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Geological interpretation and geodynamic implications of the deep seismic reflection and MT line 09GA-GA1: Georgina Basin-Arunta Region

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Geoscience Australia

Onshore Energy Security Program

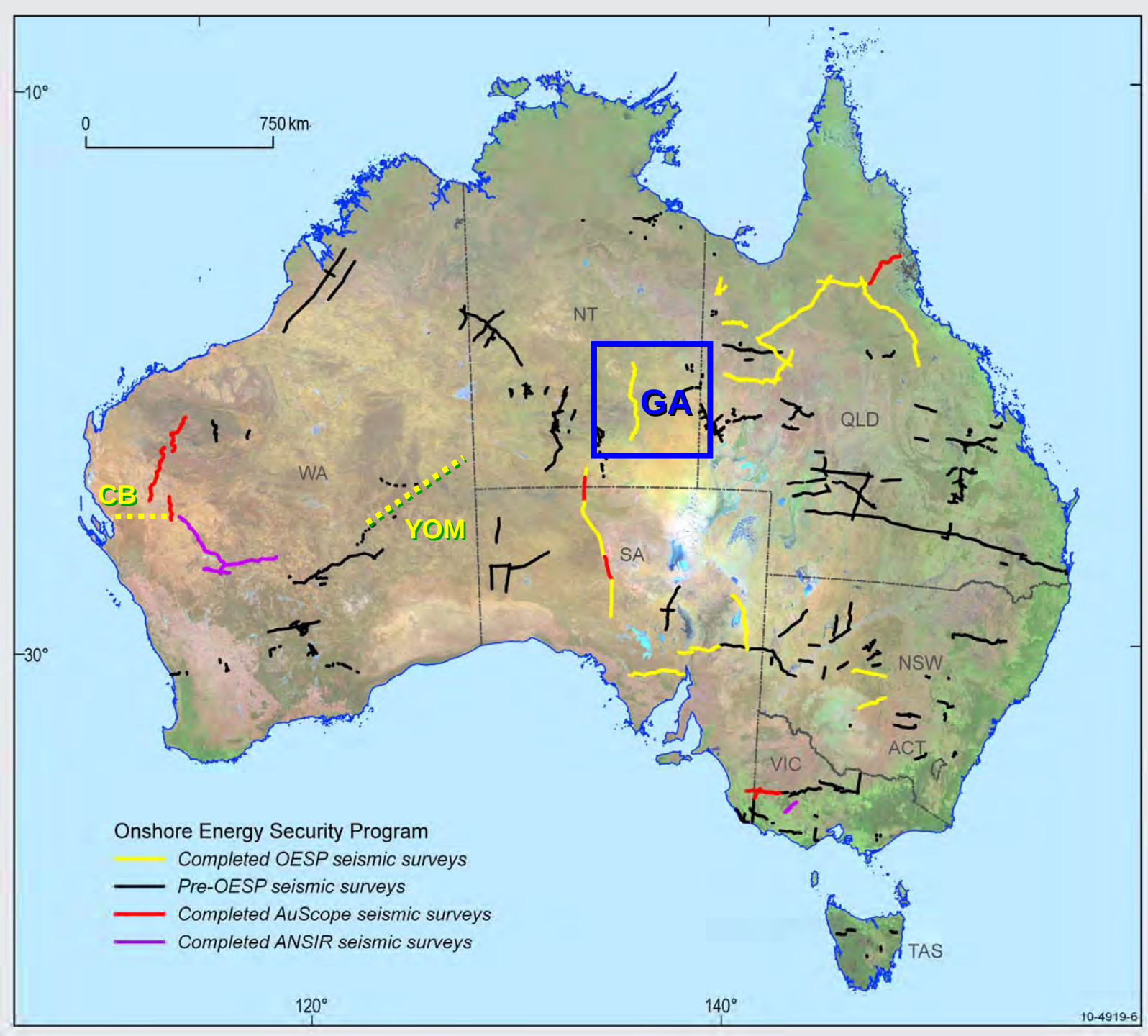
Geological potential for uranium, geothermal and petroleum

Northern Territory Geological Survey

Bringing Forward Discovery initiative

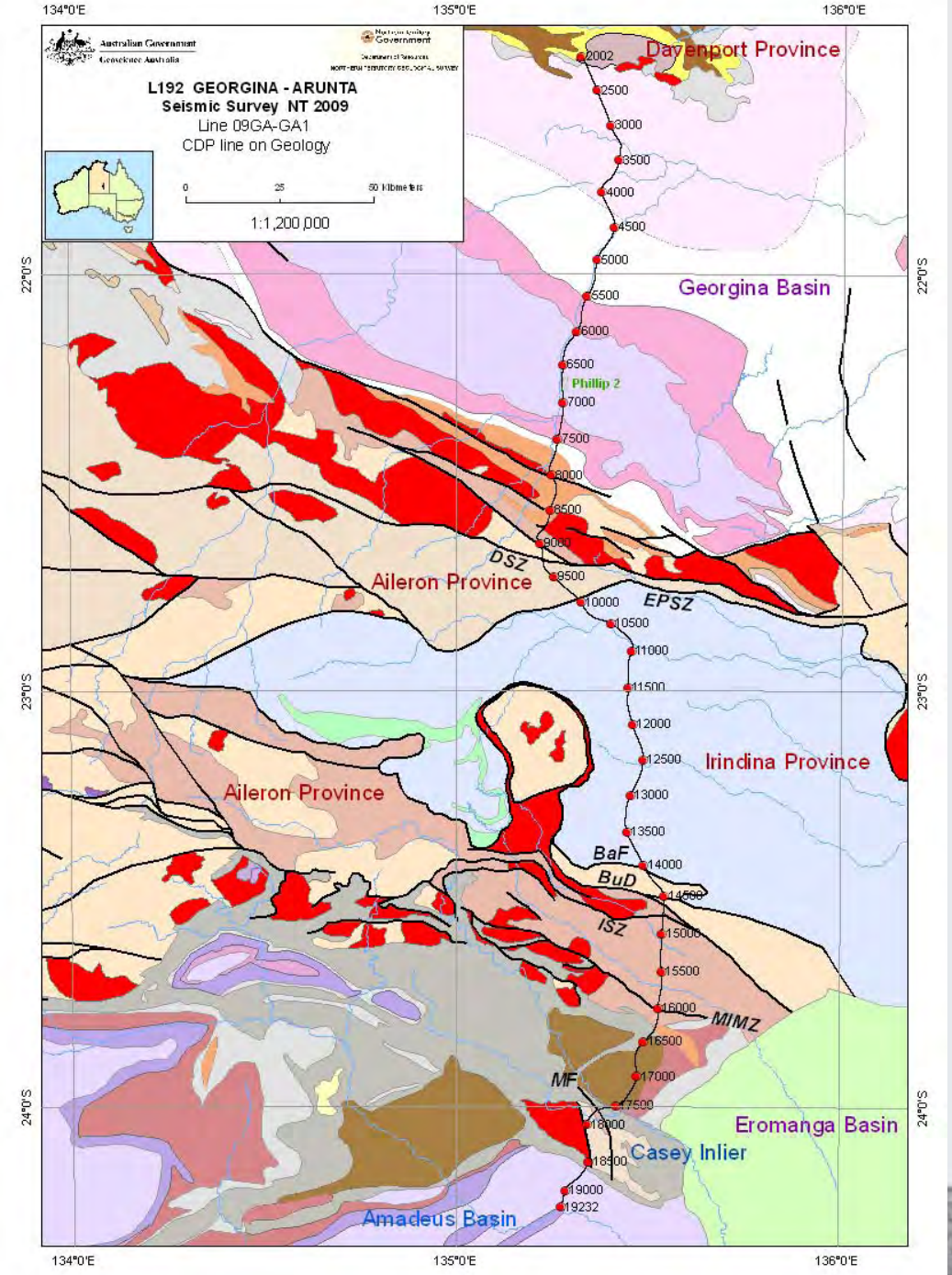
Comprehensive 3D understanding of NT geology and pinpoint exploration opportunities in greenfields regions

Deep seismic reflection lines in Australia



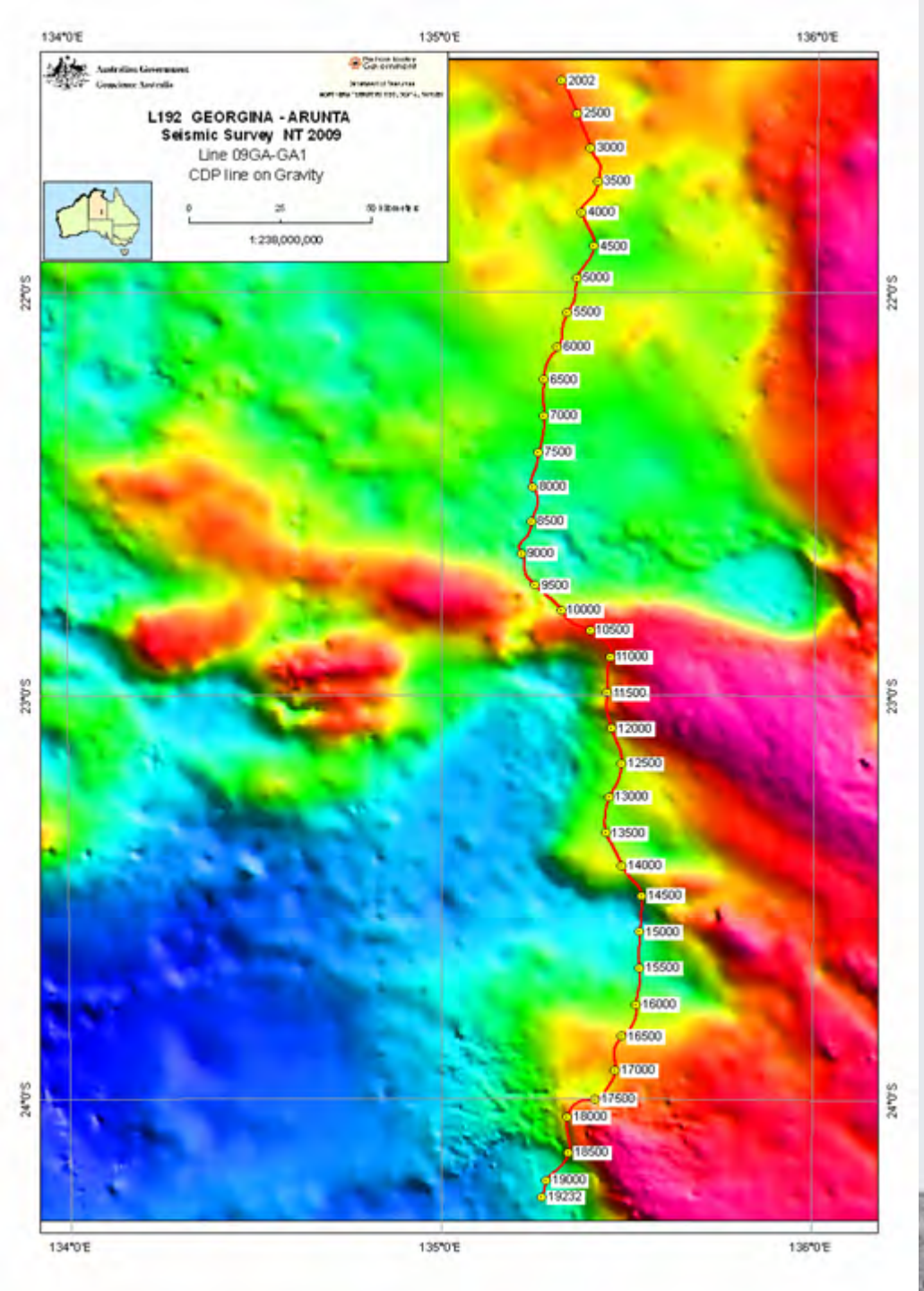
Georgina-Arunta deep seismic line 09GA-GA1

- **Deep seismic reflection line**
  - 373 line km
  - 300 channels @ 40 m (= 12 km active)
  - 80 m vibration interval → 75 fold
  - 20 s record length (@ 2ms) = ~60 km depth
- **Gravity stations**
  - every 400 m
- **MT stations**
  - 39 stations @ 5-20 km spacing
  - Imaged to >150 km depth



Key Provinces

Davenport Province
Georgina Basin
Aileron Province
Irindina Province
Casey Inlier
Amadeus Basin
(Aremra Basin)



Regional Gravity

- Includes new 4, 2 & 1 km grids

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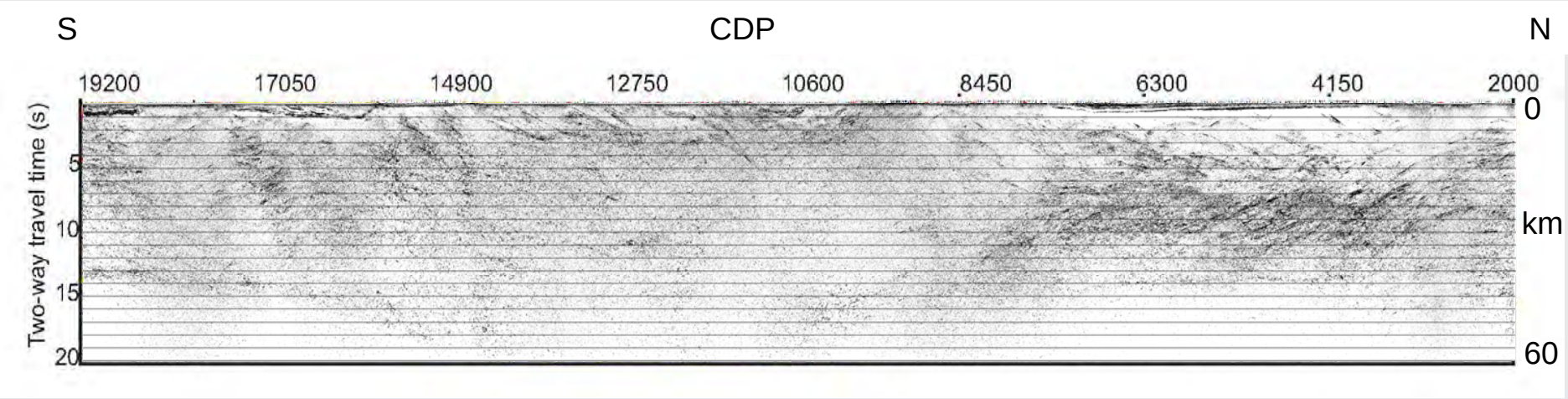
Deep seismic profile 09GA-GA1

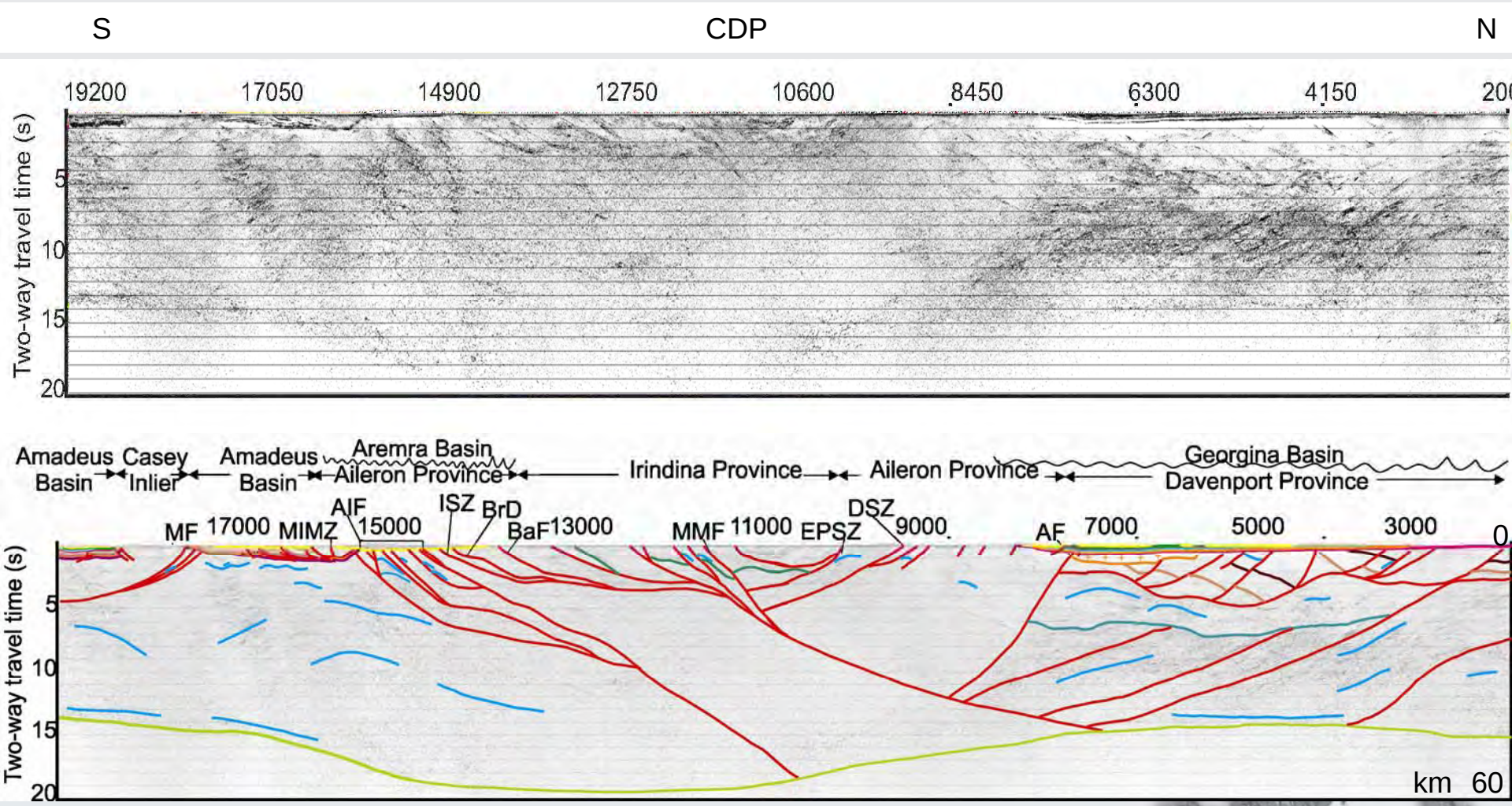


373 km long

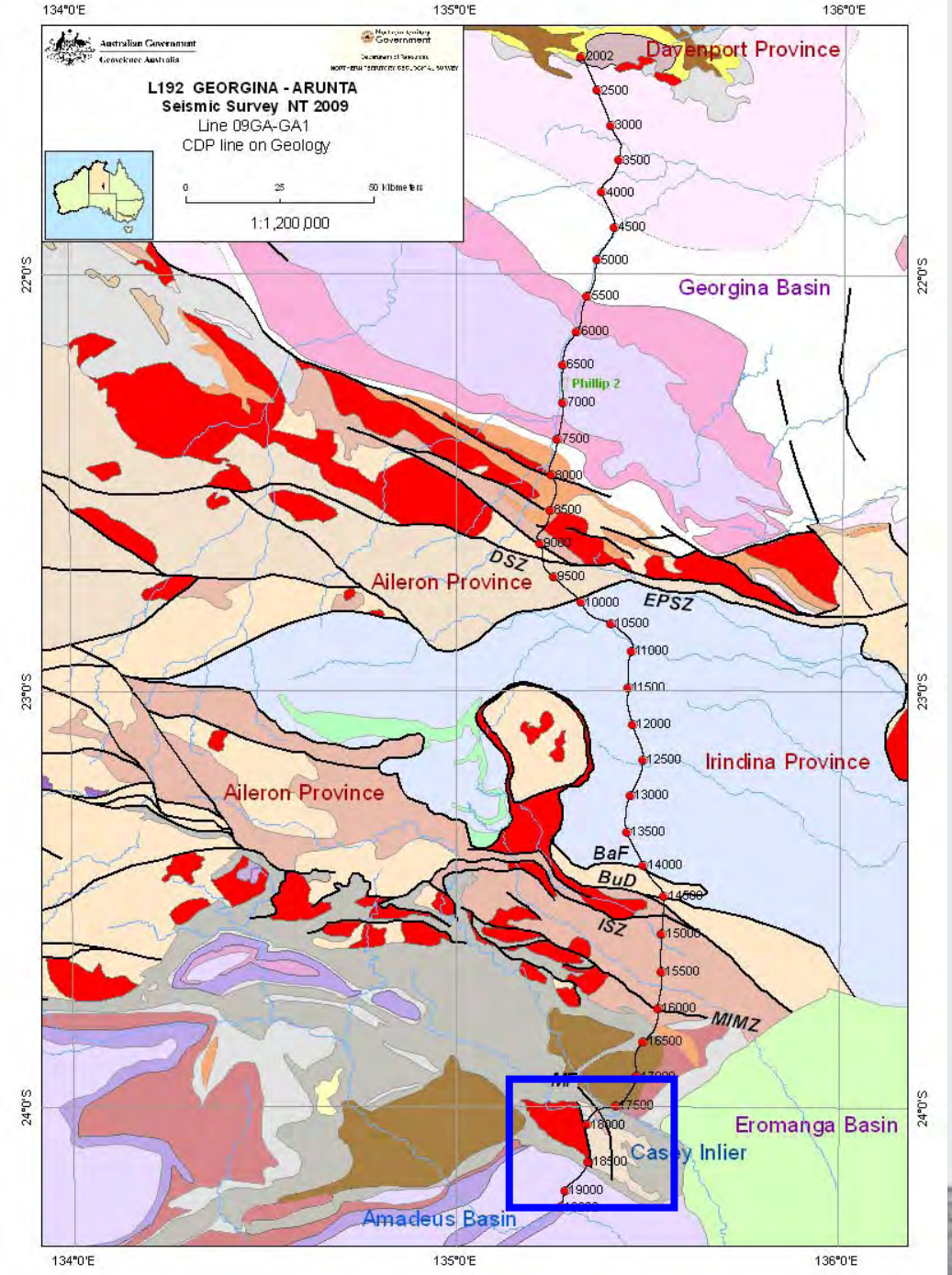
V = H, assuming average crustal velocity of 6000 m s^{-1}

Note: all sections have south on left hand side

Interpretation of seismic line 09GA-GA1



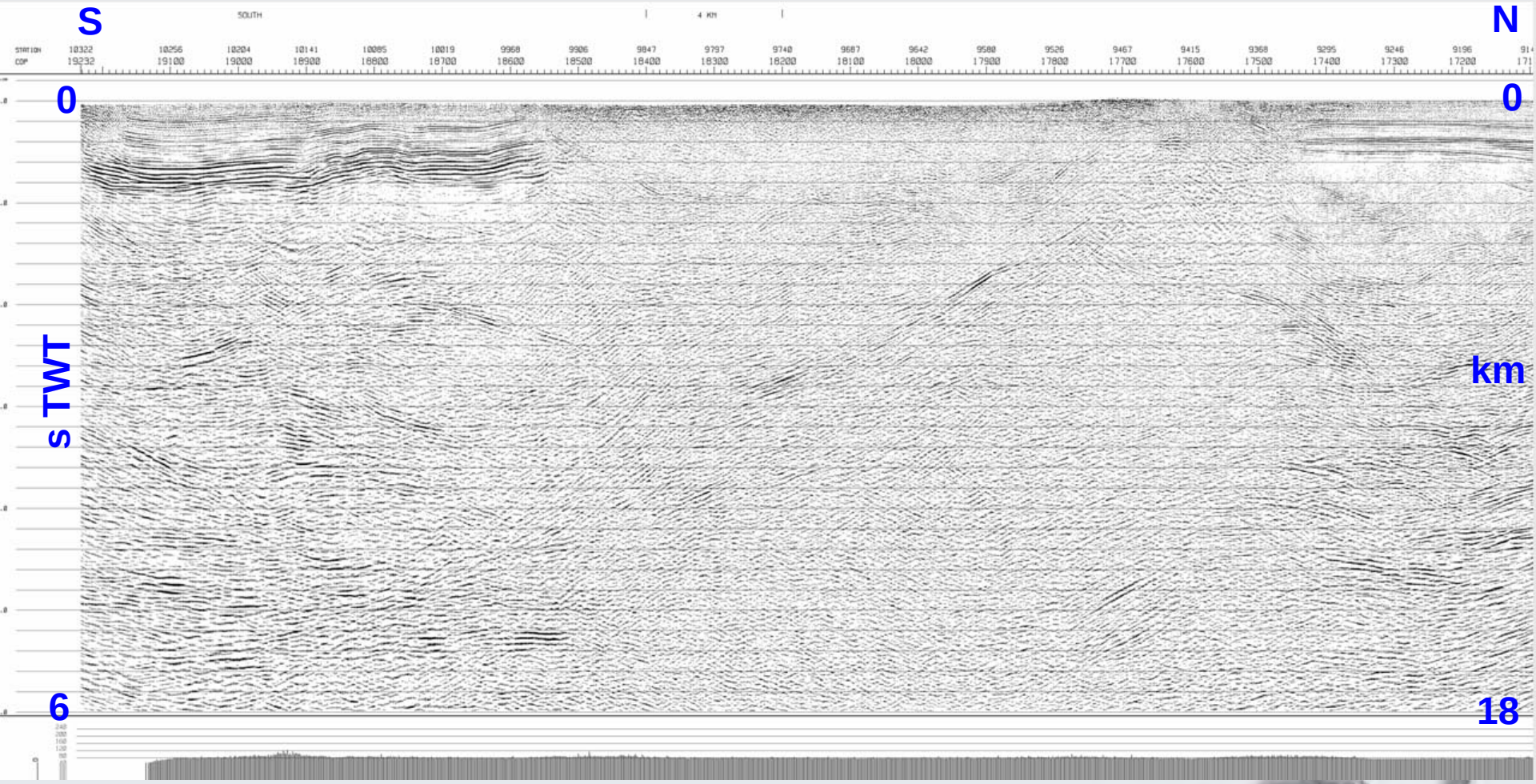
Very deep Moho

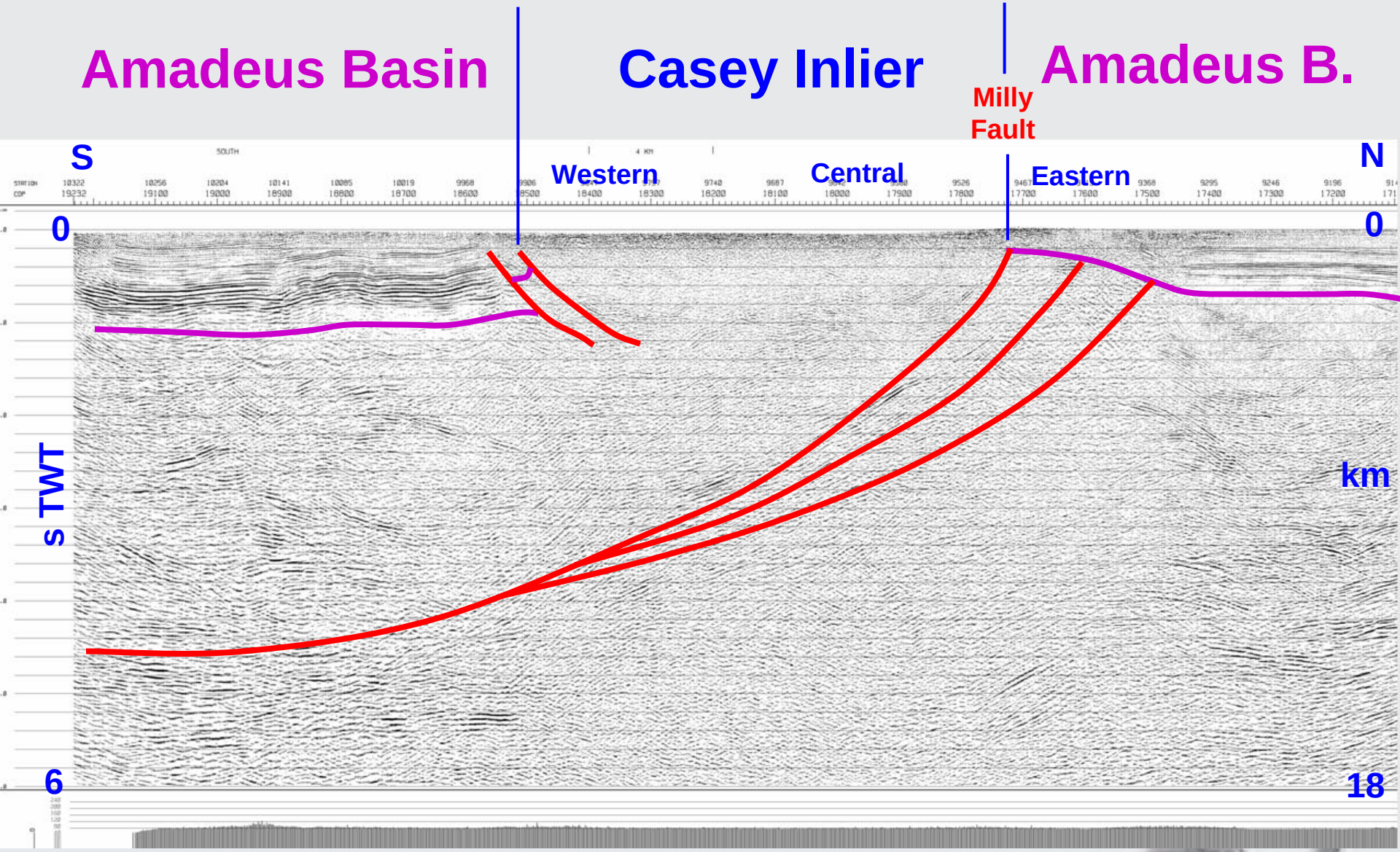


Casey Inlier

Paleoproterozoic basement surrounded by Amadeus Basin

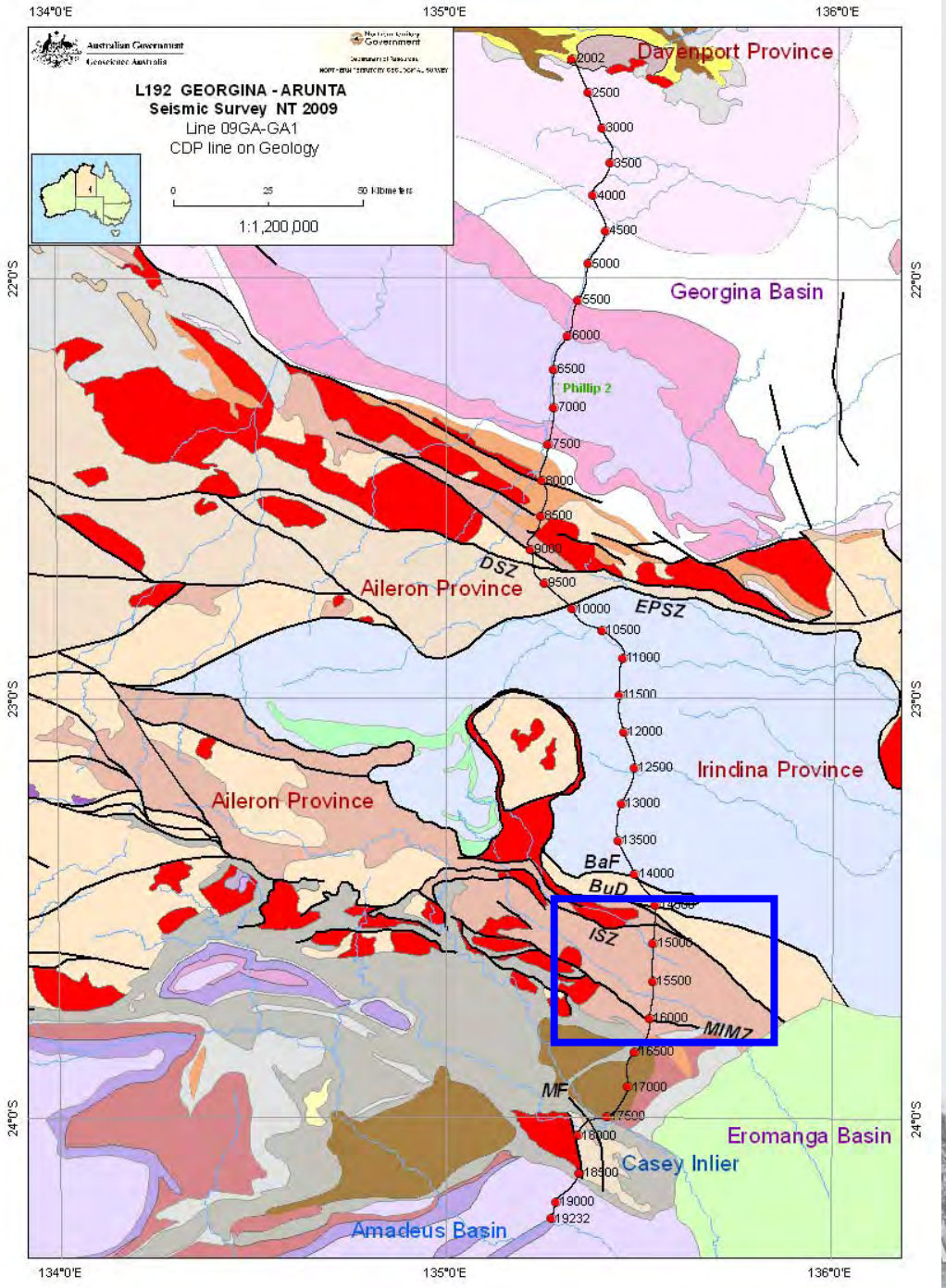
Casey Inlier



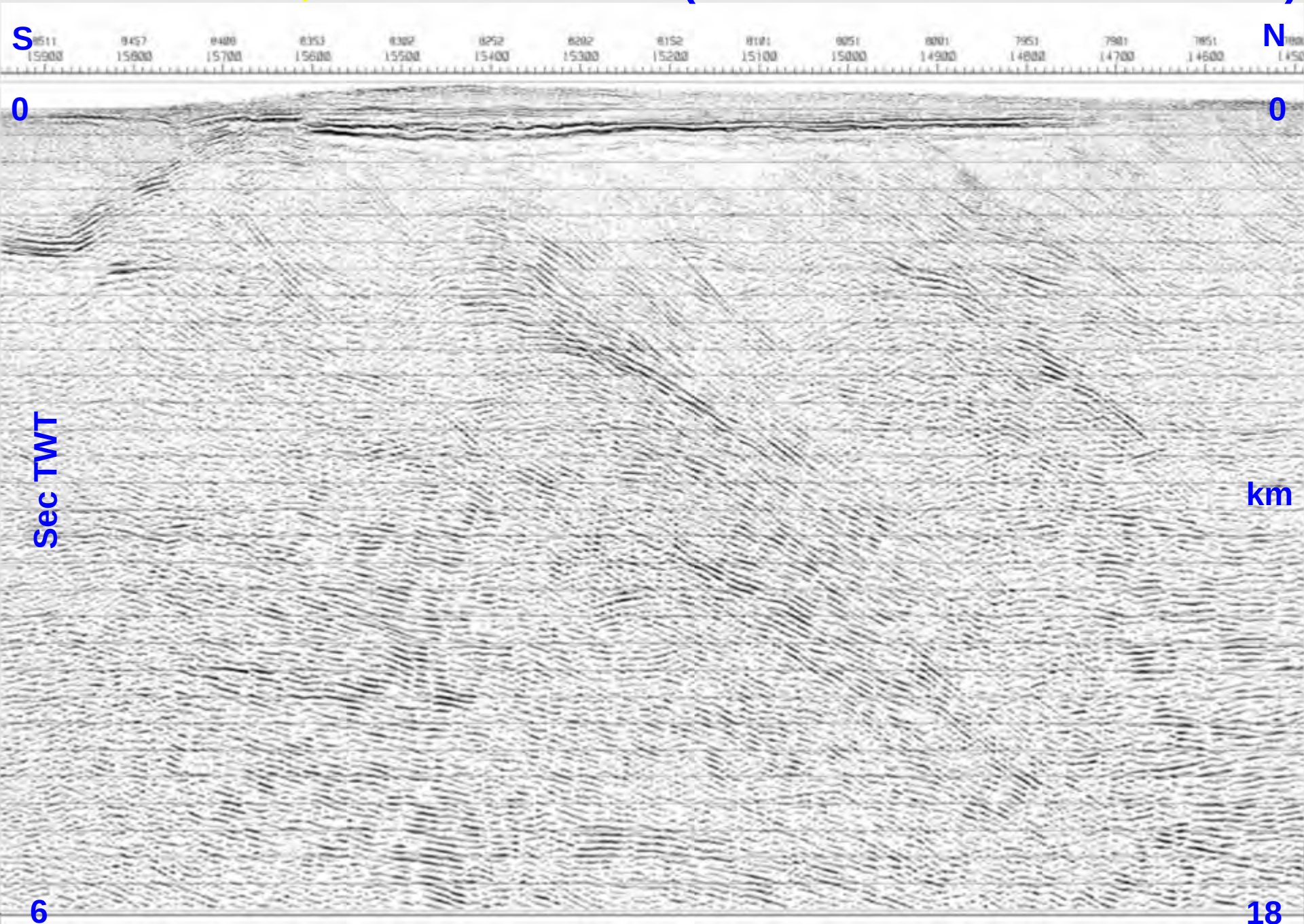


Casey Inlier = “pop-up” structure

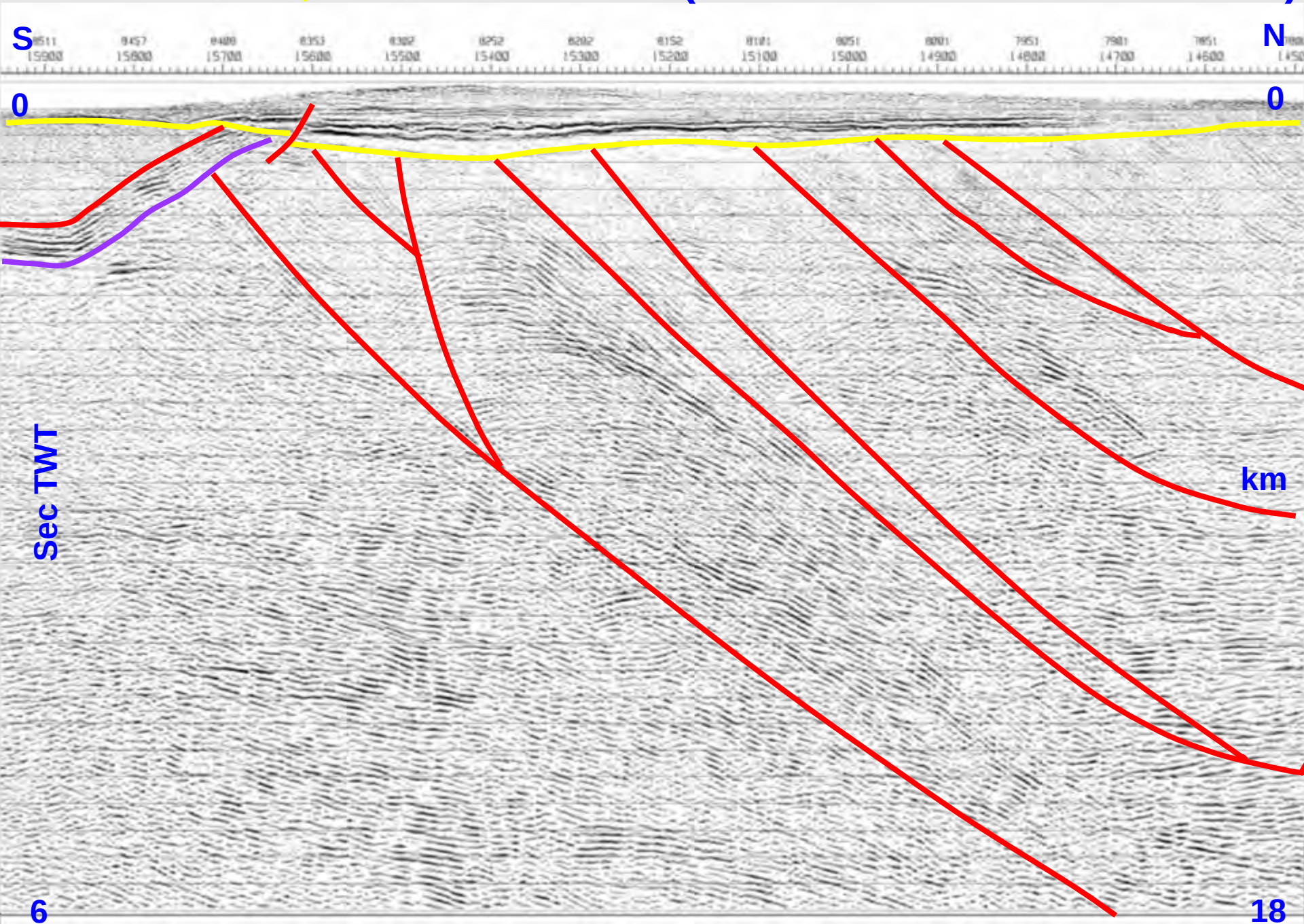
Aileron Province (Paleoproterozoic) south of Illogwa Shear Zone (Atnarta Imbricate Fault Zone)

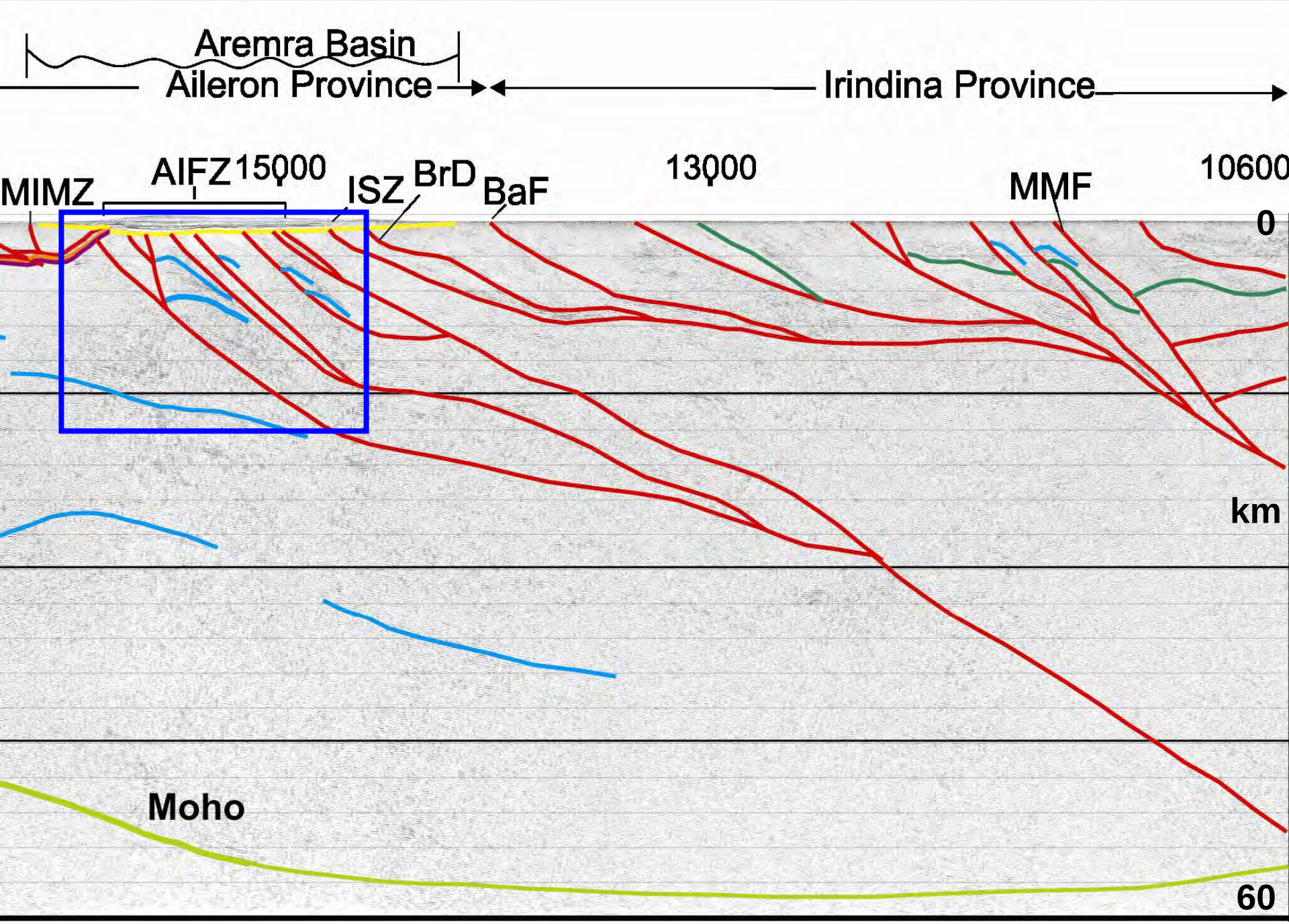


Aremra Basin, Aileron Province (Atnarta Imbricate Fault Zone)



Aremra Basin, Aileron Province (Atnarta Imbricate Fault Zone)

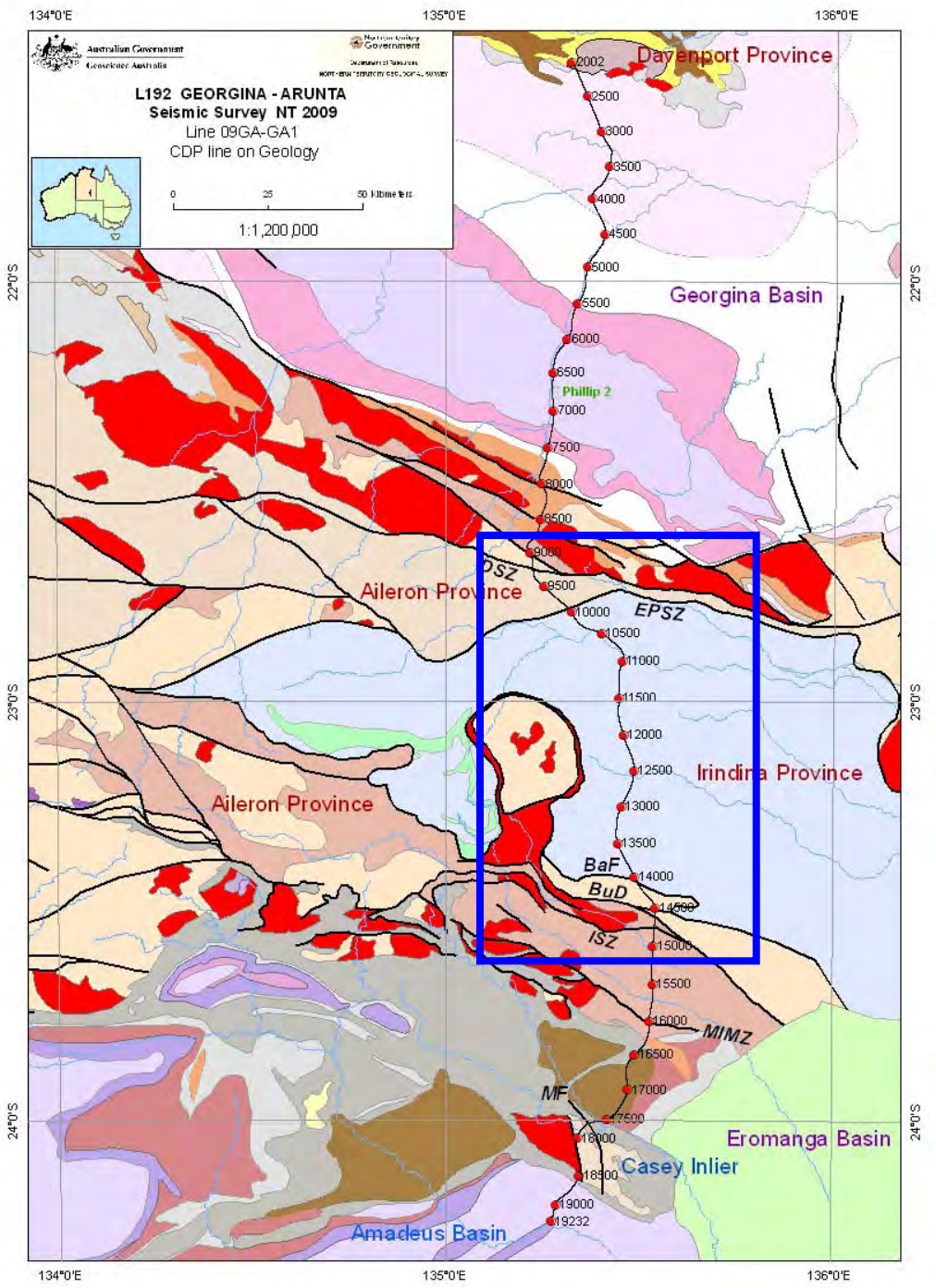



Aremra Basin
Aileron Province
Irindina Province
MIMZ
AIFZ
15000
ISZ
BrD
BaF
13000
MMF
10600
0
km
Moho
60

Illogwa Shear Zone to Delny Shear Zone

Irindina Province (Neoproterozoic to early Paleozoic)

- Between Basil Fault and Entire Point Shear Zone



Illogwa Shear Zone

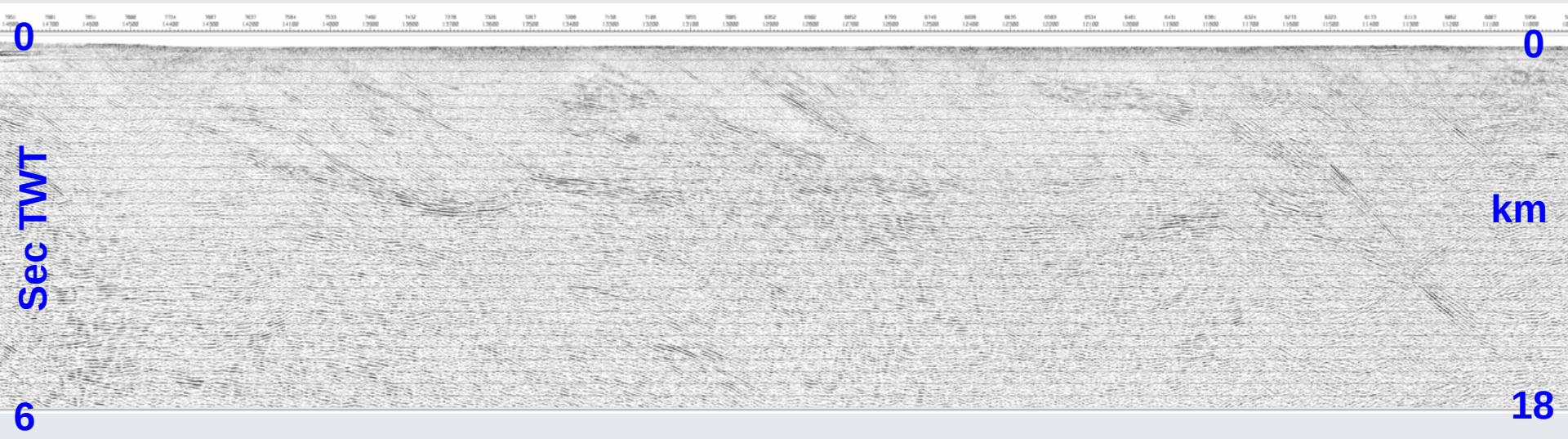
New SHRIMP ages:

Zircon crystallisation 1794 ± 2 Ma

Recrystallisation 1769 ± 3 Ma

(Kositcin et al., in prep.)

Irindina Province (southern part)



Irindina Province (southern part)

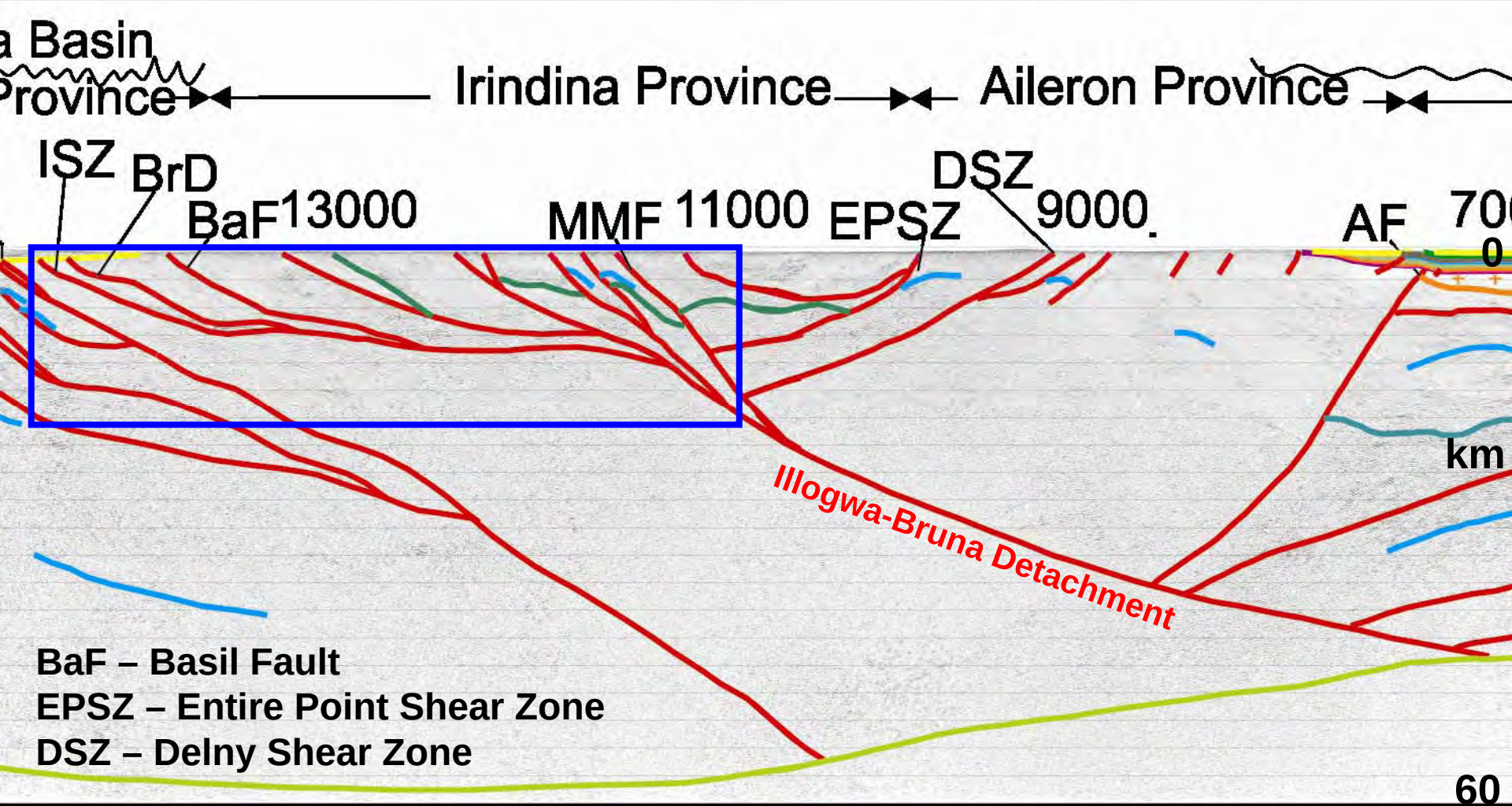
Several north-dipping faults:

- **ISZ – Illogwa Shear Zone**
- **BrD – Bruna Detachment**
- **BaF – Basil Fault**
- **MMF - Mount Mary Fault**

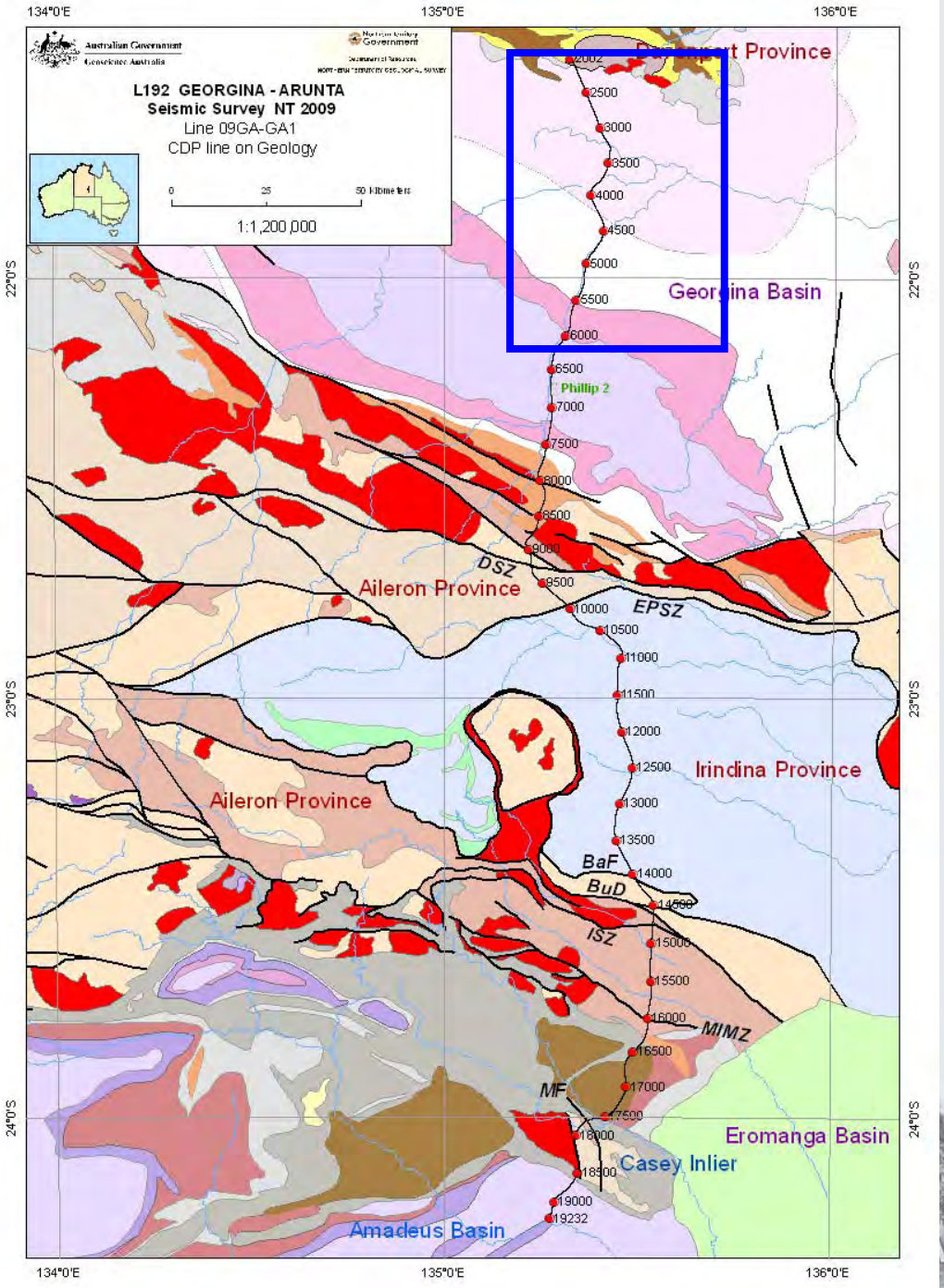
Brady Gneiss – reflective

Irindina Gneiss – nonreflective

Irindina Province (BaF to EPSZ)
Illogwa-Bruna Detachment
Aileron Province north of EPSZ

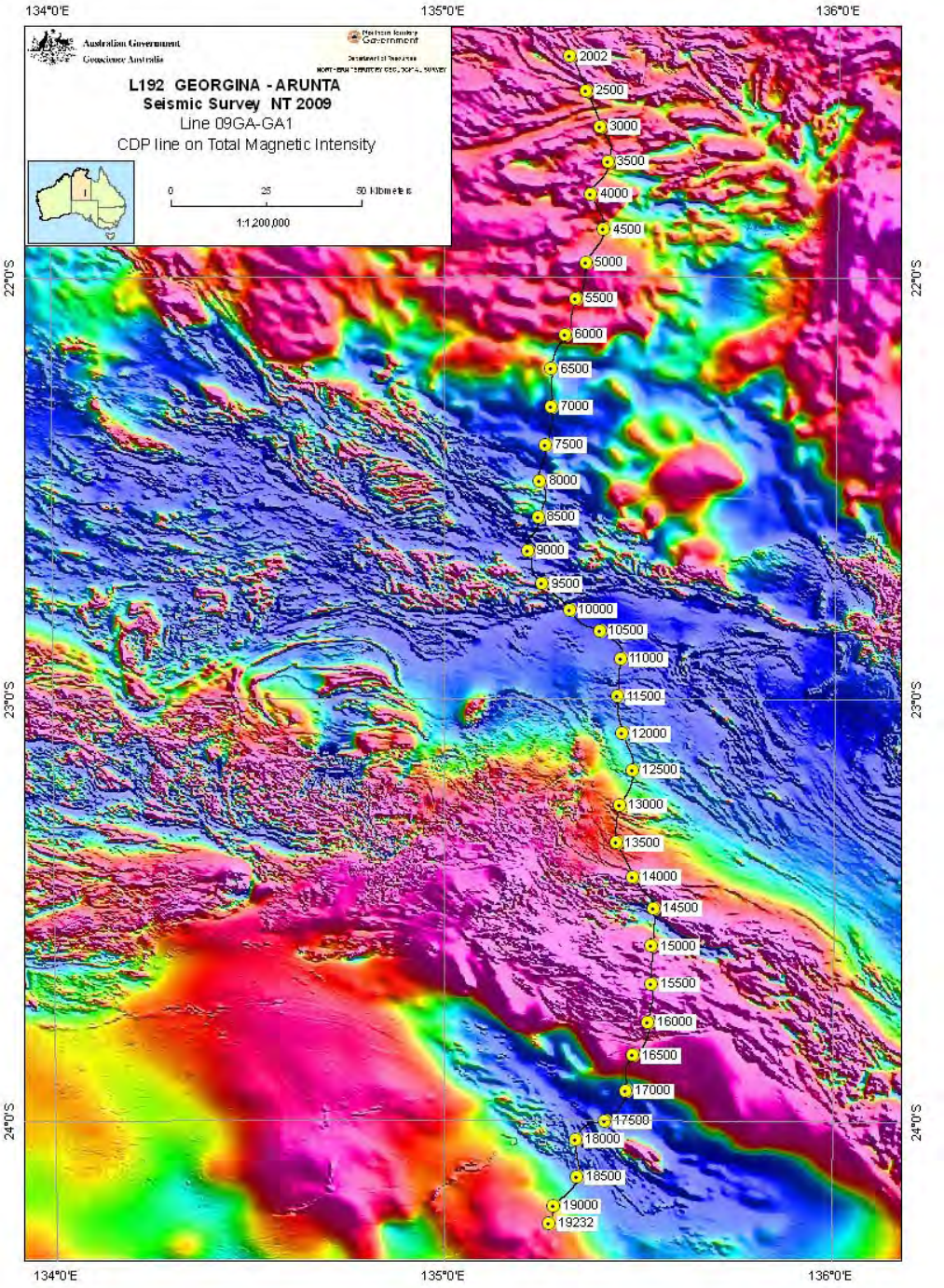


Davenport Province (Paleoproterozoic)

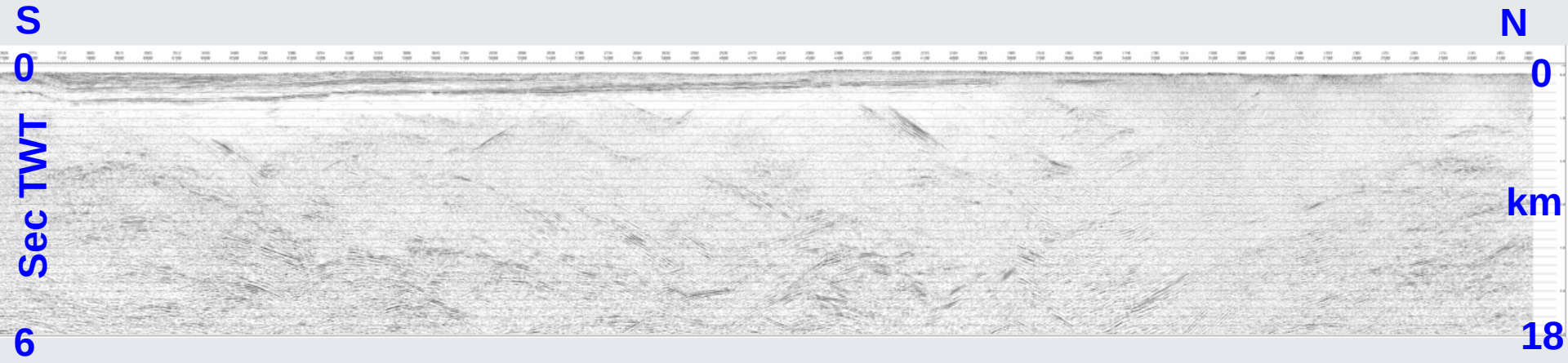


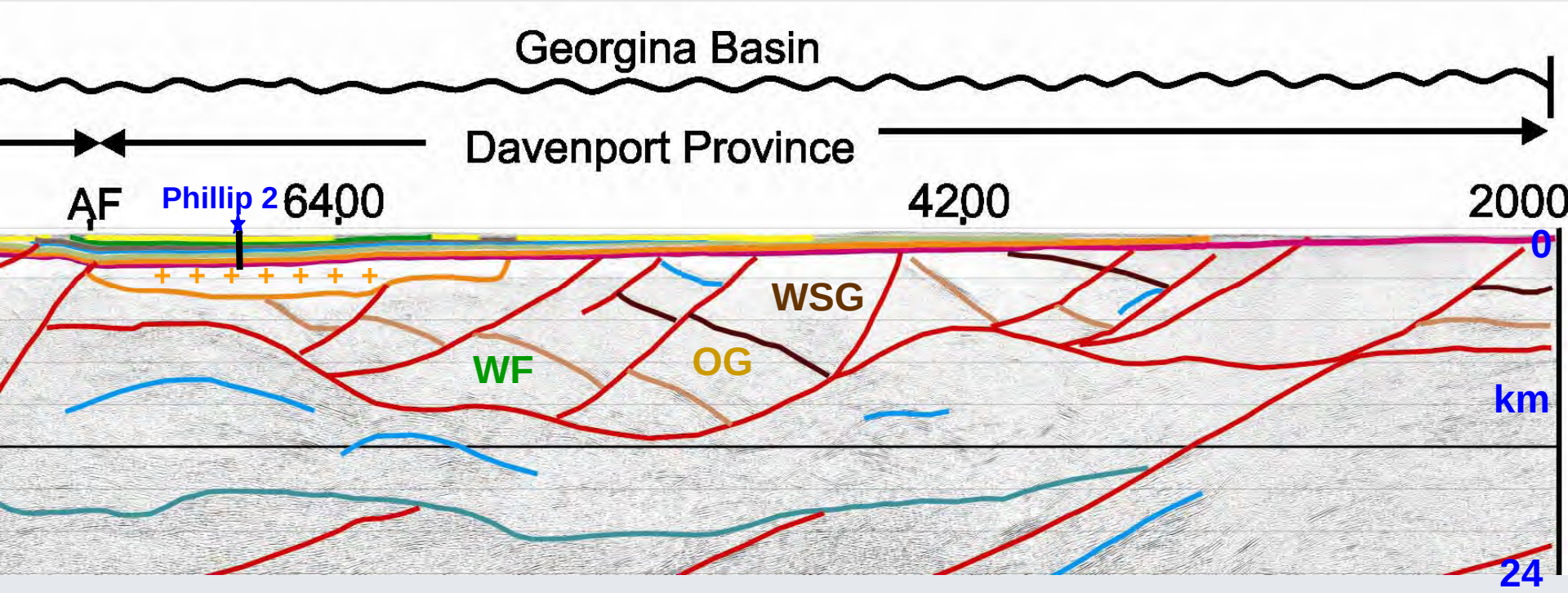
TMI

Note extension of Davenport Province to the south under the Georgina Basin



Davenport Province
(outcrop at northern end of line)

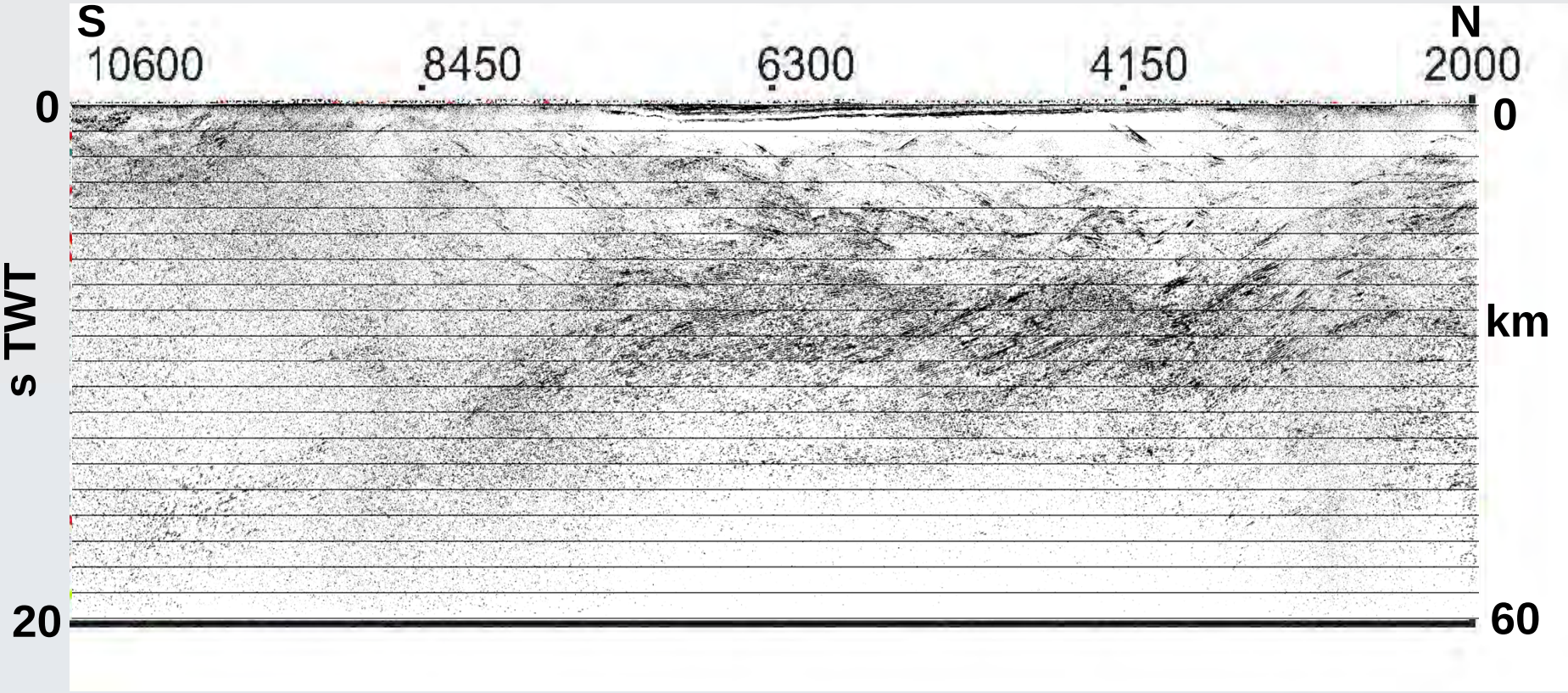




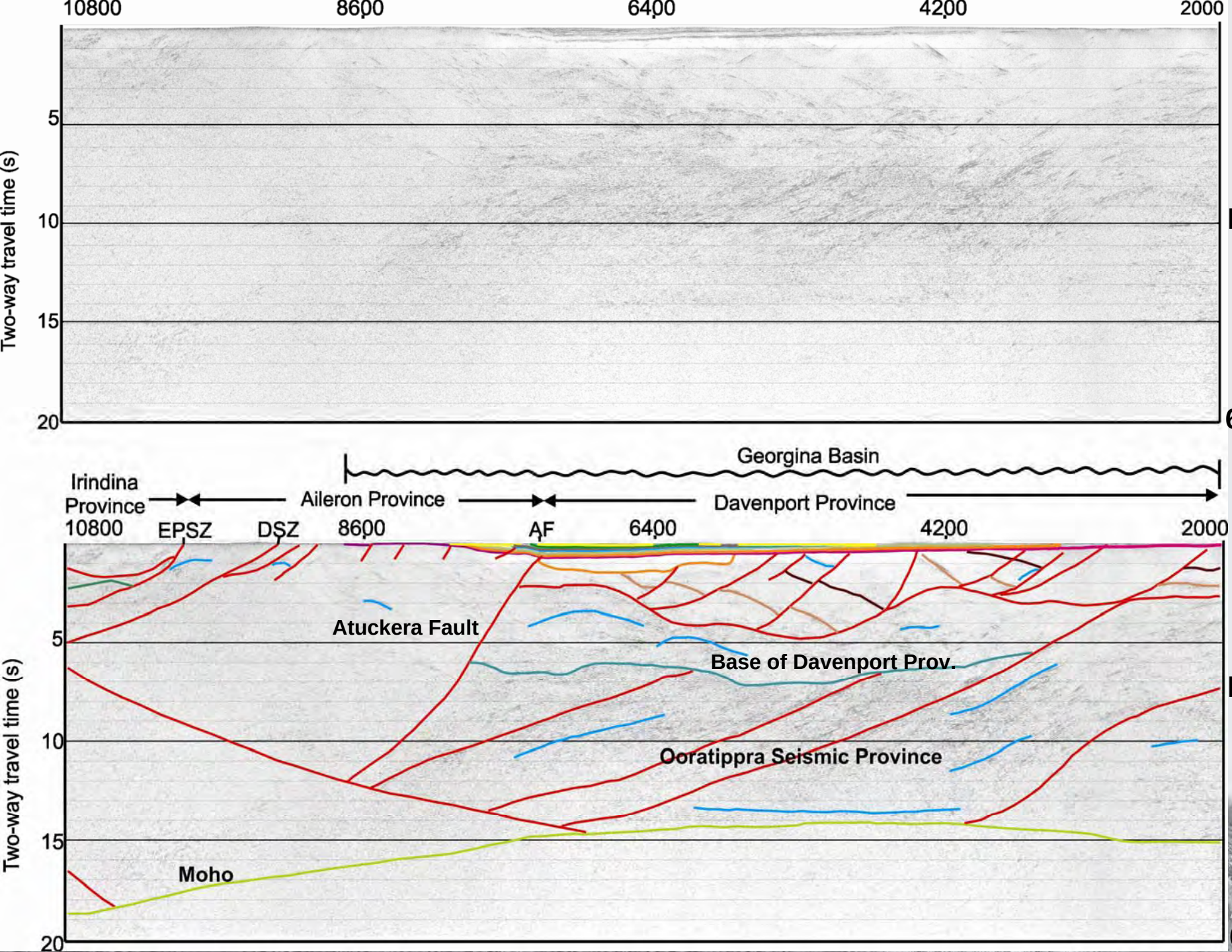
Granite in Phillip 2 well (depth ~1489-1493 m)
New SHRIMP zircon crystallisation age - 1802 ± 6 Ma
(Kositcin et al., in prep.)

WSG – Wauchope Subgroup (Hatches Creek Group) (~1814-?1805 Ma)
OG – Ooradidgee Group (~1840-1814 Ma)
WF – Warramunga Formation (~1880-1860 Ma)

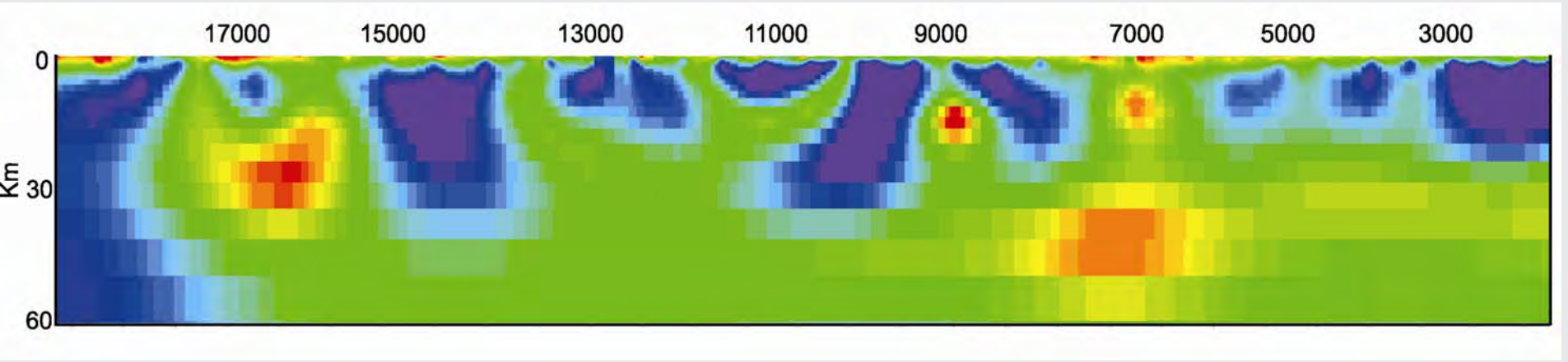
Crustal reflectivity: distinct change from south to north

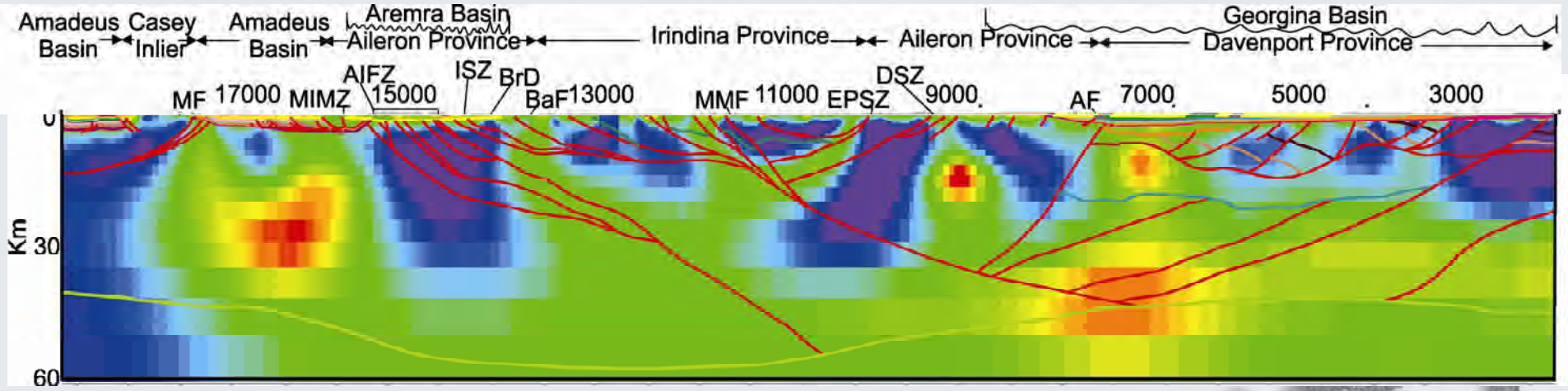


Atuckera Fault
Base of Davenport Province
Ooratippra Seismic Province

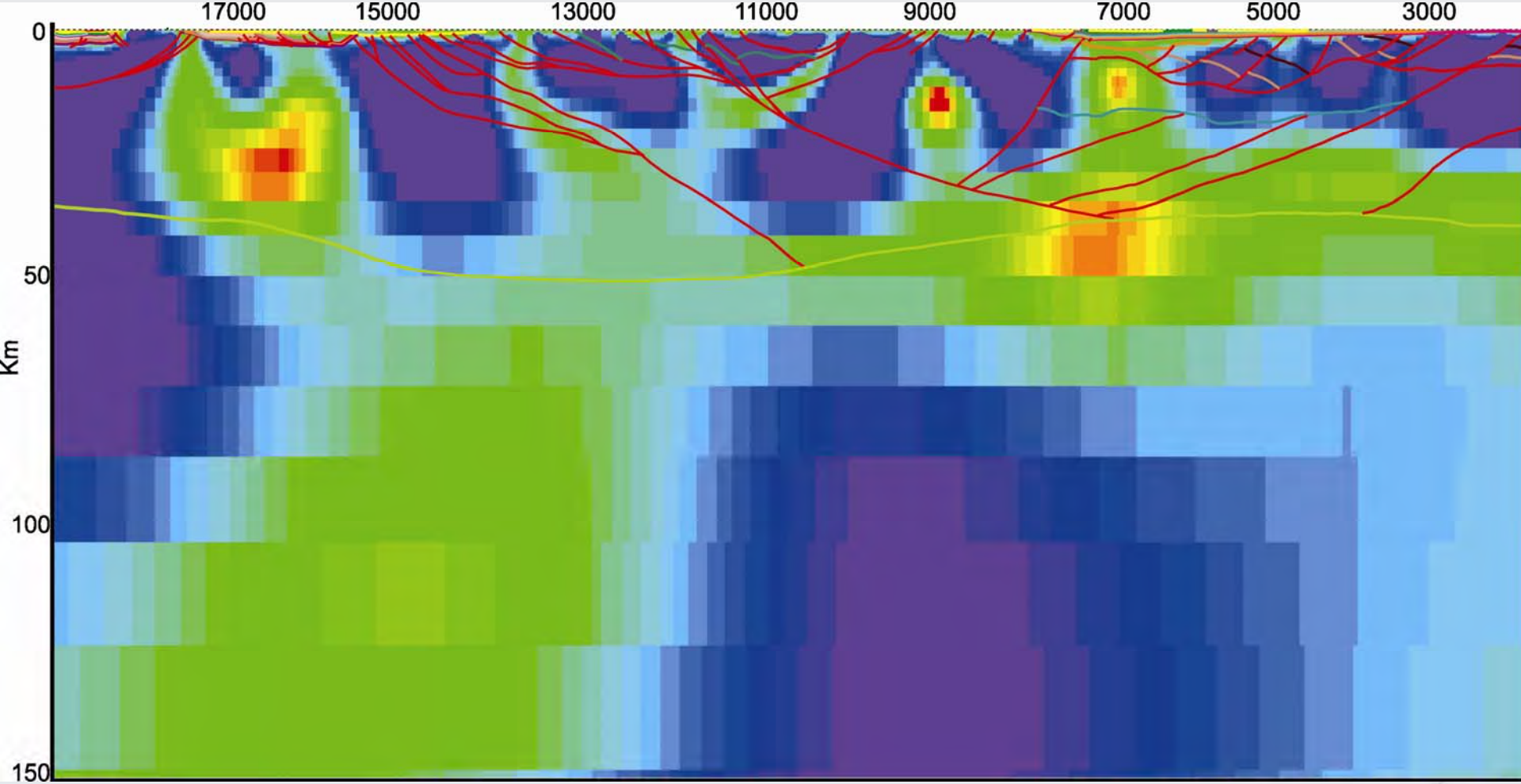

10800
8600
6400
4200
2000
0
5
10
15
20
Two-way travel time (s)
km
60
Georgina Basin
Irindina Province
Aileron Province
Davenport Province
EPSZ
DSZ
AF
Atuckera Fault
Base of Davenport Prov.
Ooratippra Seismic Province
Moho

Magnetotelluric model – to 60 km depth



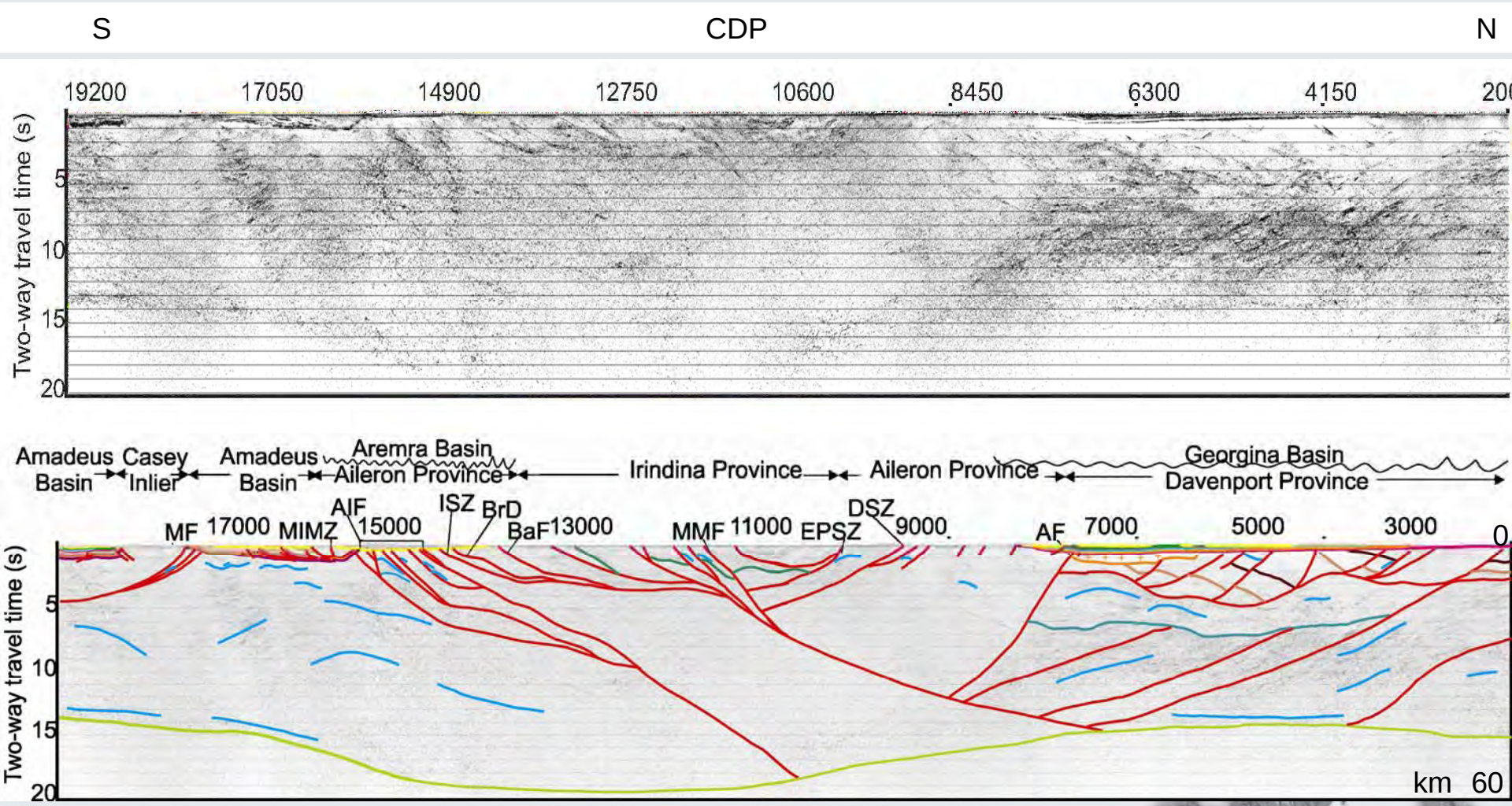


MT to 150 km depth

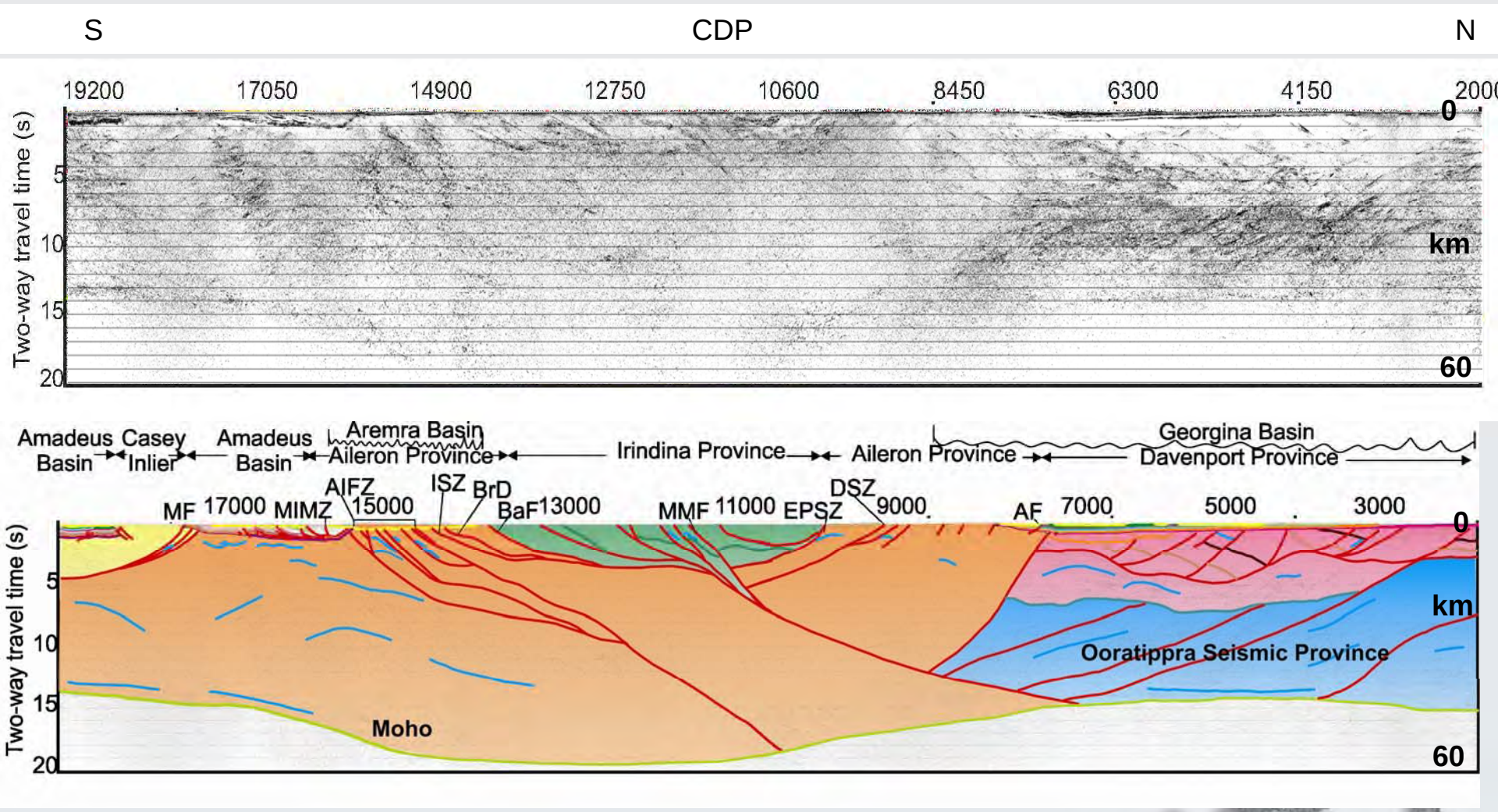


Lithosphere in south much more conductive than in the north

Interpretation of seismic line 09GA-GA1

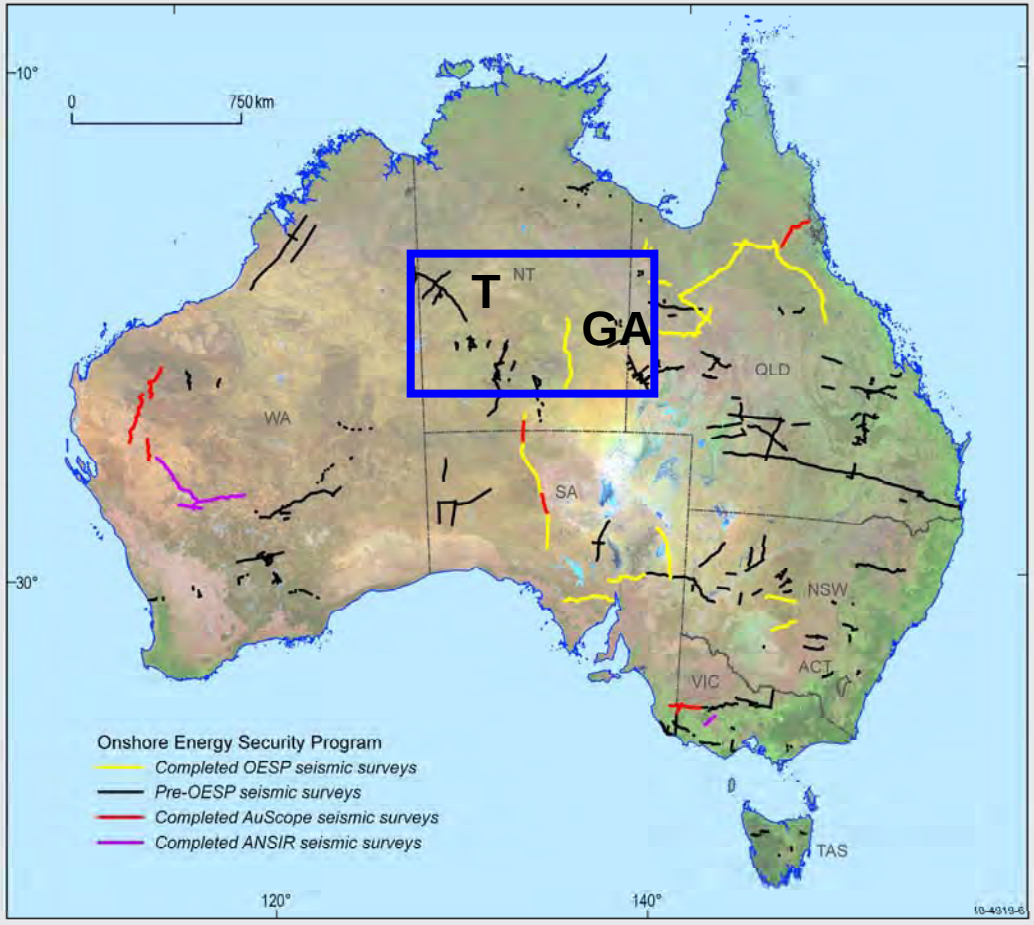


Key provinces



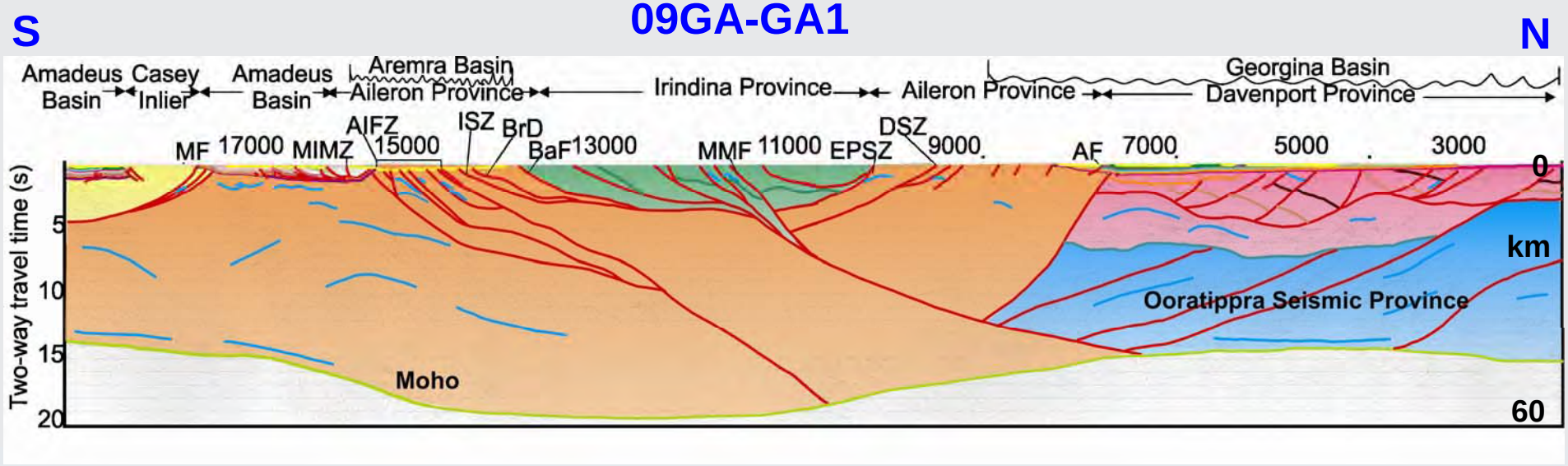
Some geodynamic implications

1. **Suture between Aileron Province and Davenport Province (Collision 1860-1840 Ma?)**

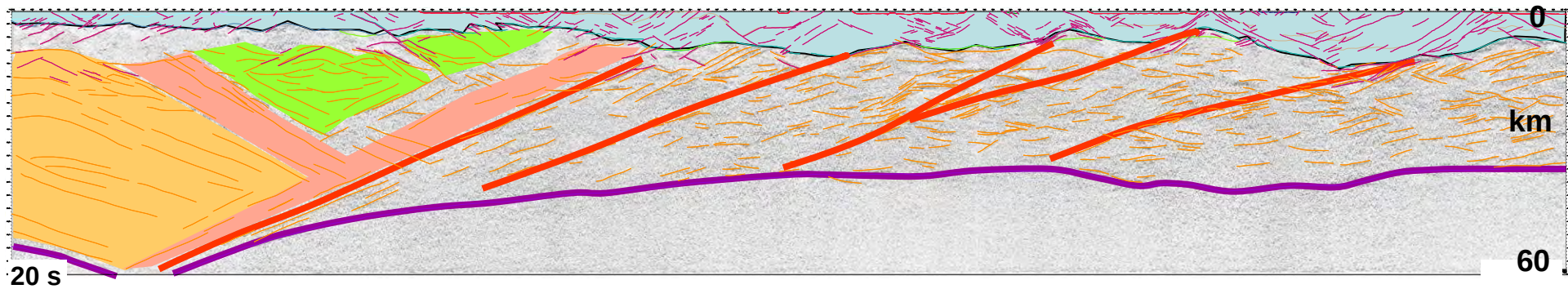


Willowra Suture – seismic evidence

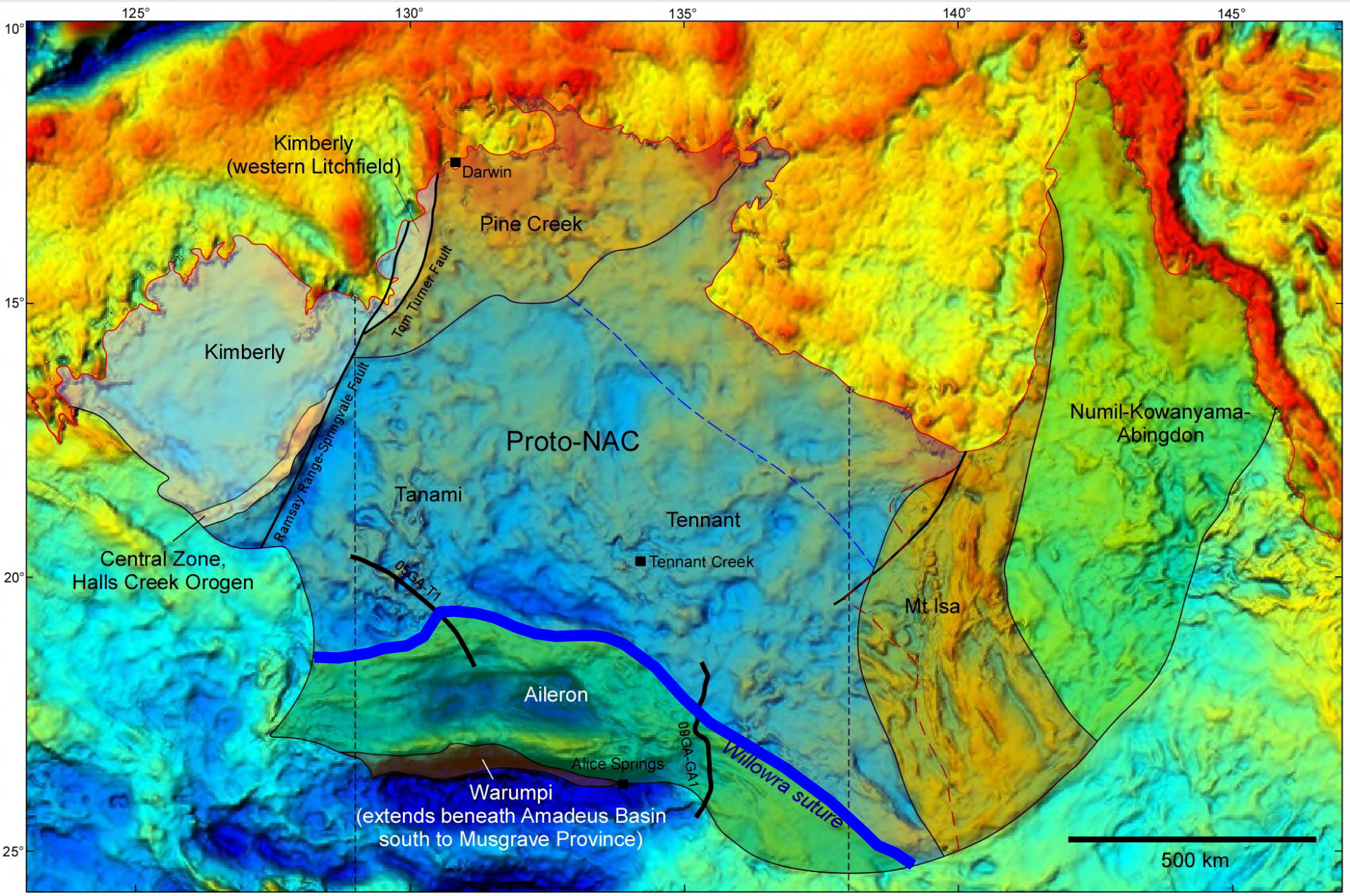
09GA-GA1



05GA-T1

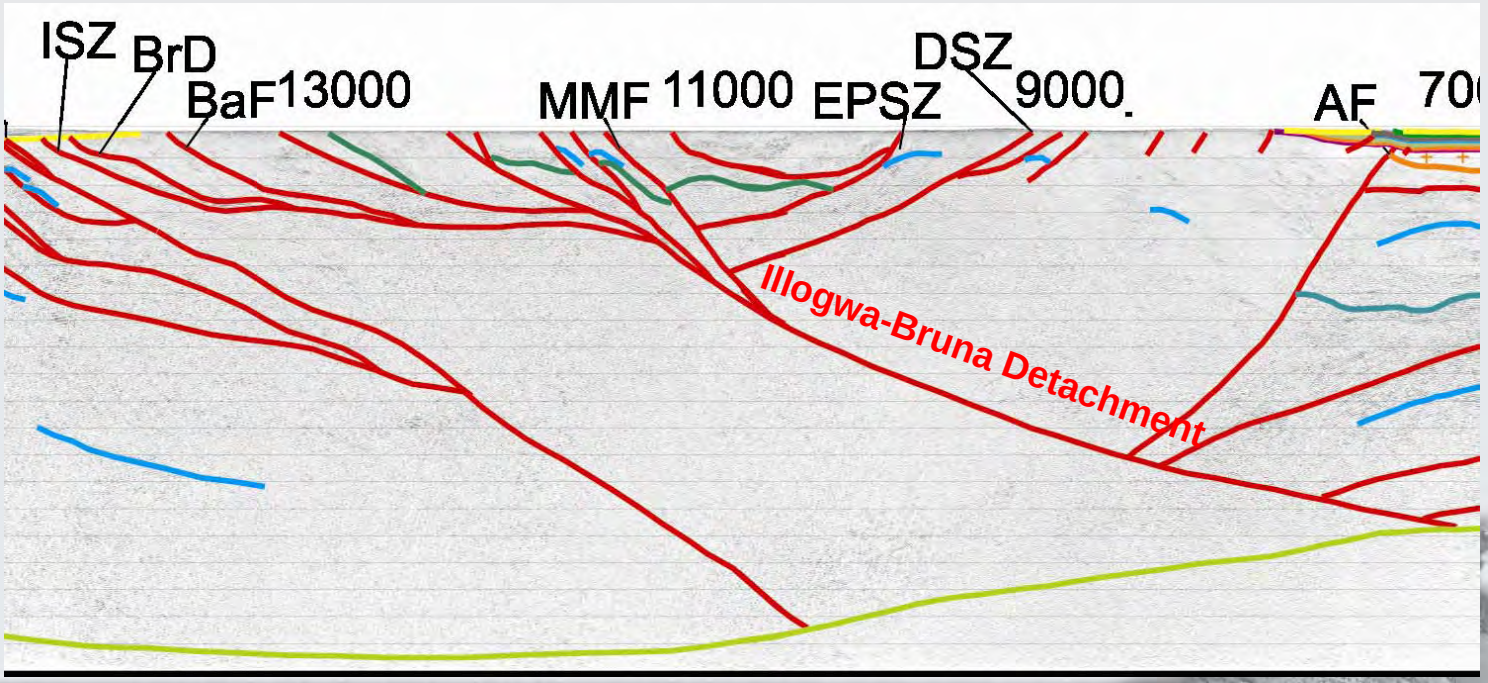


Willowra Suture – surface extent

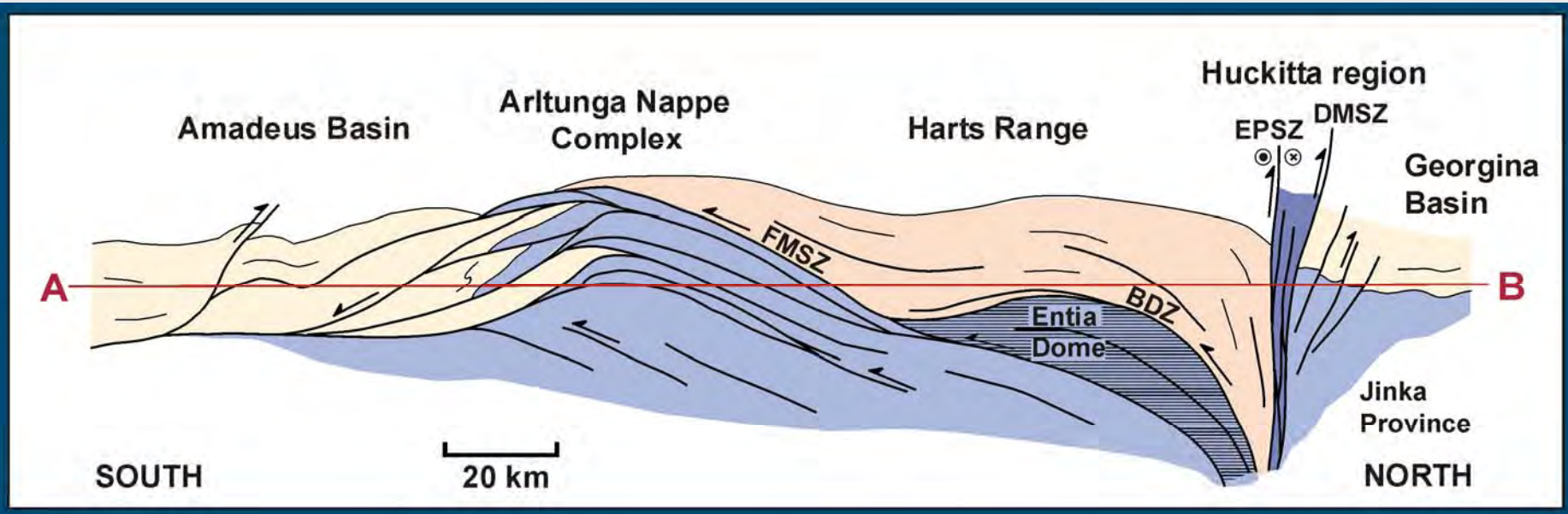


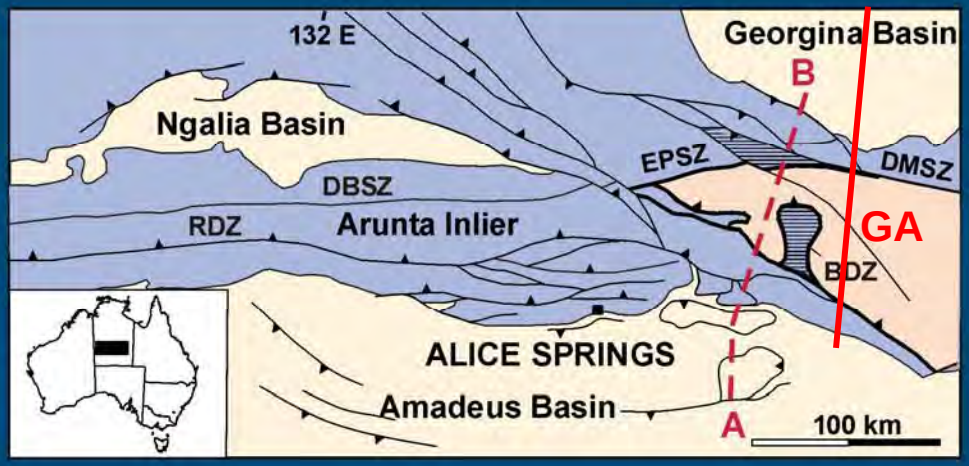
Some geodynamic implications

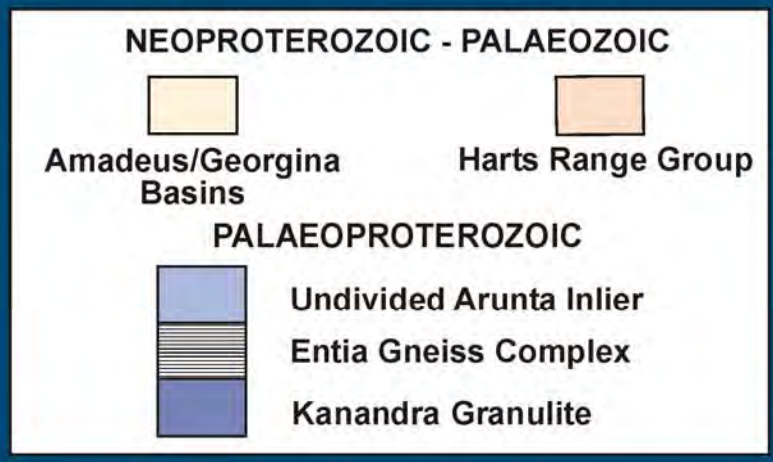
2. Irindina Province – deep extensional basin, but now a doubly-vergent orogen, with master thrust connecting to Moho (crust ~60 km thick)



Schematic cross-section - eastern Arunta
(Scrimgeour & Raith, 2001)



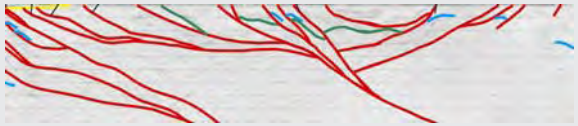




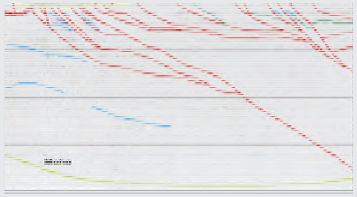
Some geodynamic implications

3. <u>Alice Springs Orogeny</u> – several different manifestations depending on crustal rheologies

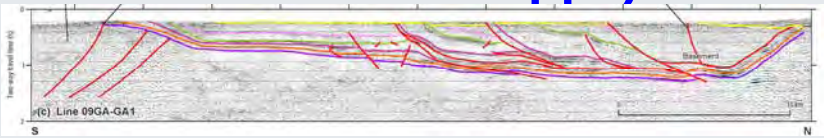
- Irindina Province – thin-skinned, doubly vergent orogen



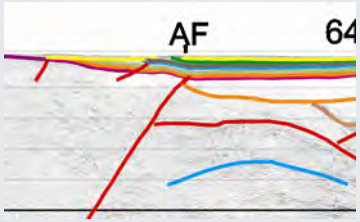
- Atnarta Imbricate Fault Zone – thick skinned



- Amadeus Basin – south-directed foreland fold-thrust belt (plus basement-cored nappe)



- Reactivation of Paleoproterozoic structures (e.g. Atuckera Fault)



Summary

- 09GA-GA1 – image of whole of crust
- Five distinct provinces – Casey, Aileron, Irindina, Davenport, Ooratippra Seismic Province
- Major, crustal-scale faults
- Amalgamation of crustal blocks in Paleoproterozoic
- Extension in Neoproterozoic to early Paleozoic, followed by intense shortening and basin inversion


That's All, Folks!