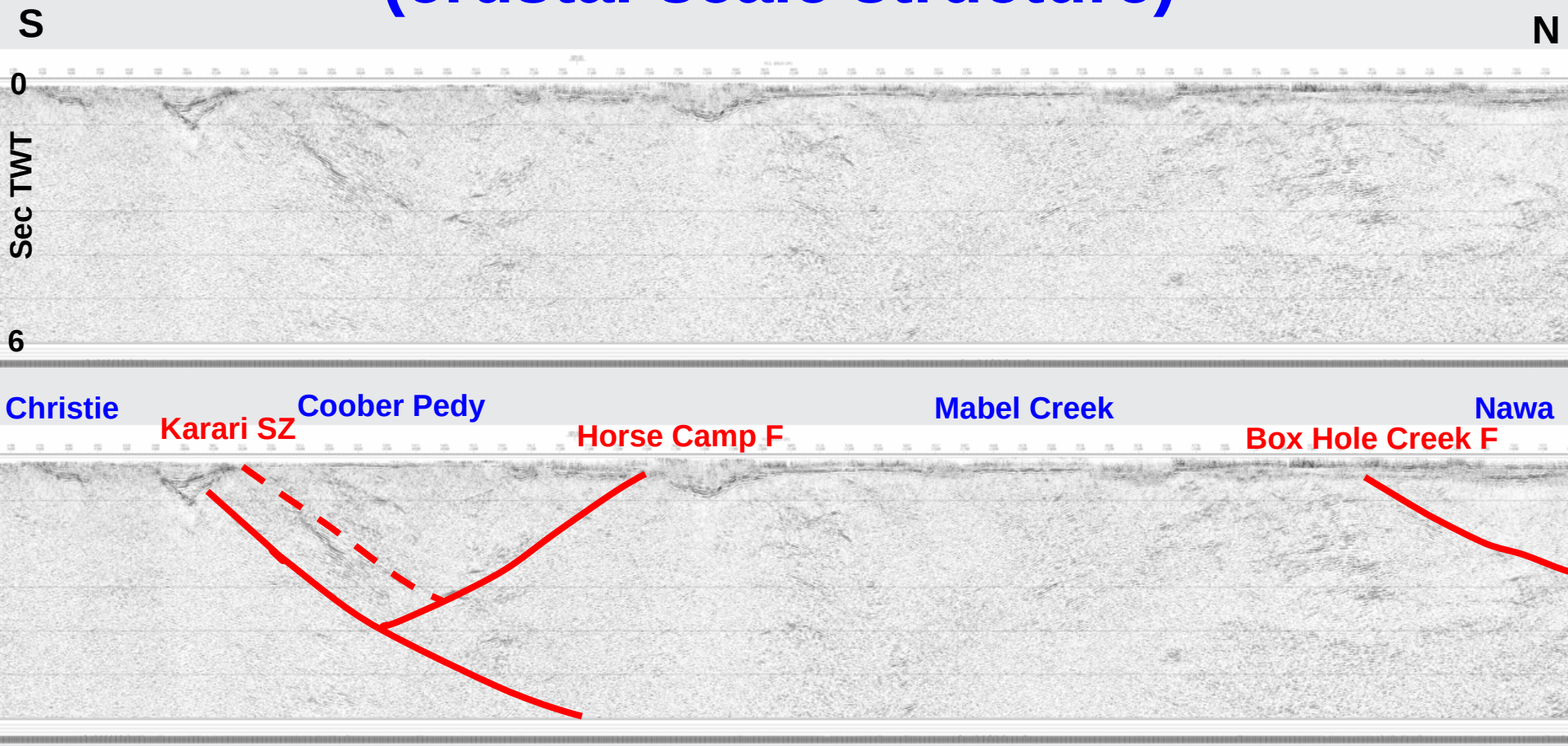
Both have late Neoarchean (Mulgathing) in upper crust

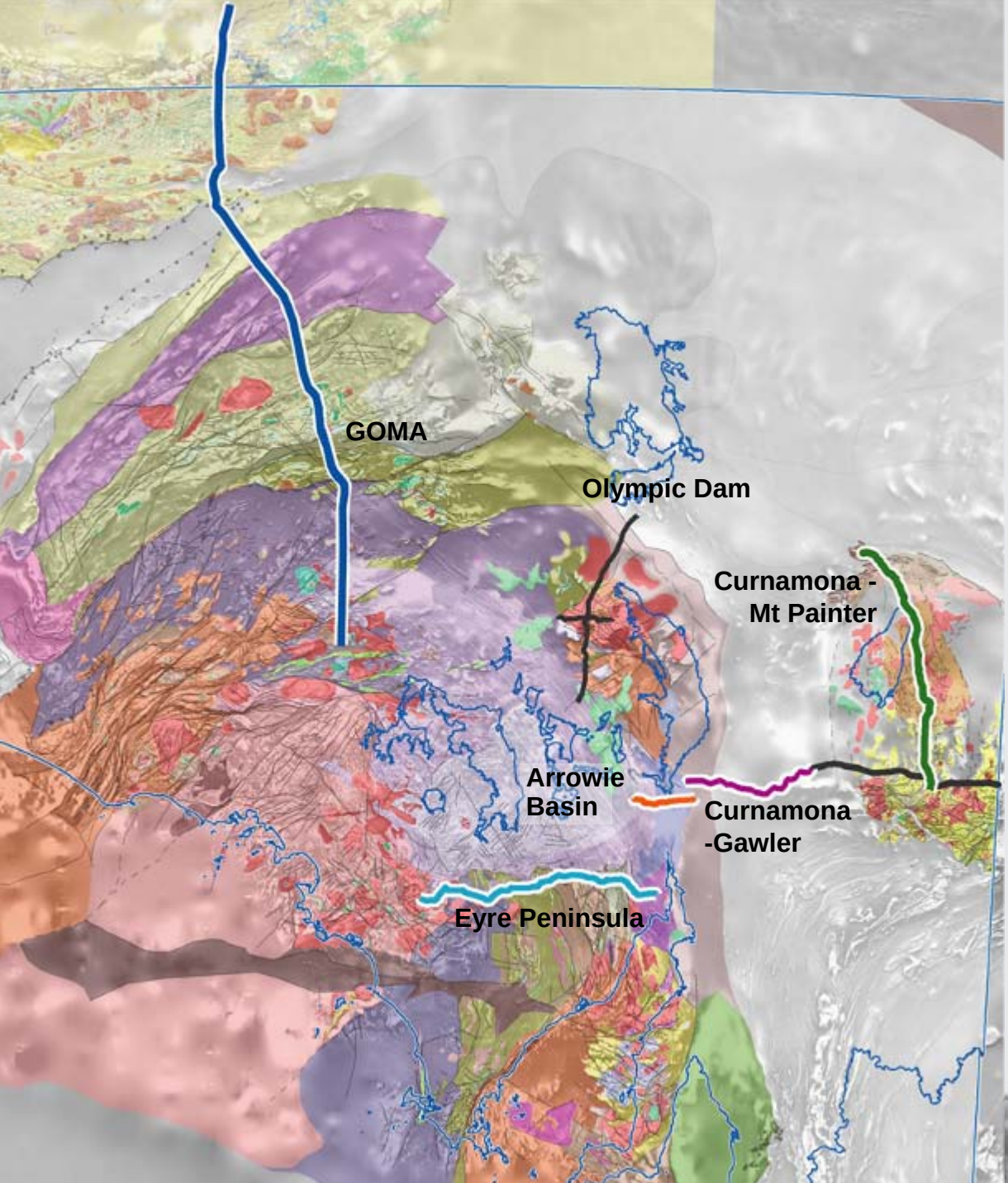
One coherent block?

Karari Shear Zone
Christie - Coober Pedy boundary



Karari Shear Zone
(crustal-scale structure)



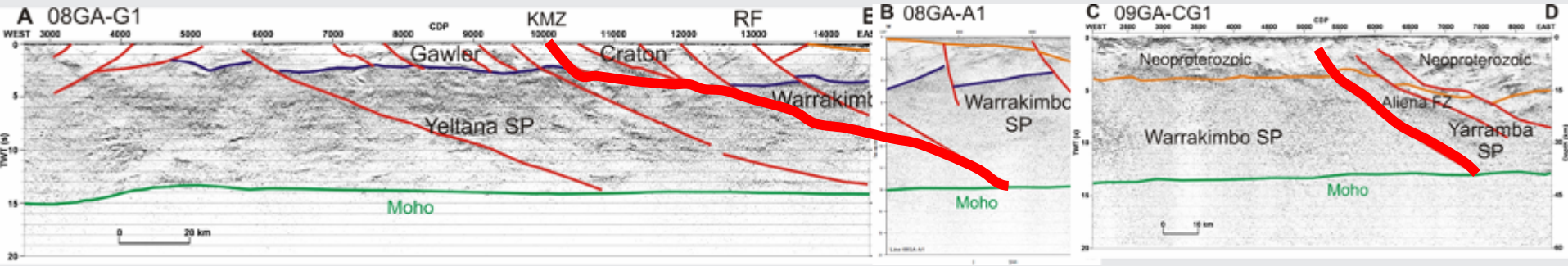


Previous seismic lines in Gawler Craton-Curnamona Province

2008-2009
Eyre Peninsula +
Arrowie +
Curnamona-Gawler Link

2003
Olympic Dam

Kalinjala Mylonite Zone



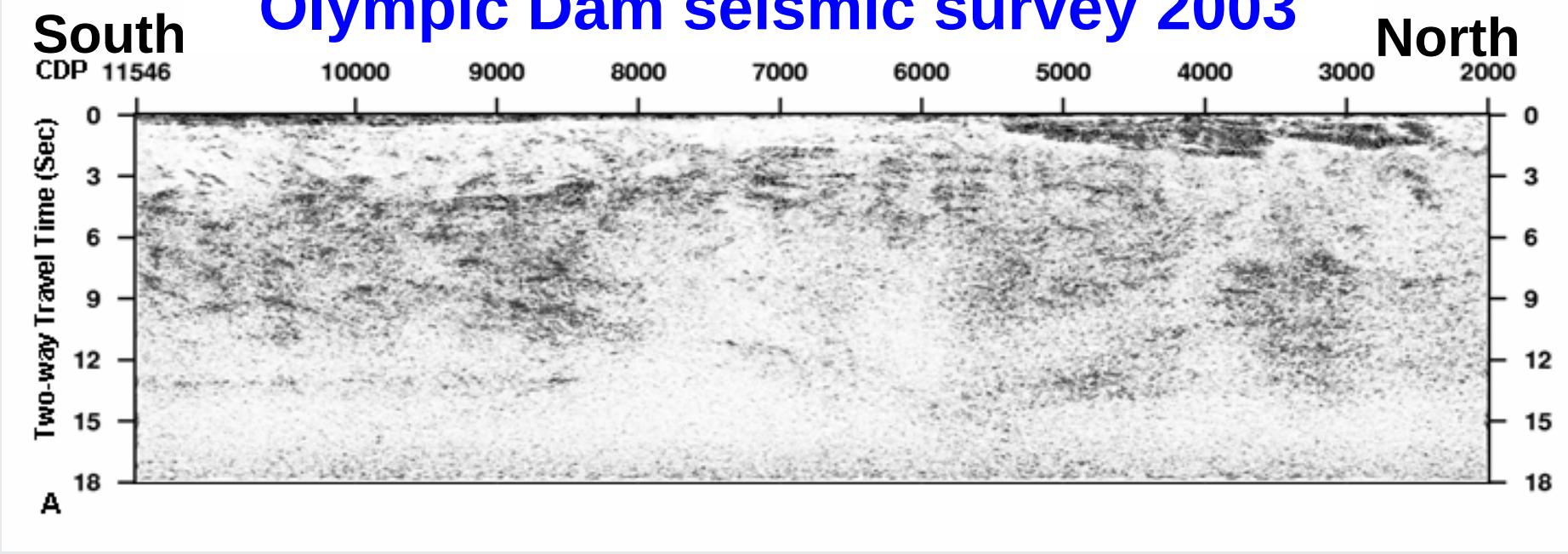
- Middle and lower crust not tracked to the surface

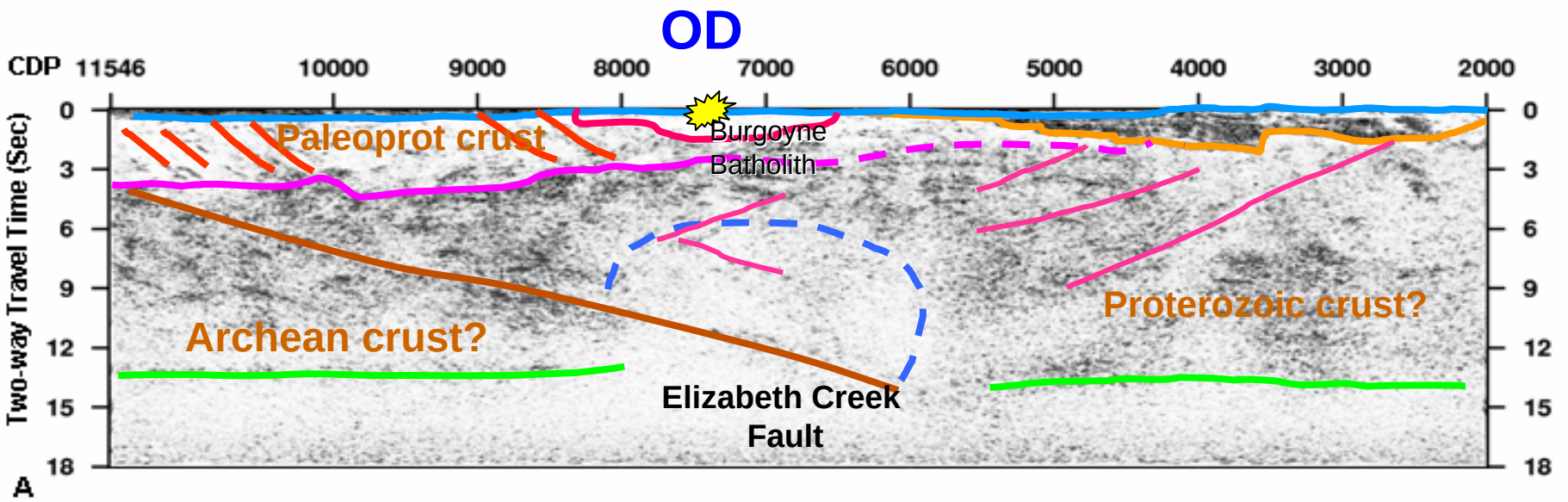
- West of Kalinjala Mylonite Zone
  - Yeltana Seismic Province –Reflective crust
  - Late Neoarchean (Sleaford) at surface to west of KMZ

- East of Kalinjala Mylonite Zone
  - Warrakimbo Seismic Province - Much less reflectivity than to west
  - No Late Neoarchean at surface to east of KMZ

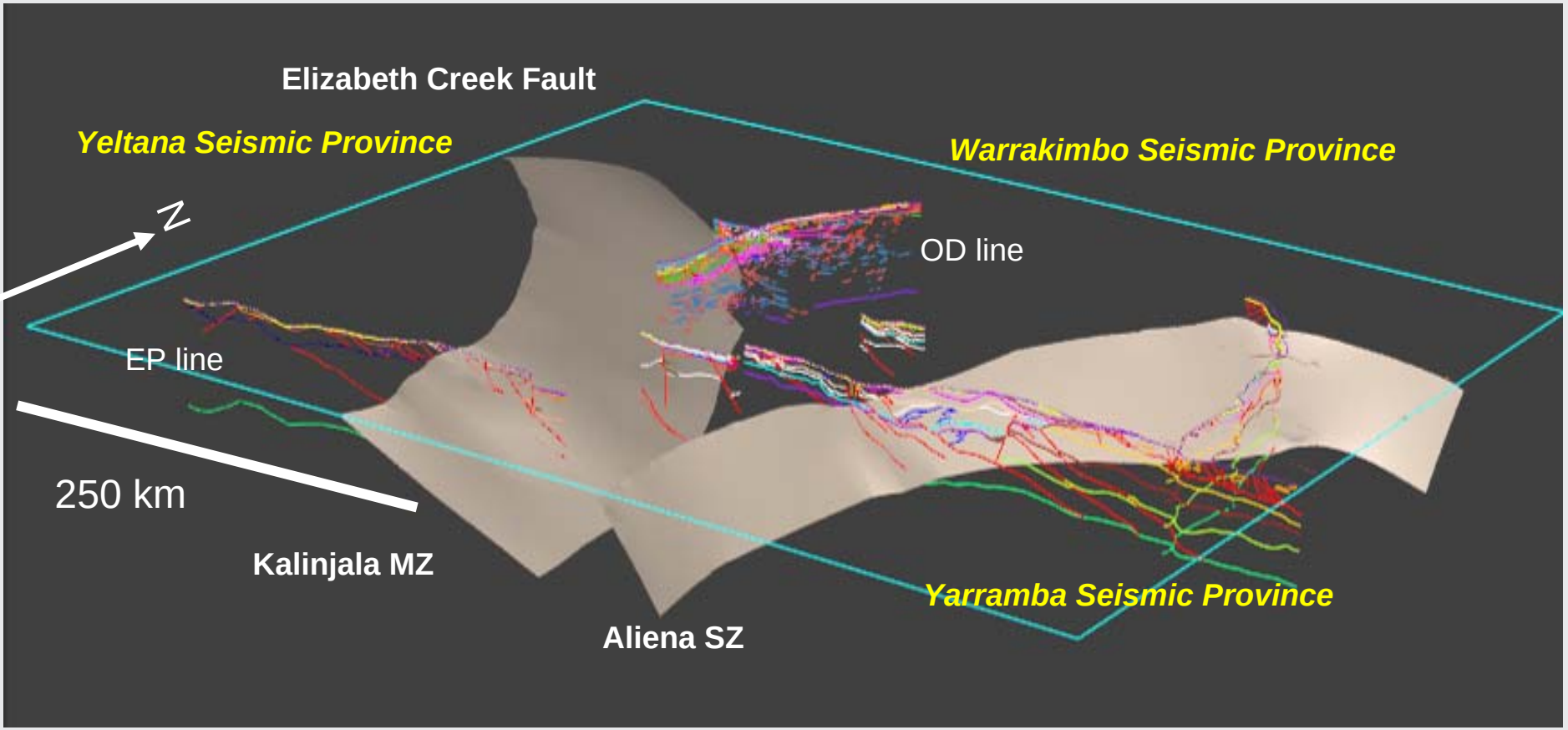
- Kalinjala Mylonite Zone – major crustal suture?

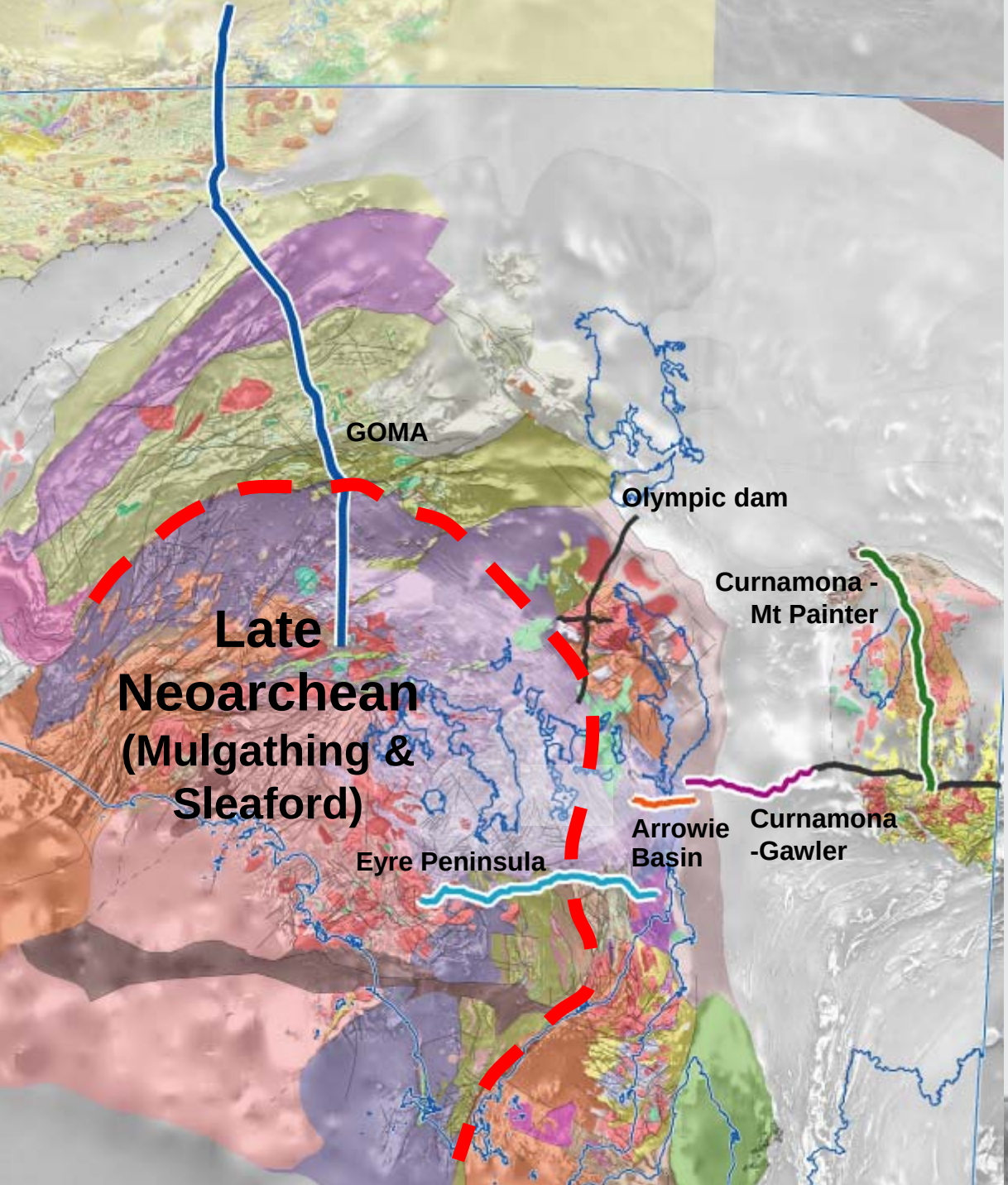
Olympic Dam seismic survey 2003





Gawler-Curnamona 3D model



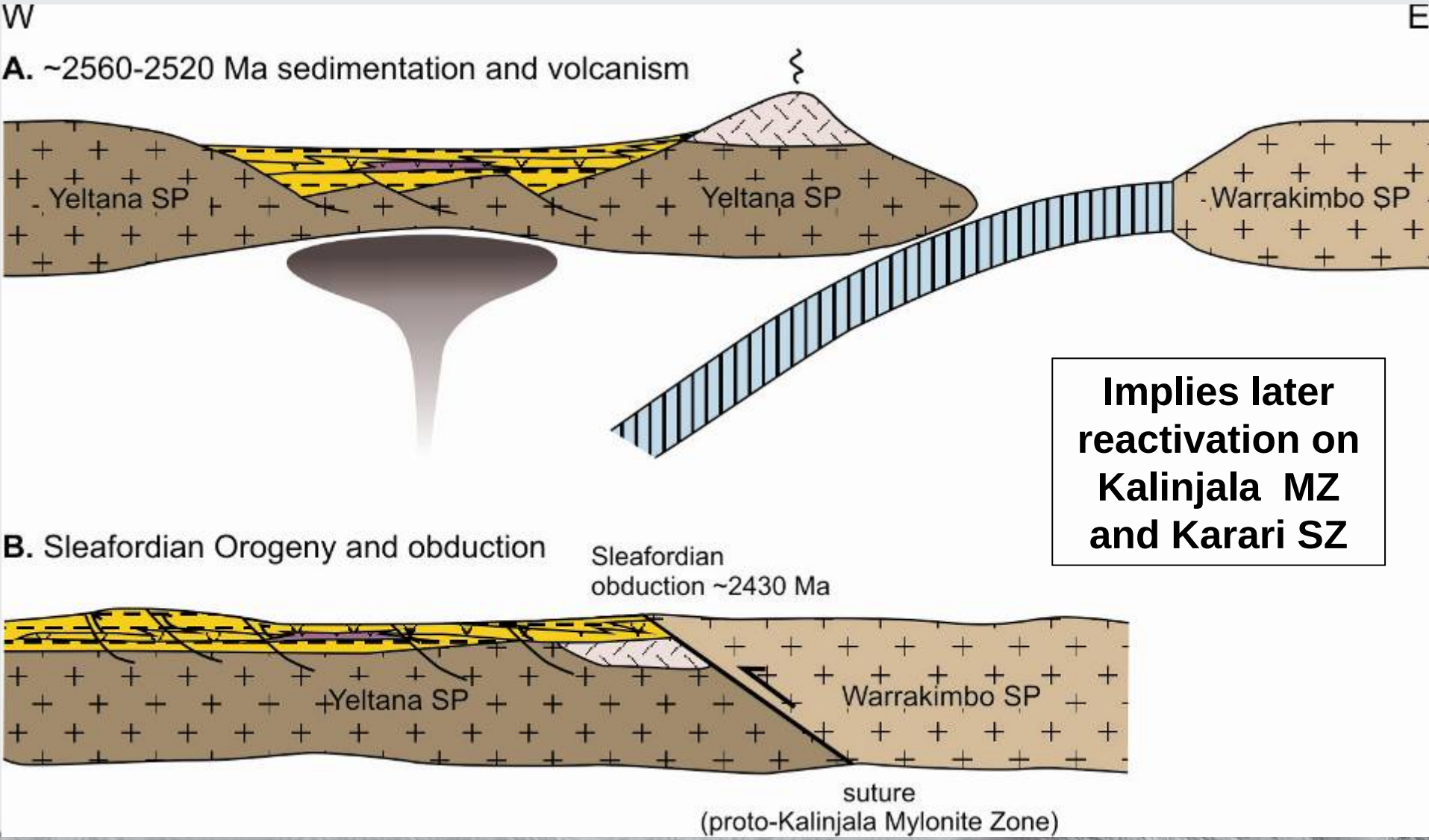


Possible linkage of:

Kalinjala Mylonite Zone
Elizabeth Creek Fault
Karari Shear Zone

Late reactivation?

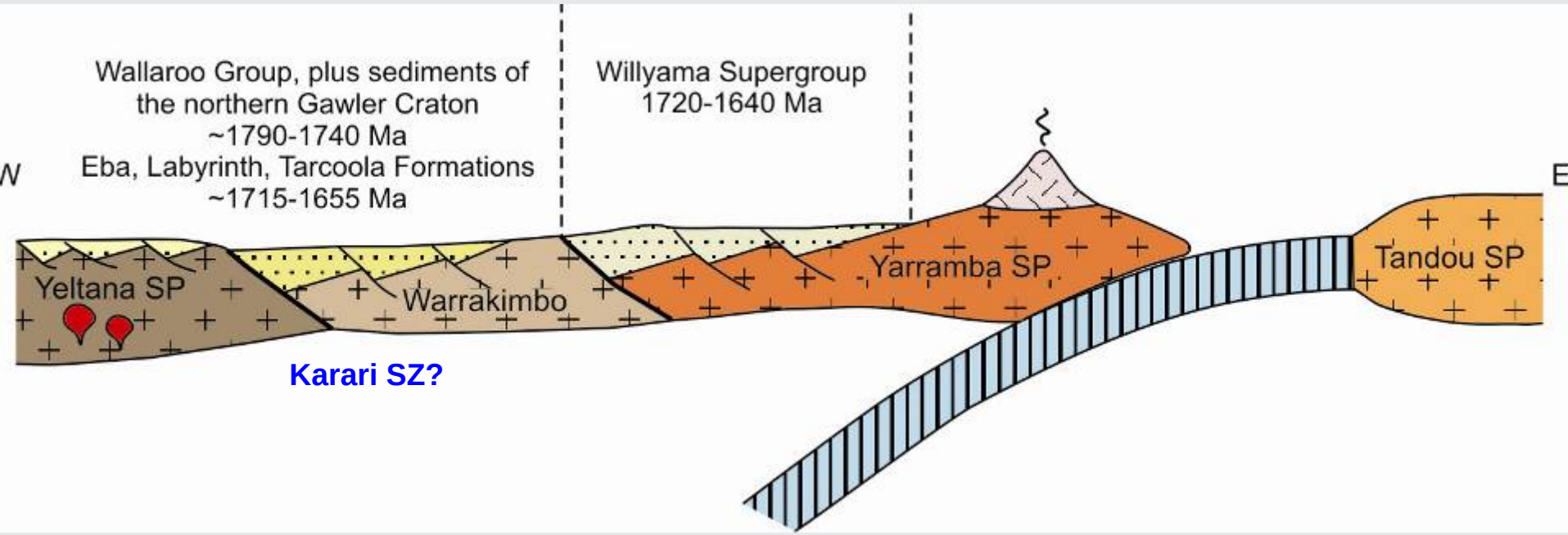
A model for formation of proto-Kalinjala Mylonite Zone (? = proto-Karari Shear Zone)



Implies later reactivation on Kalinjala MZ and Karari SZ

Absence of 2000-1850 Ma rocks and events in GOMA region

Younger extensional basins – possible backarc environment (? arc to east to northeast)

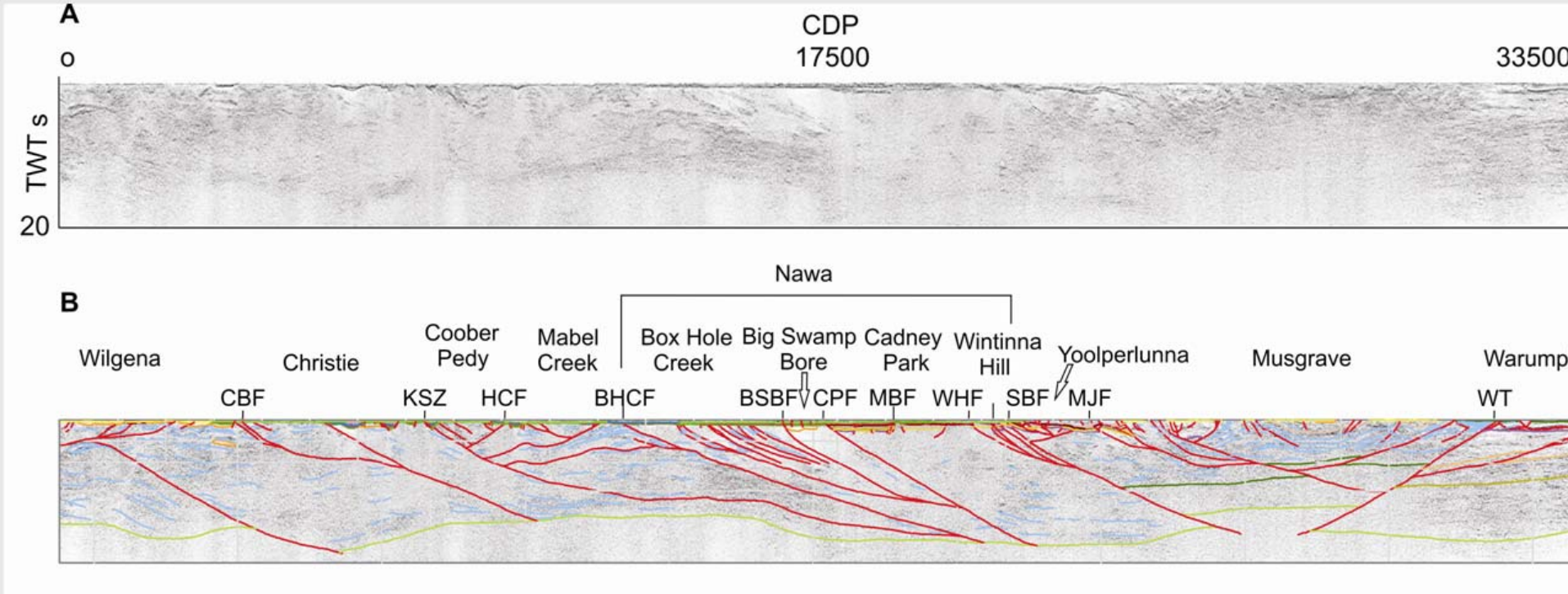


Coober Pedy and Mabel Creek Domains

upper crust - possible north-directed (south-dipping) thrust duplex or antiformal stack between two north-dipping crustal-scale faults

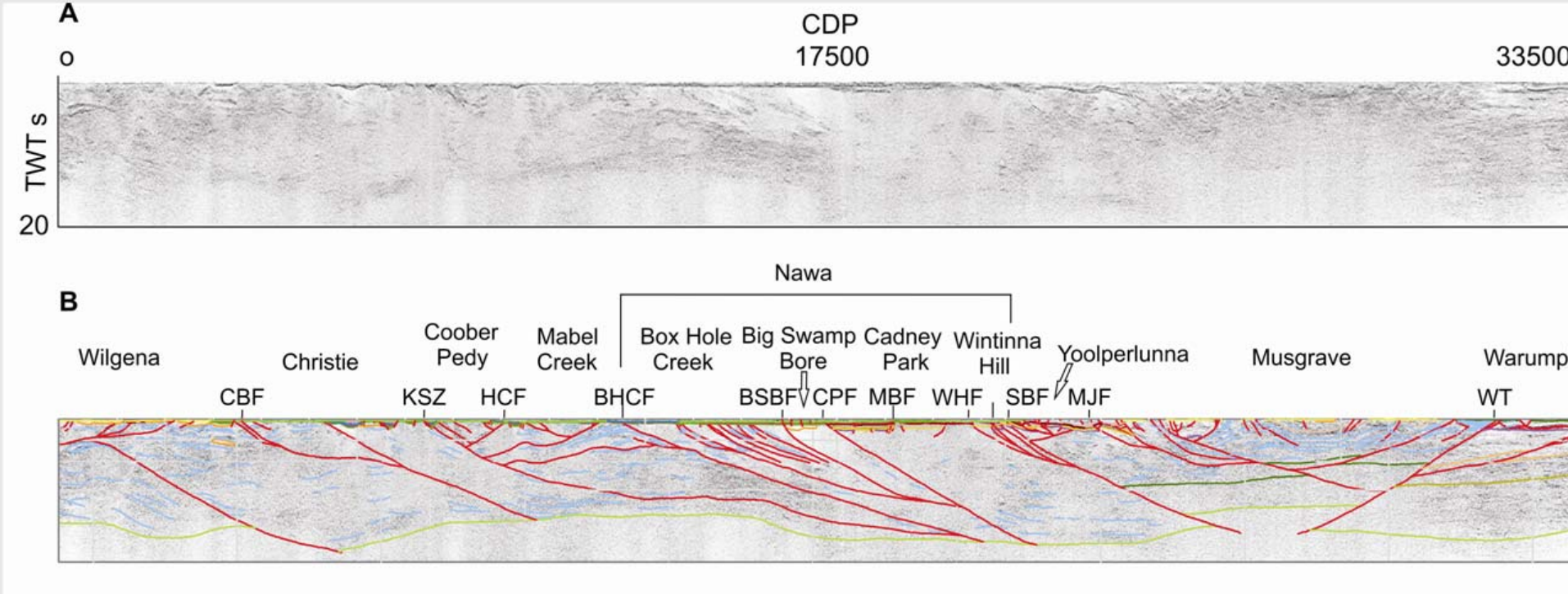
?younger succession thrust to north over Neoarchean

?younger succession deposited on Neoarchean & detached later

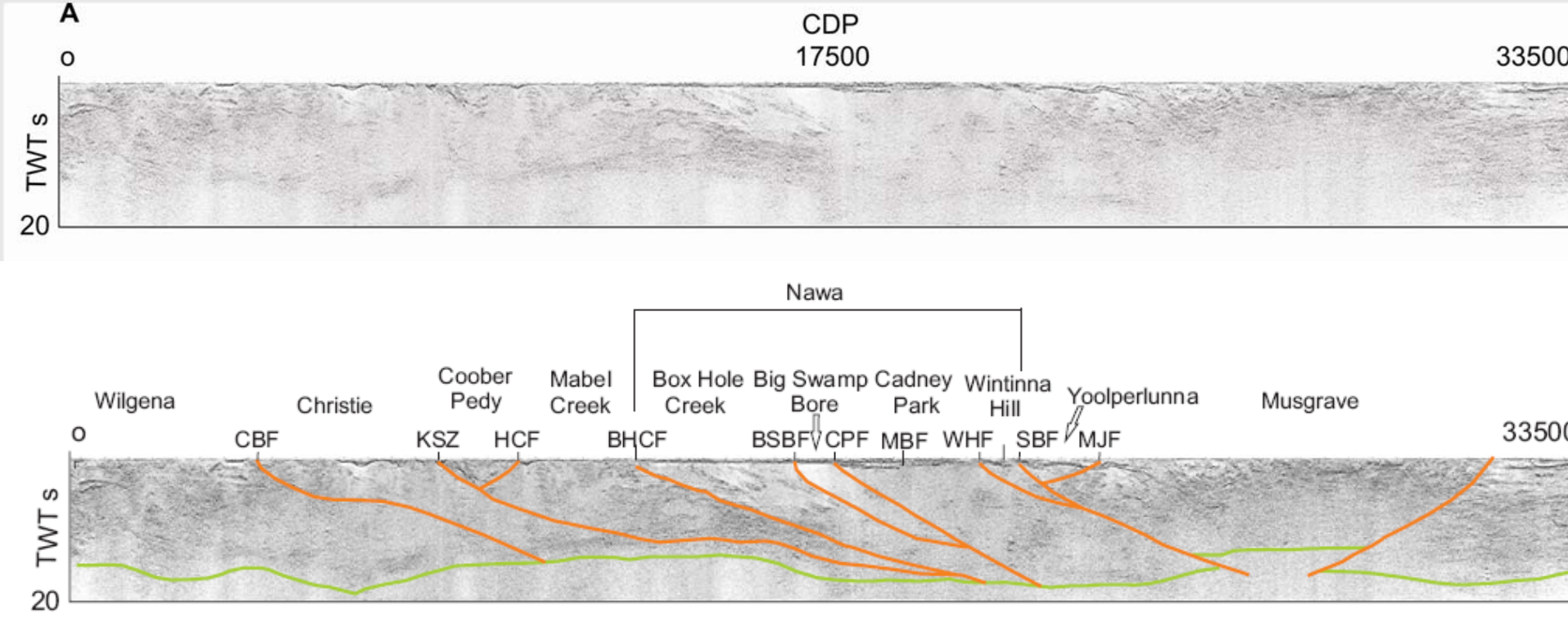


Box Hole Creek Fault
Mabel Creek – Nawa boundary

? Significance of Neoarchean in GOMA 4



Subdomains within Nawa Domain

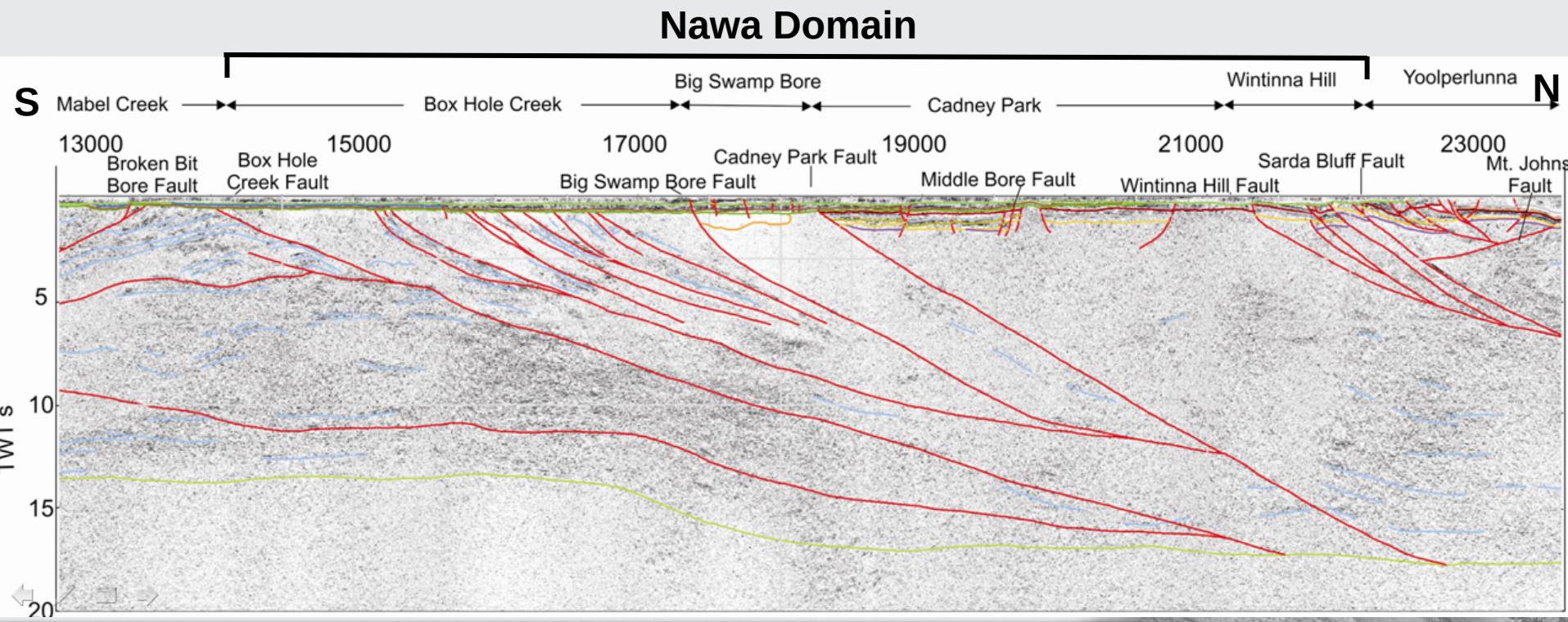


Subdomains within Nawa Domain

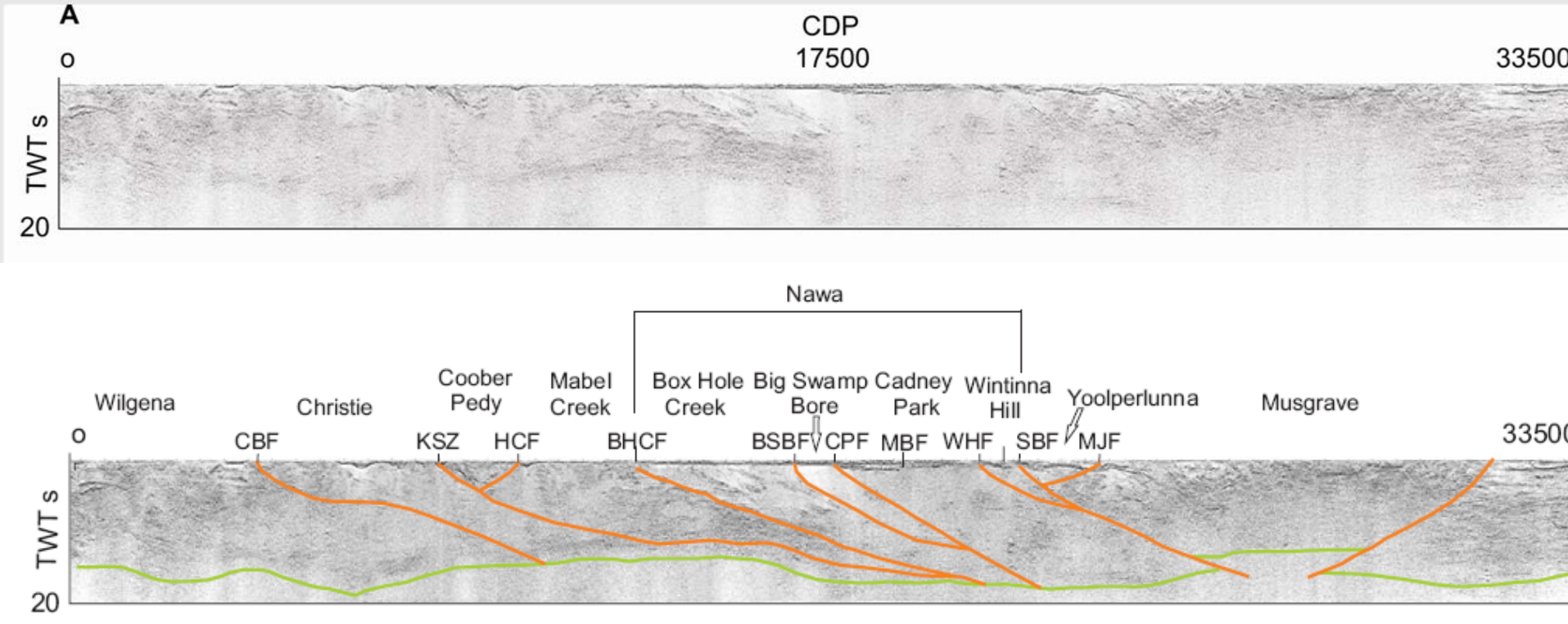
Boundaries of subdomains: north-dipping, subparallel reflections = crustal-scale faults?

Nawa Domain = imbricated, crustal-scale thrust stack?

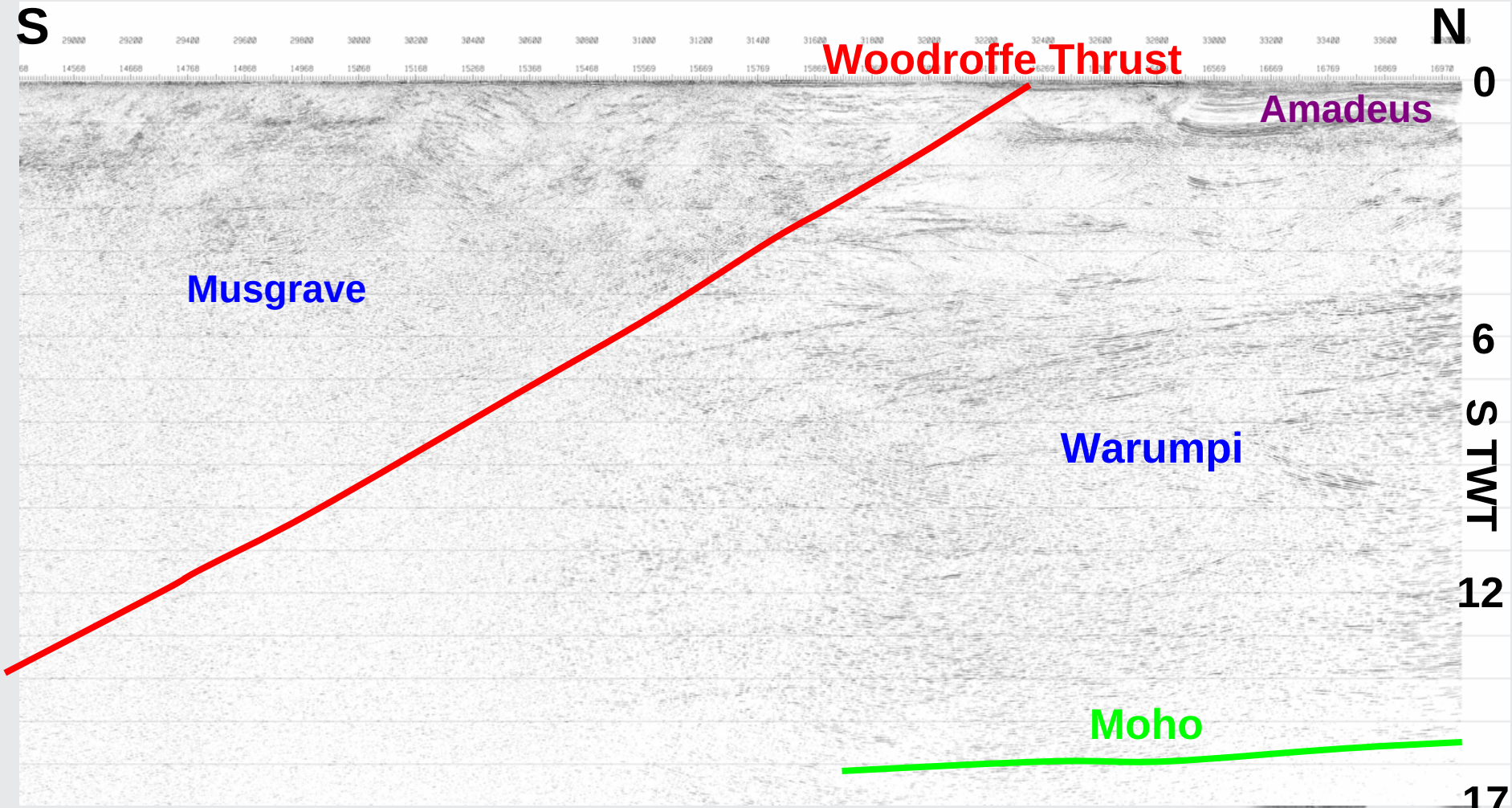
Imbrication in Kimban (1740-1690 Ma) or Kararan (~1570 Ma) or Coorabie (~1450 Ma – M. Hand et al. SAREIC data)?



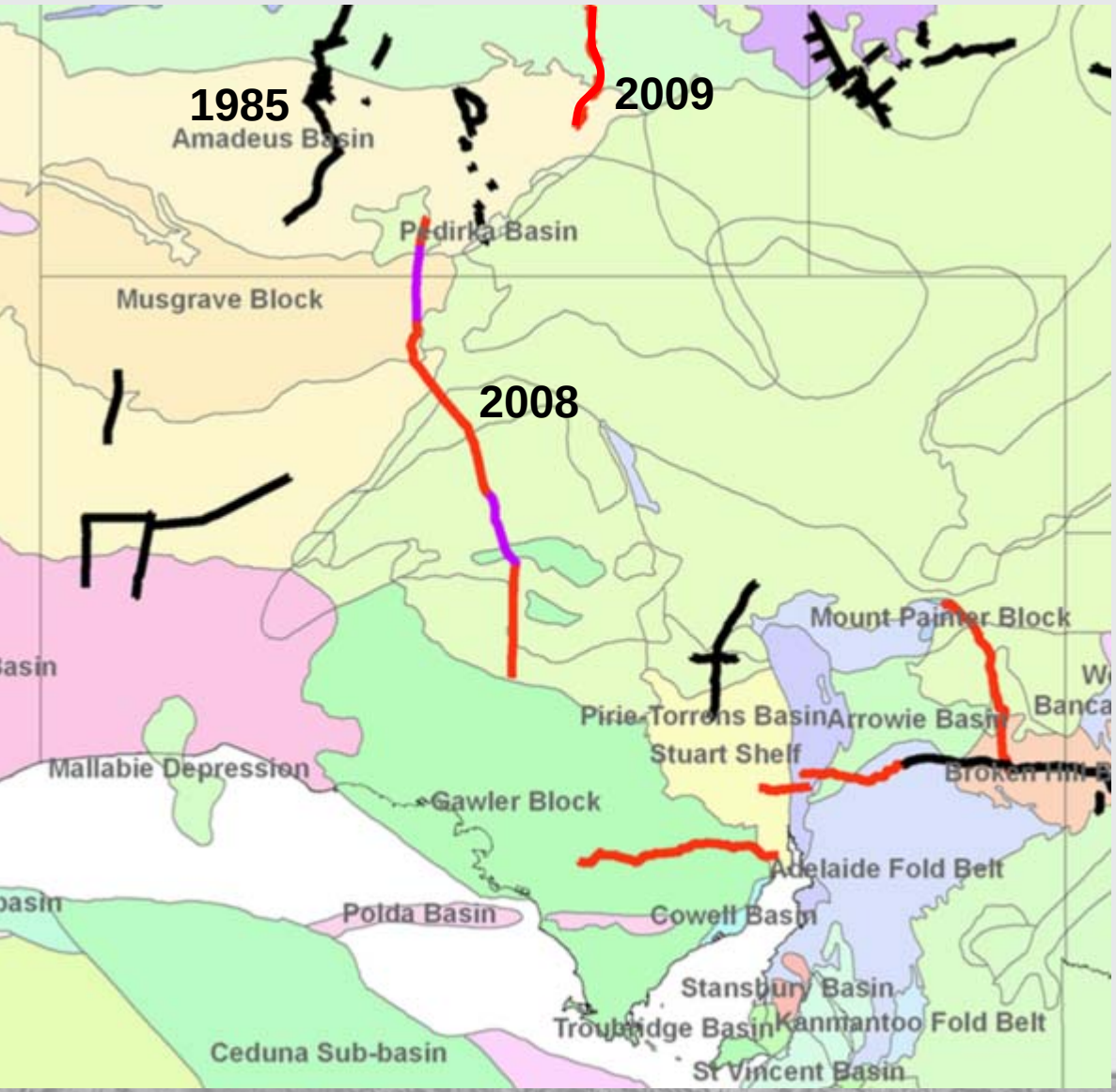
Northern end of GOMA -Woodroffe Thrust Musgrave – Warumpi boundary



Musgrave to Warumpi Provinces



Seismic Lines in central Australia

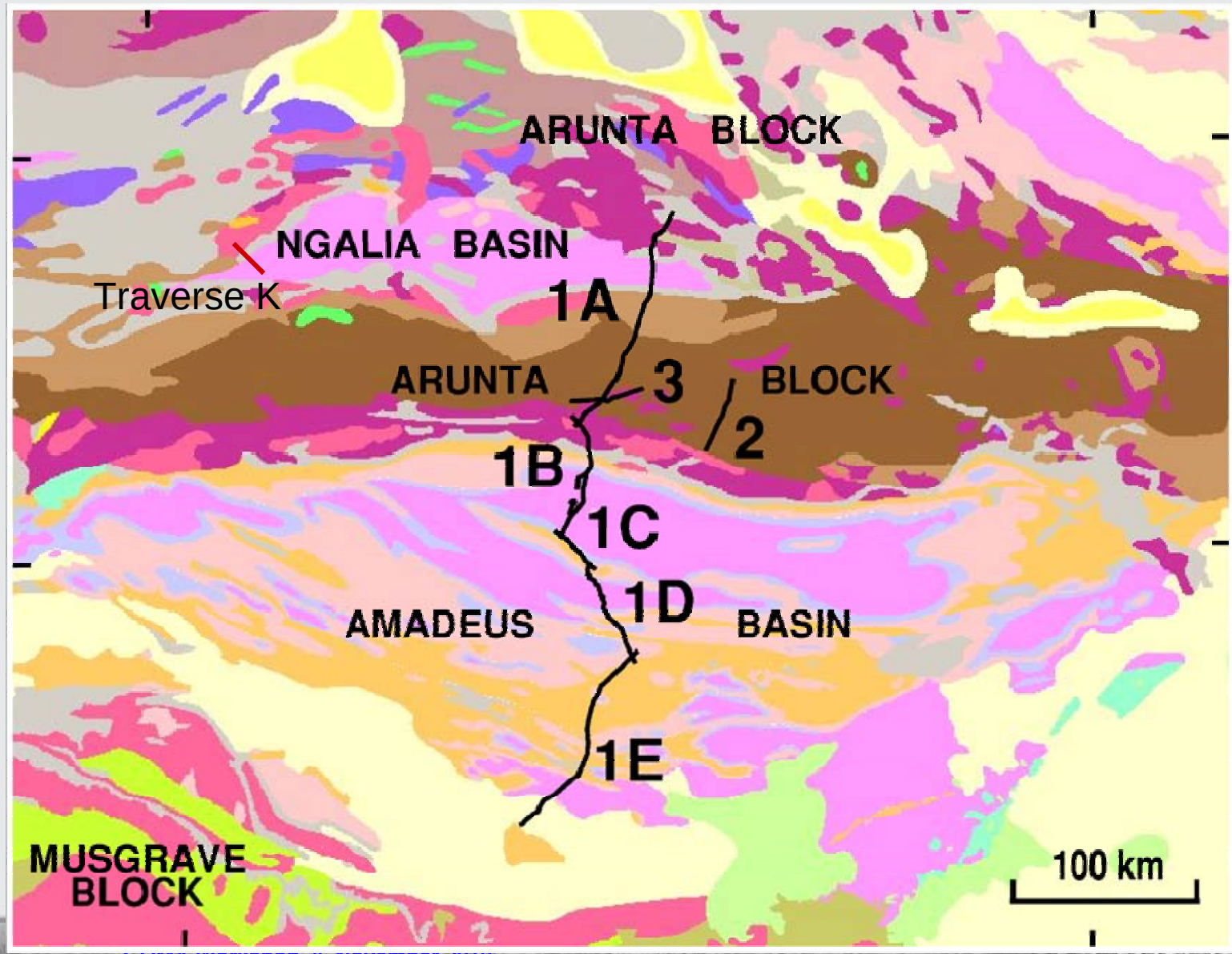


2008 GOMA

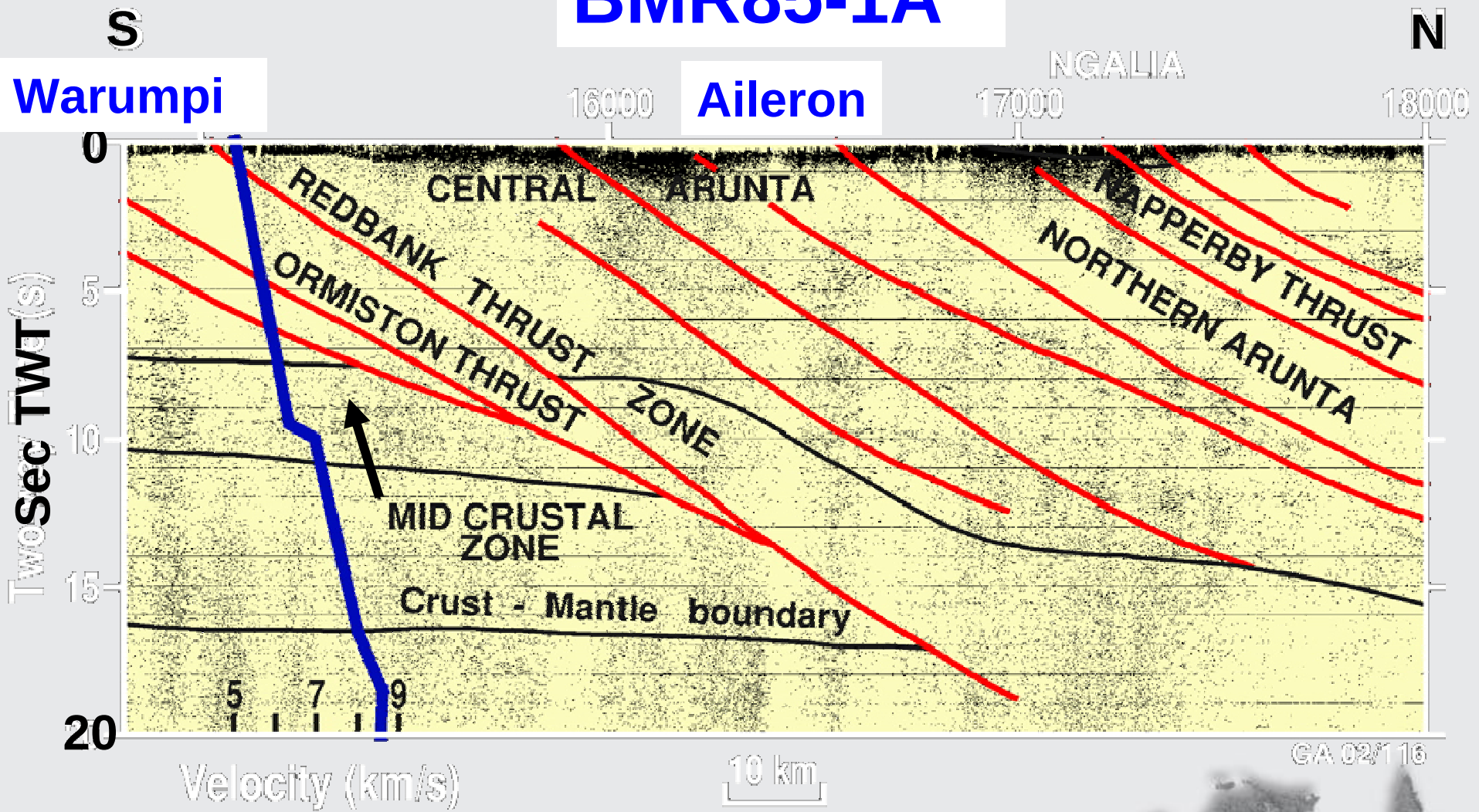
1985 Amadeus-Arunta

(2009 Georgina-Arunta)

1985 Arunta-Amadeus deep seismic reflection line

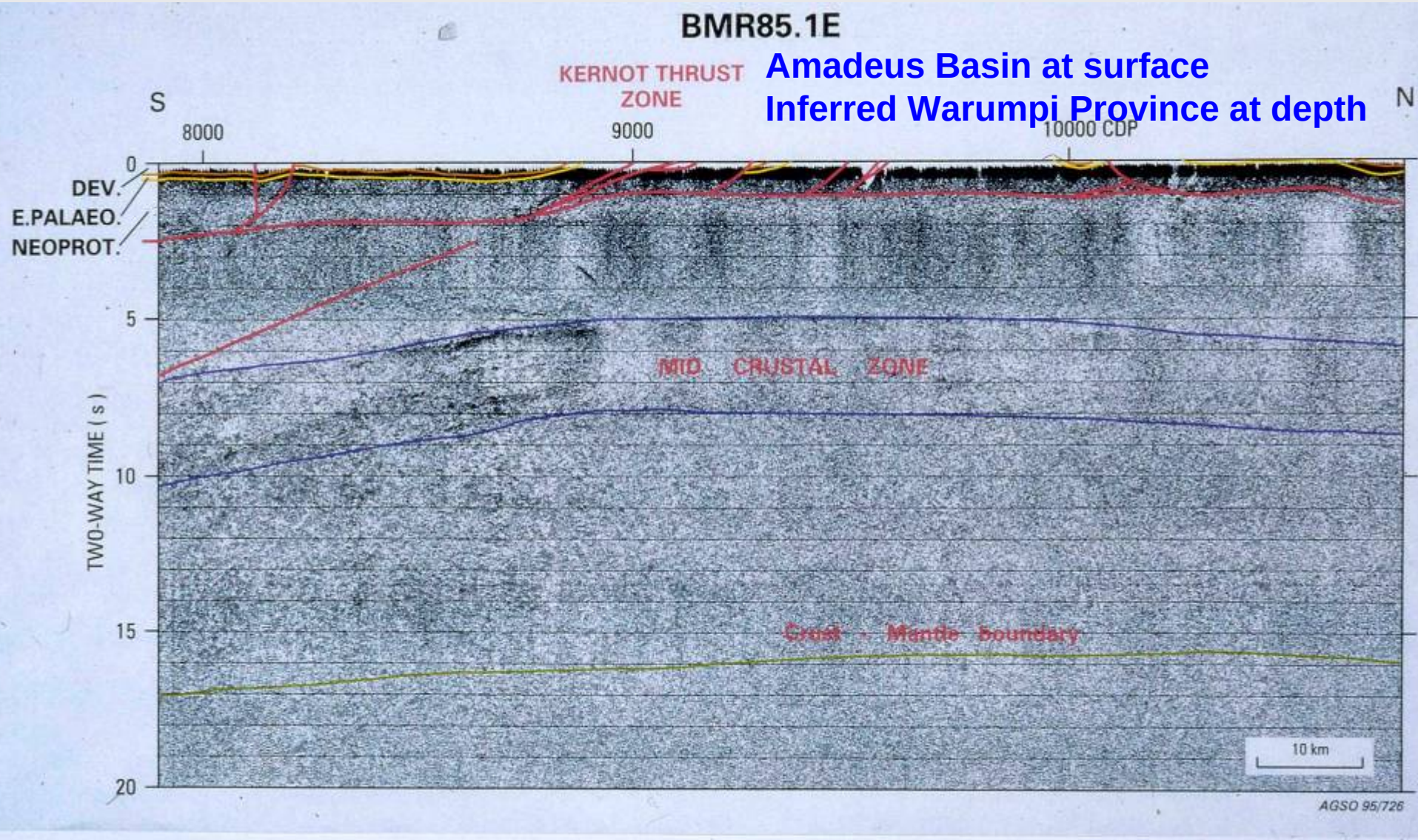


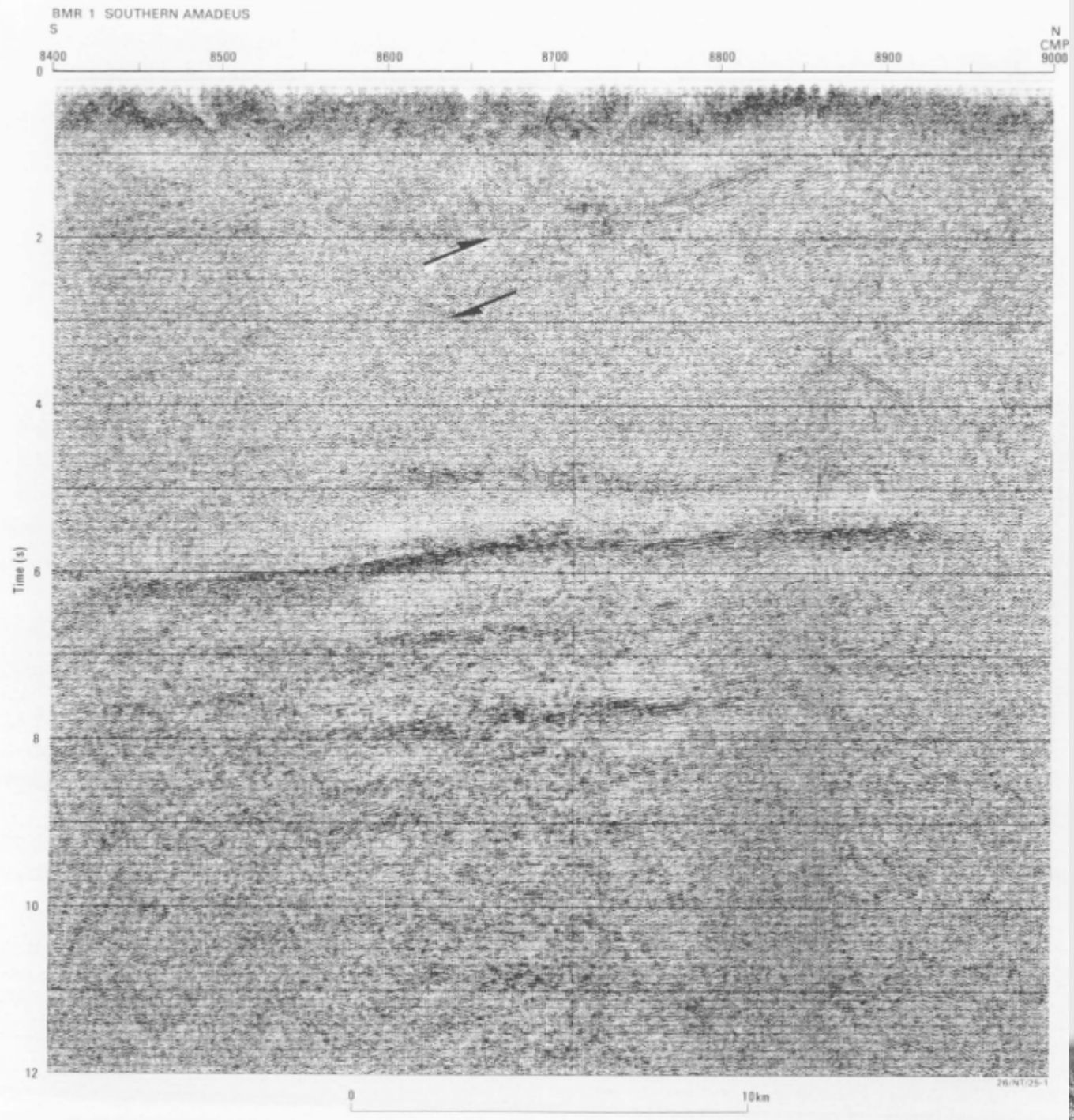
BMR85-1A



Old processing

Seismic line in southern Amadeus Basin



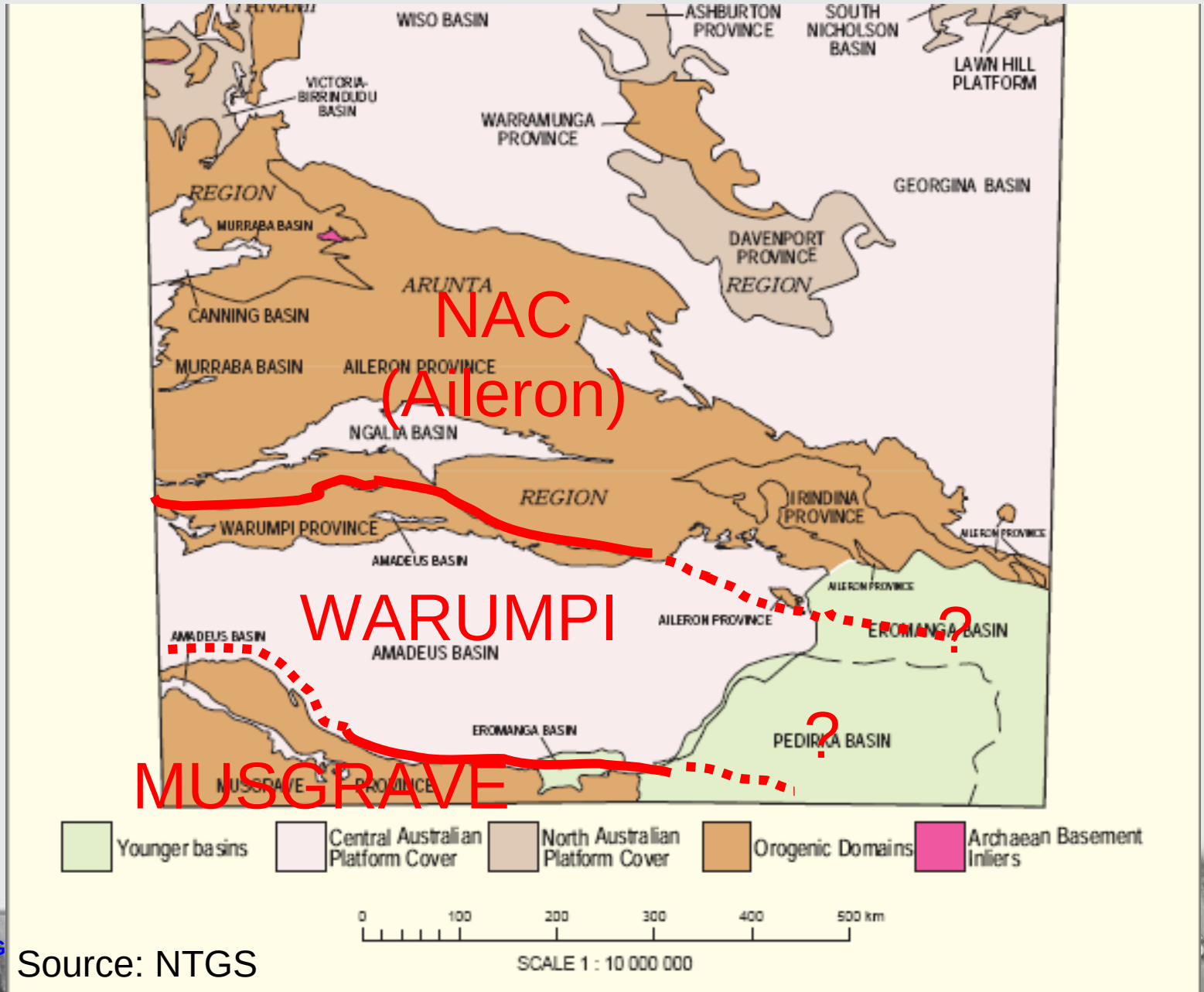


Southern end of 1985 seismic line

GEOSCIENCE AUSTRALIA

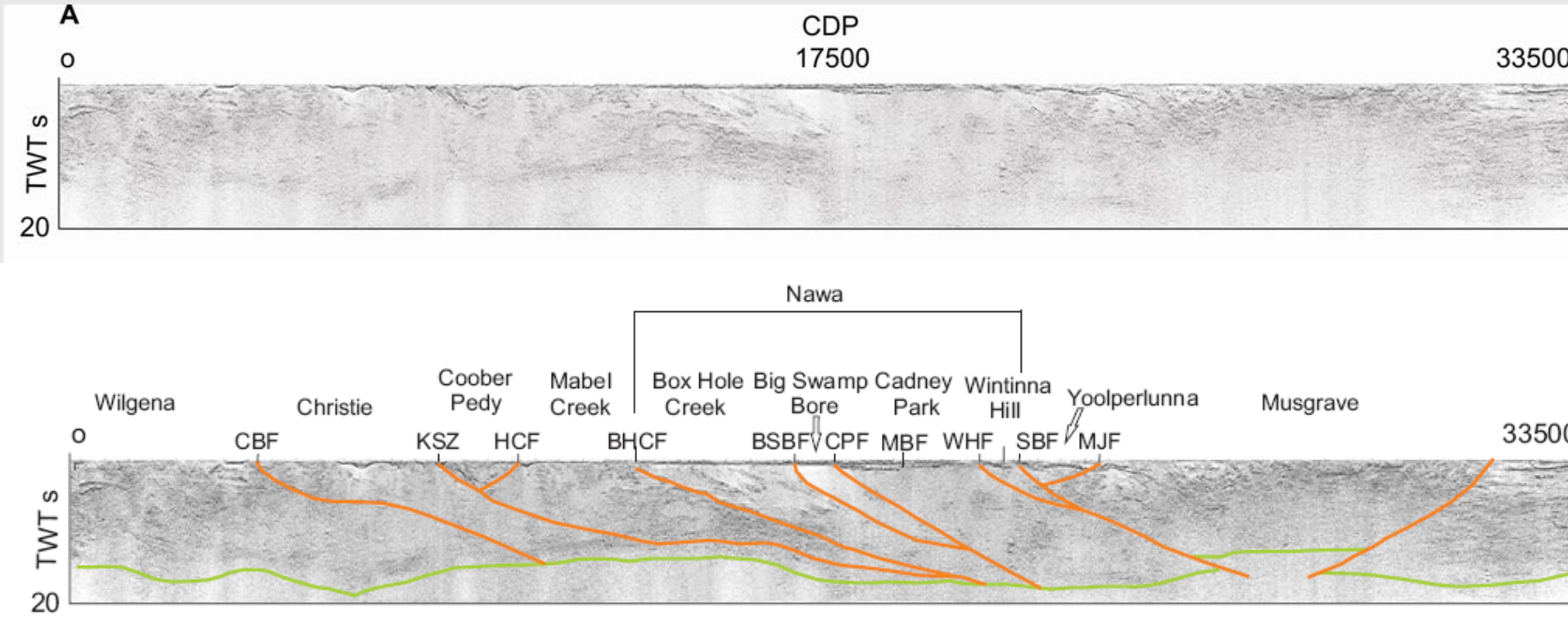
Cartoon – crustal architecture Gawler Craton to Arunta region

Crustal units in southern Northern Territory

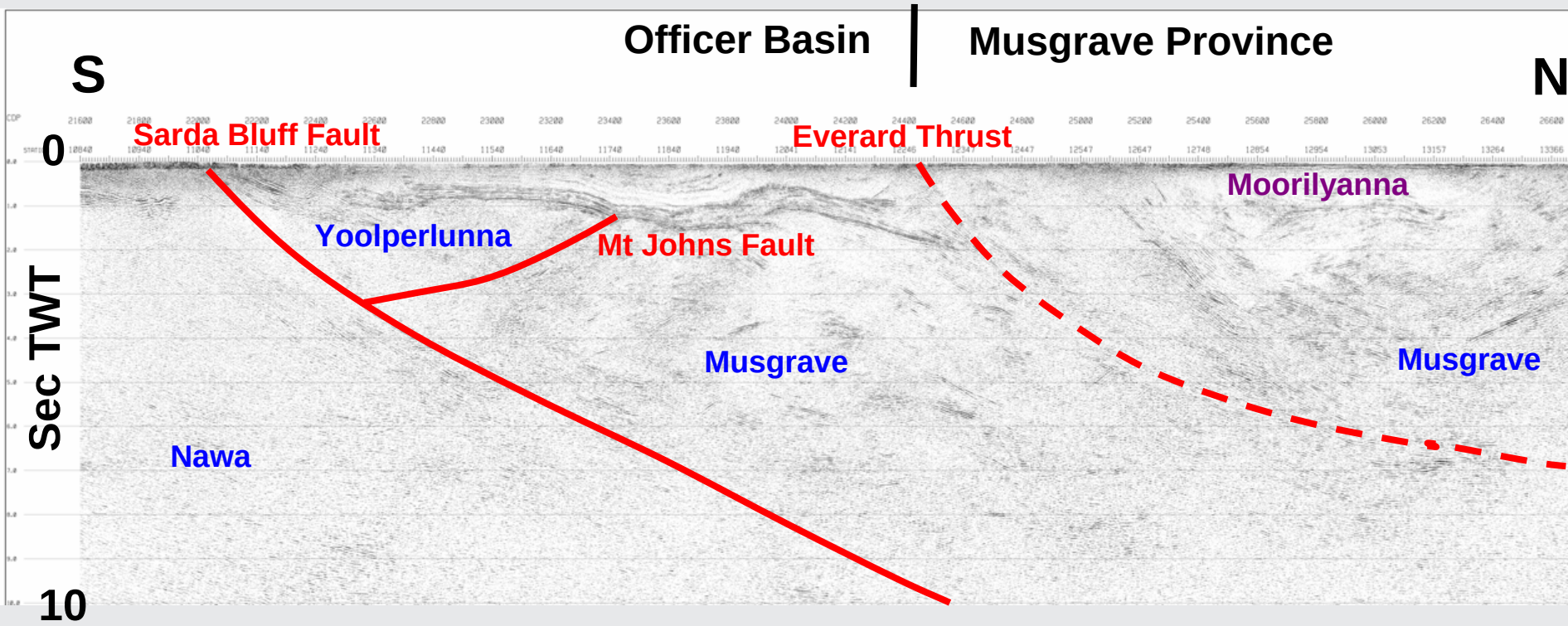


Source: NTGS

Sarda Bluff Fault
Gawler (Nawa) – Musgrave boundary



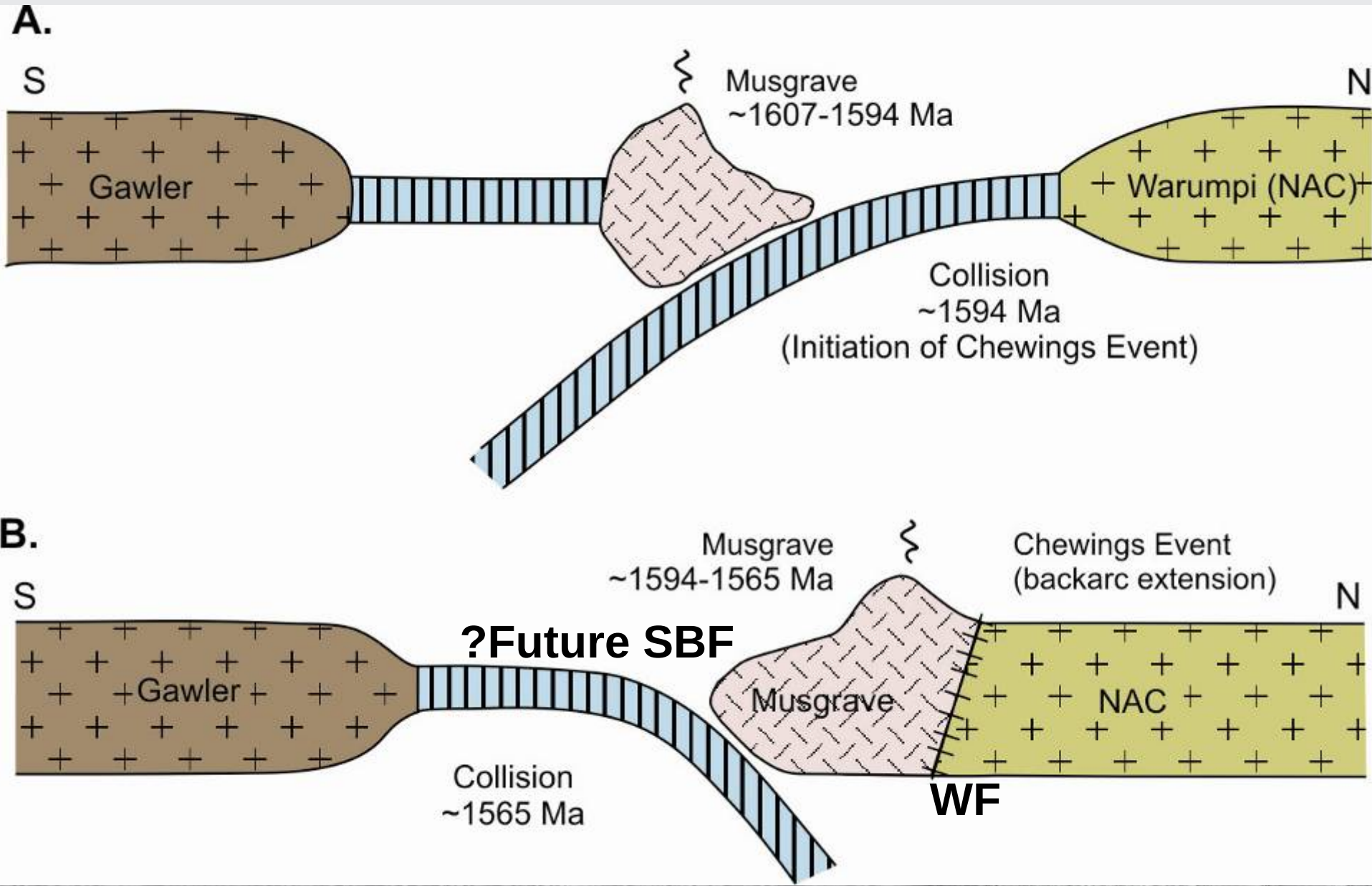
Sarda Bluff Fault



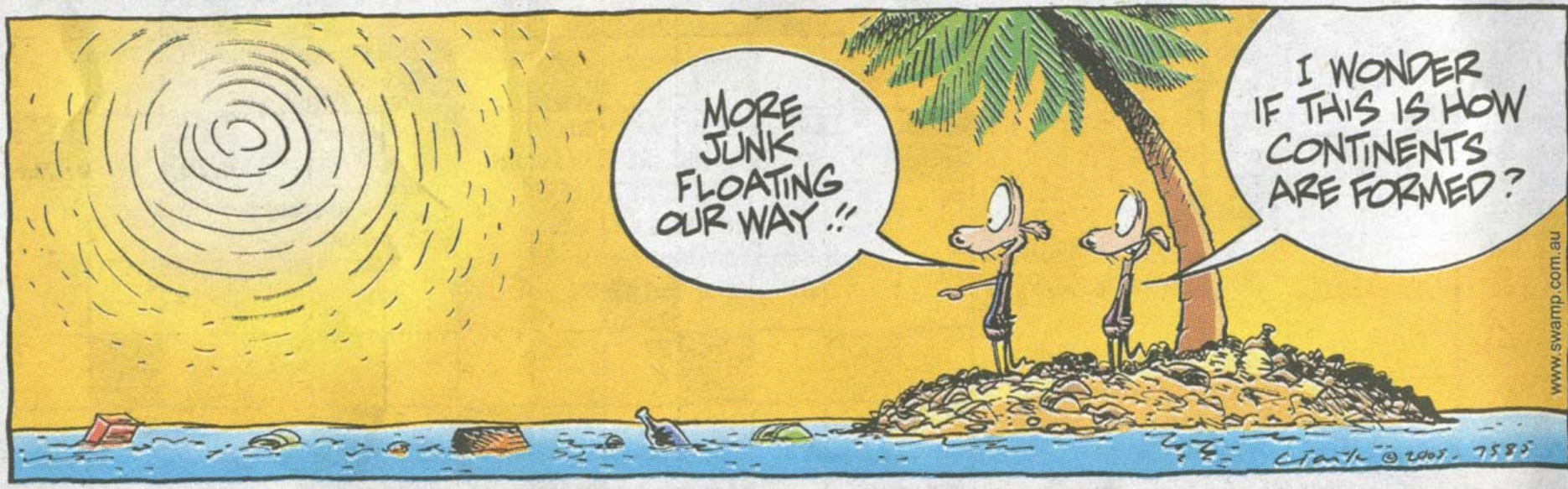
Possible suture between Gawler Craton and Musgrave Province?

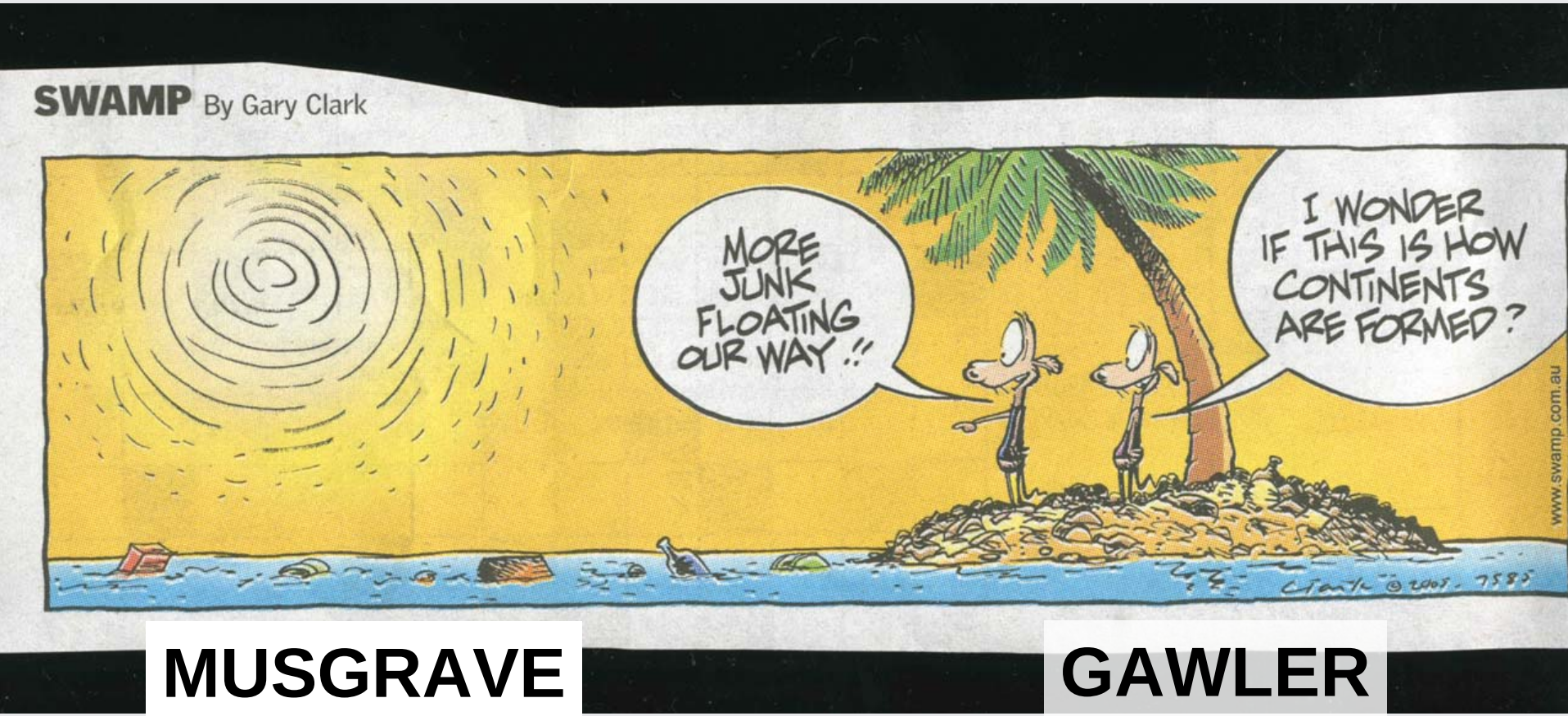
Timing: possibly Kararan Orogeny (~1570 Ma)

A model for amalgamation of Gawler-Musgrave-NAC (Arunta)



SWAMP By Gary Clark

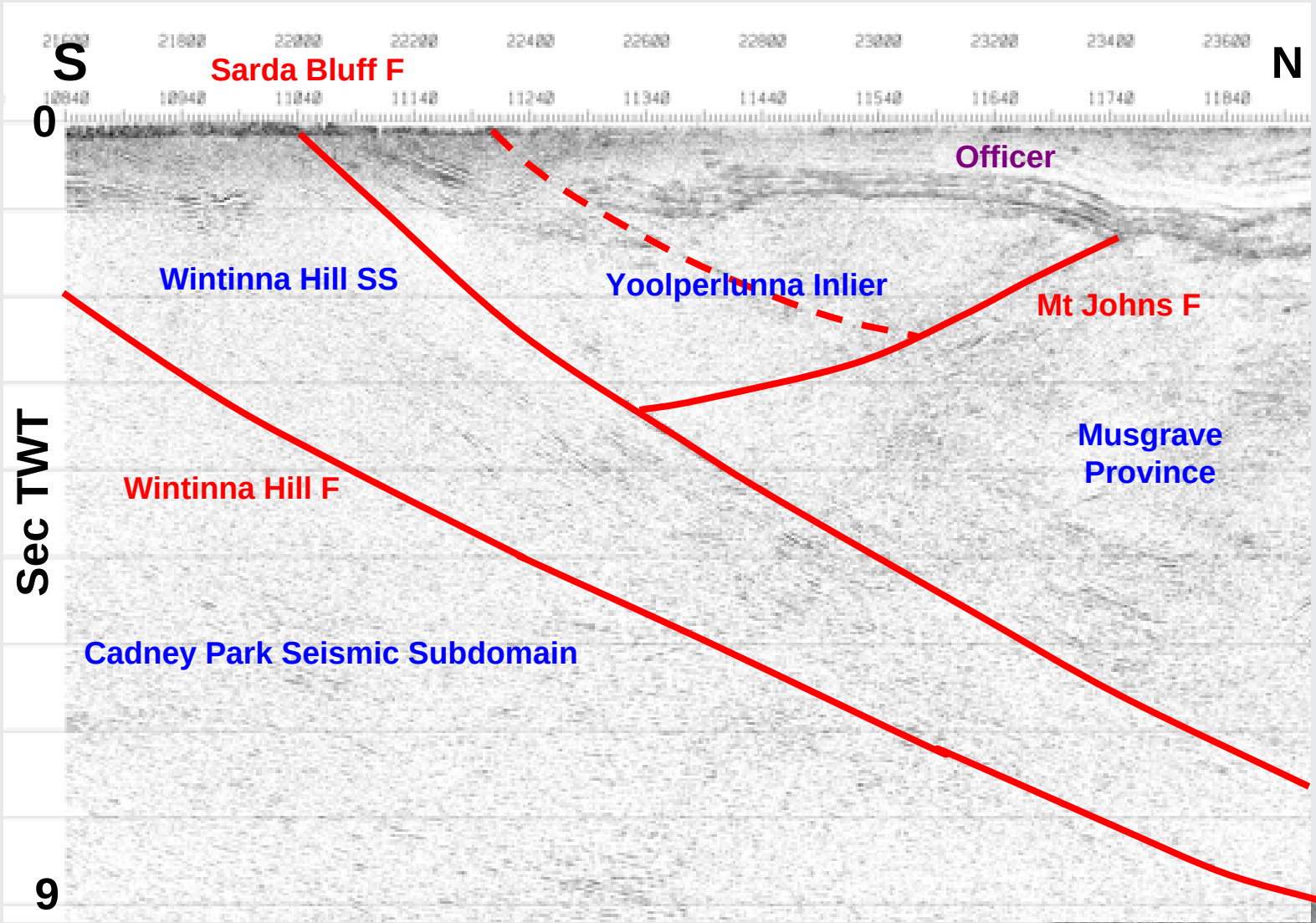




MUSGRAVE

GAWLER (NAWA)

Yoolperlunna Inlier



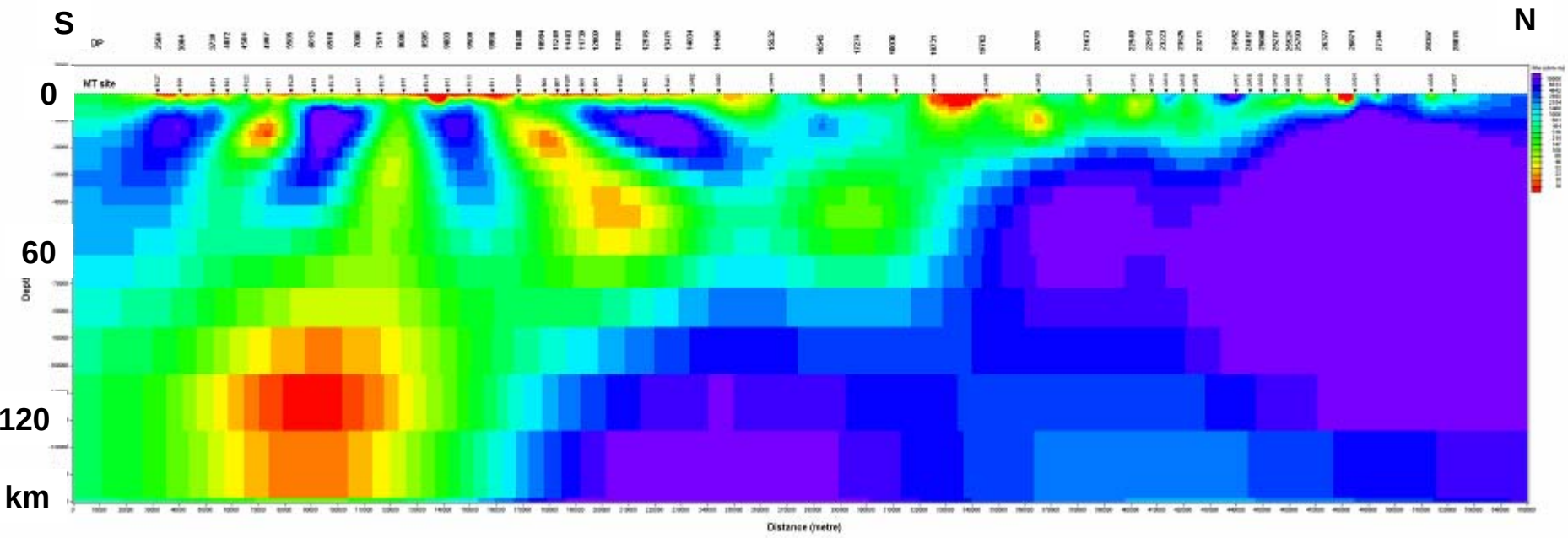
Yoolperlunna Inlier

- Yoolperlunna Inlier (Gawler affinities) backthrust to north over Musgrave Province
- Timing – after amalgamation of Nawa Domain with Musgrave Province
- But, earlier than deposition of Neoproterozoic in Officer Basin

Later events

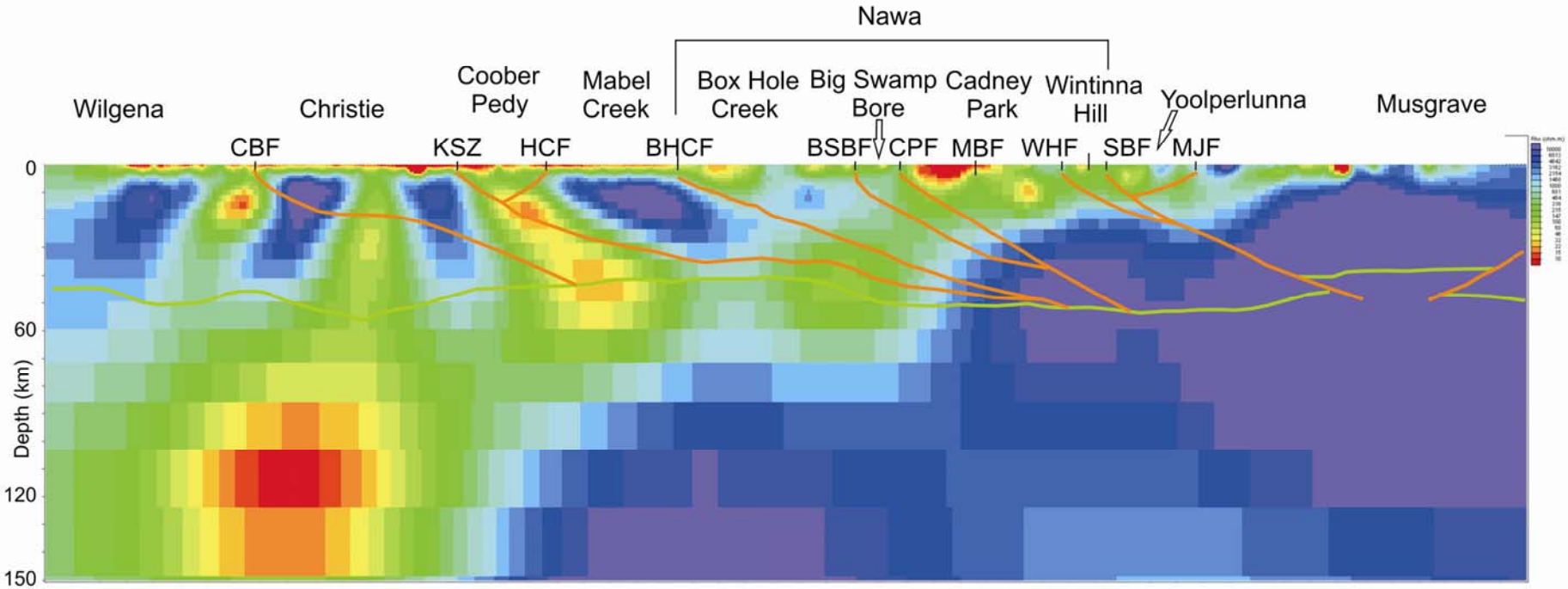
- Neoproterozoic extension
  - Half grabens in Officer Basin
- Petermann Orogeny, e.g.
  - Everard Thrust (southern outcrop limit of Musgrave Province)
  - Southern margin of Amadeus Basin (basement nappe)
- Alice Springs Orogeny, e.g.
  - Deformation of Moorilyanna Graben
  - Reactivation of Woodroffe Thrust

Lithospheric upper mantle



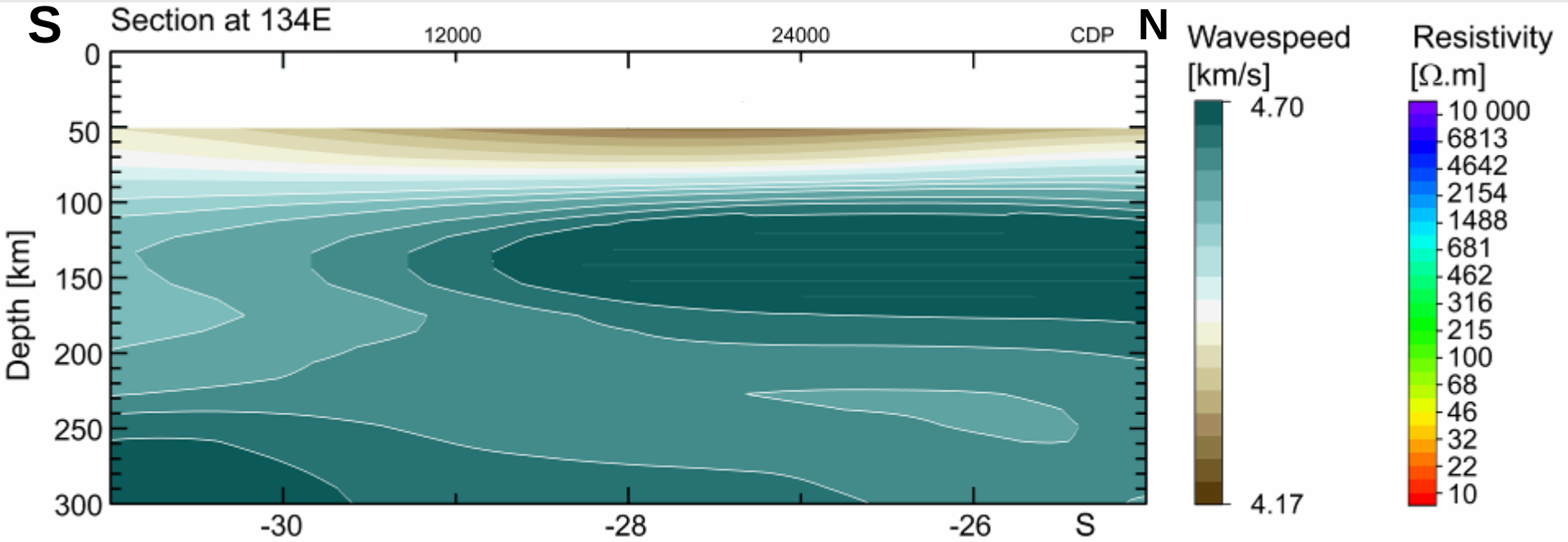
Preliminary MT model to depth of 150 km

Preliminary MT model plus seismic interpretation



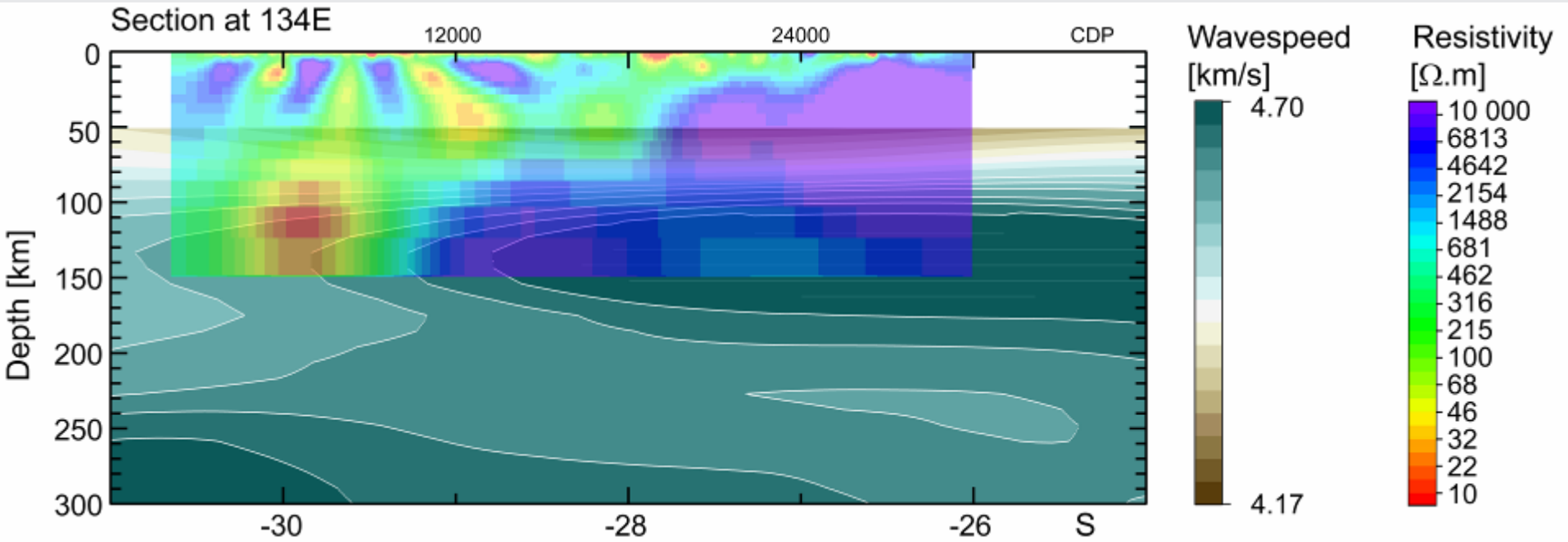
Low resistivity in lithosphere below Wilgena and Christie Domains (Neoarchean at surface)
Very high resistivity below Musgrave Province
Change in resistivity – fundamental lithospheric boundary, ?significance for mineral systems

Shear wave velocity for upper mantle (seismic tomography)

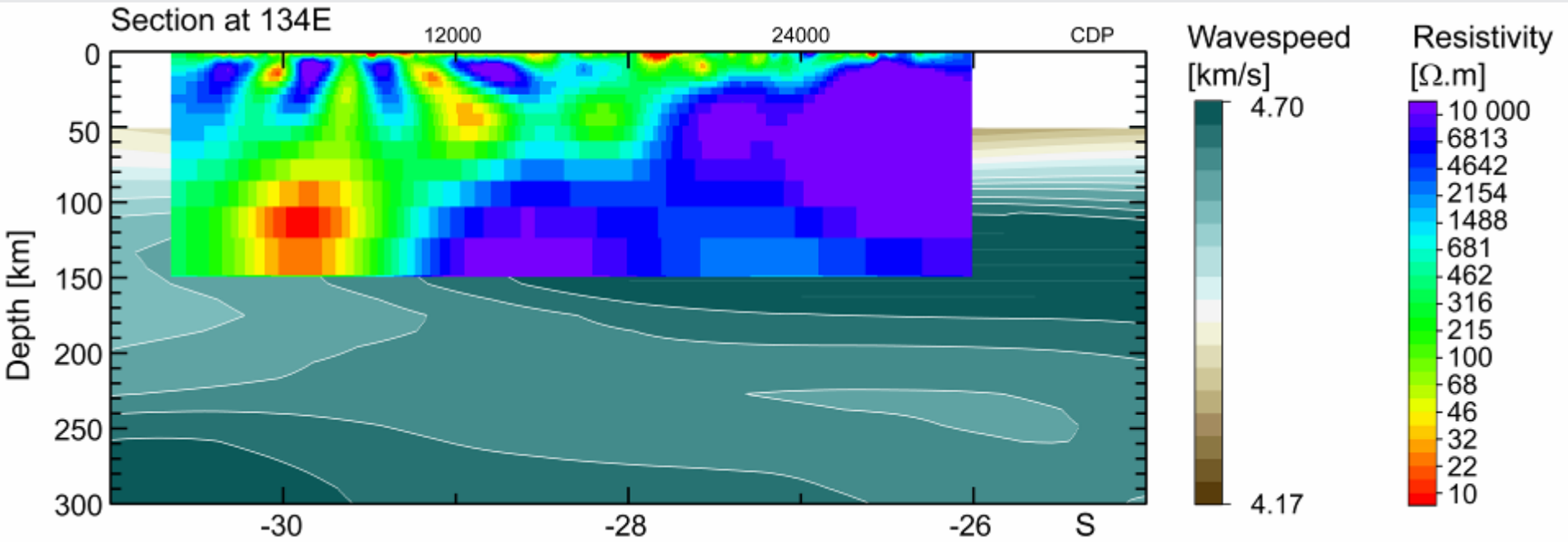


Fast seismic shear-wave speeds to ~200km depth = approximate base of lithosphere

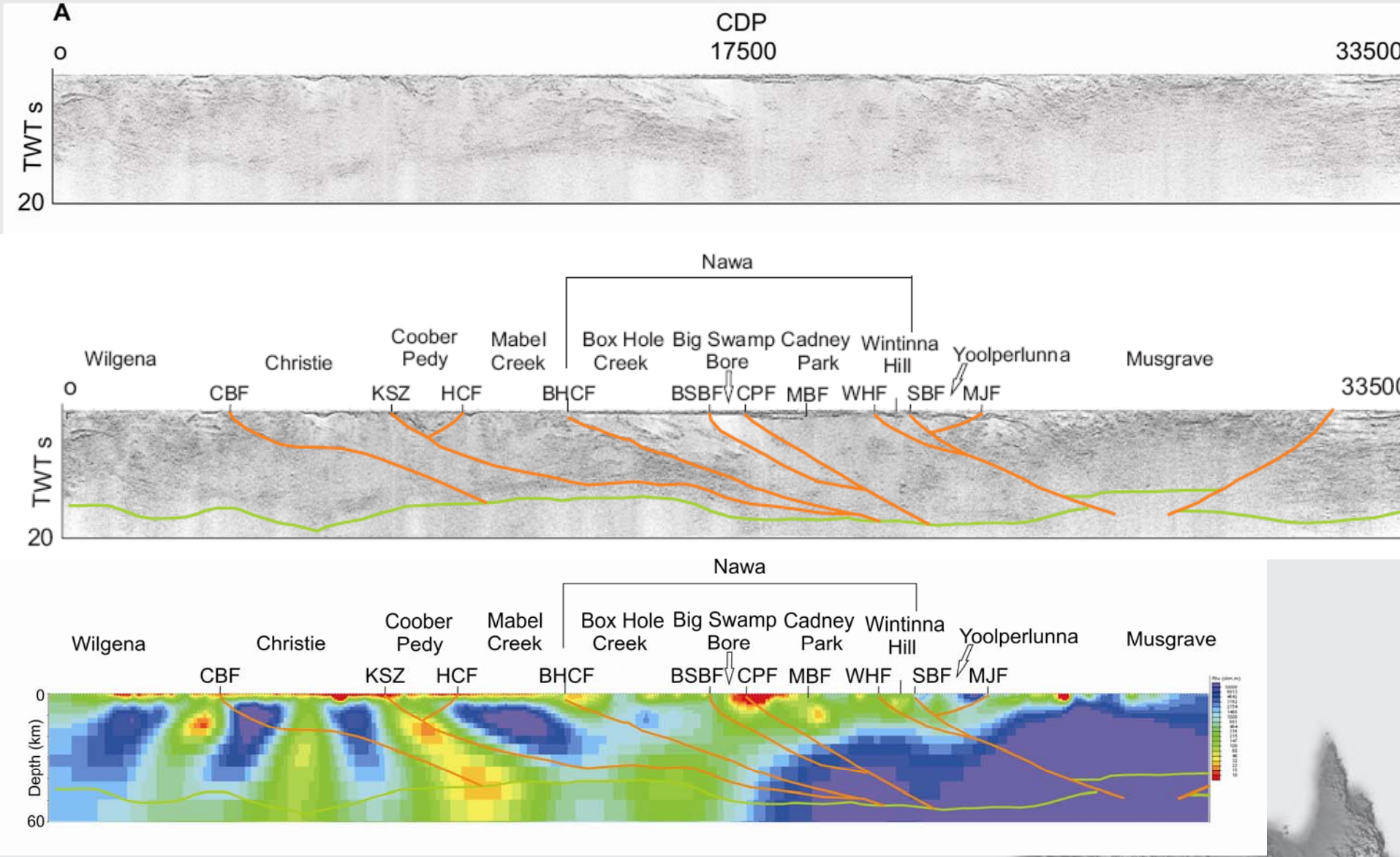
Shear wave velocity (seismic tomography) and preliminary MT model



Shear wave velocity (seismic tomography) and preliminary MT model



Summary


A
CDP
o
17500
33500
TWT s
20
Nawa
Wilgena
Christie
Coober Pedy
Mabel Creek
Box Hole Creek
Big Swamp Bore
Cadney Park
Wintinna Hill
Yoolperlunna
Musgrave
CBF
KSZ
HCF
BHCF
BSBF
CPF
MBF
WHF
SBF
MJF
33500
Depth (km)
0
60

Conclusions

- **Seismic defines several discrete crustal blocks**
- **Speculative implications:**
  - Karari Shear Zone may link to southeast
  - Upper crust in Coober Pedy and Mabel Creek domains possible thrust duplex or antiformal stack
  - Nawa Domain – several subdomains: imbricated, crustal-scale thrust stack
  - Possible amalgamation of Arunta Region (Warumpi) – Musgrave Province – Gawler Craton (Nawa)
- **Paucity of geological data means more samples needed to constrain speculations (drilling!)**

THANK YOU

Seismic data available at:

www.ga.gov.au/minerals/research/national/seismic/