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Deep seismic reflection transect from the western Eyre Peninsula in South Australia to the Darling Basin in NSW: Geodynamic implications

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136°E

138°E

140°E

142°E

SRTM - DEM

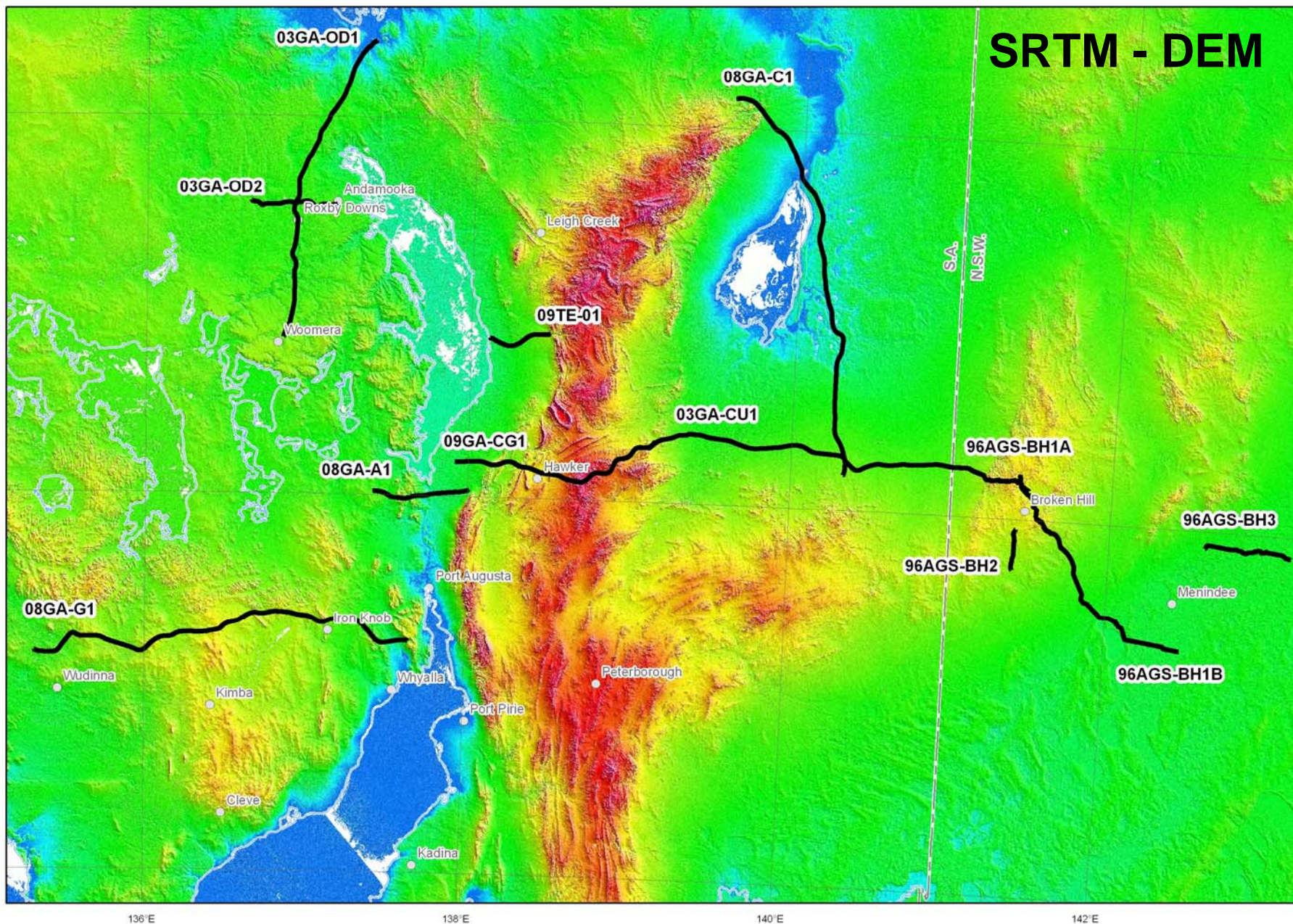
30°S

30°S

32°S

32°S

34°S



136°E

138°E

140°E

142°E

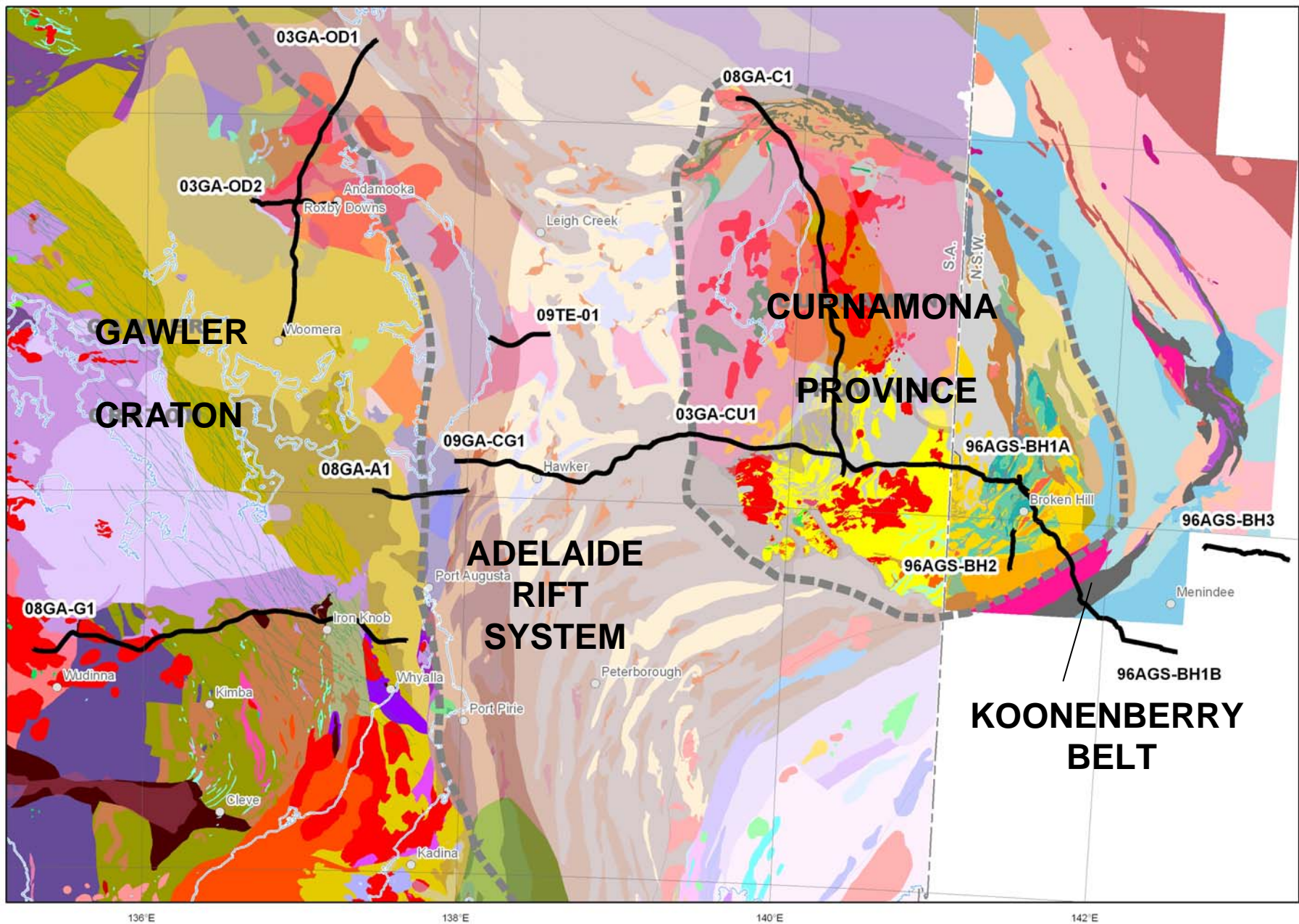
30°S

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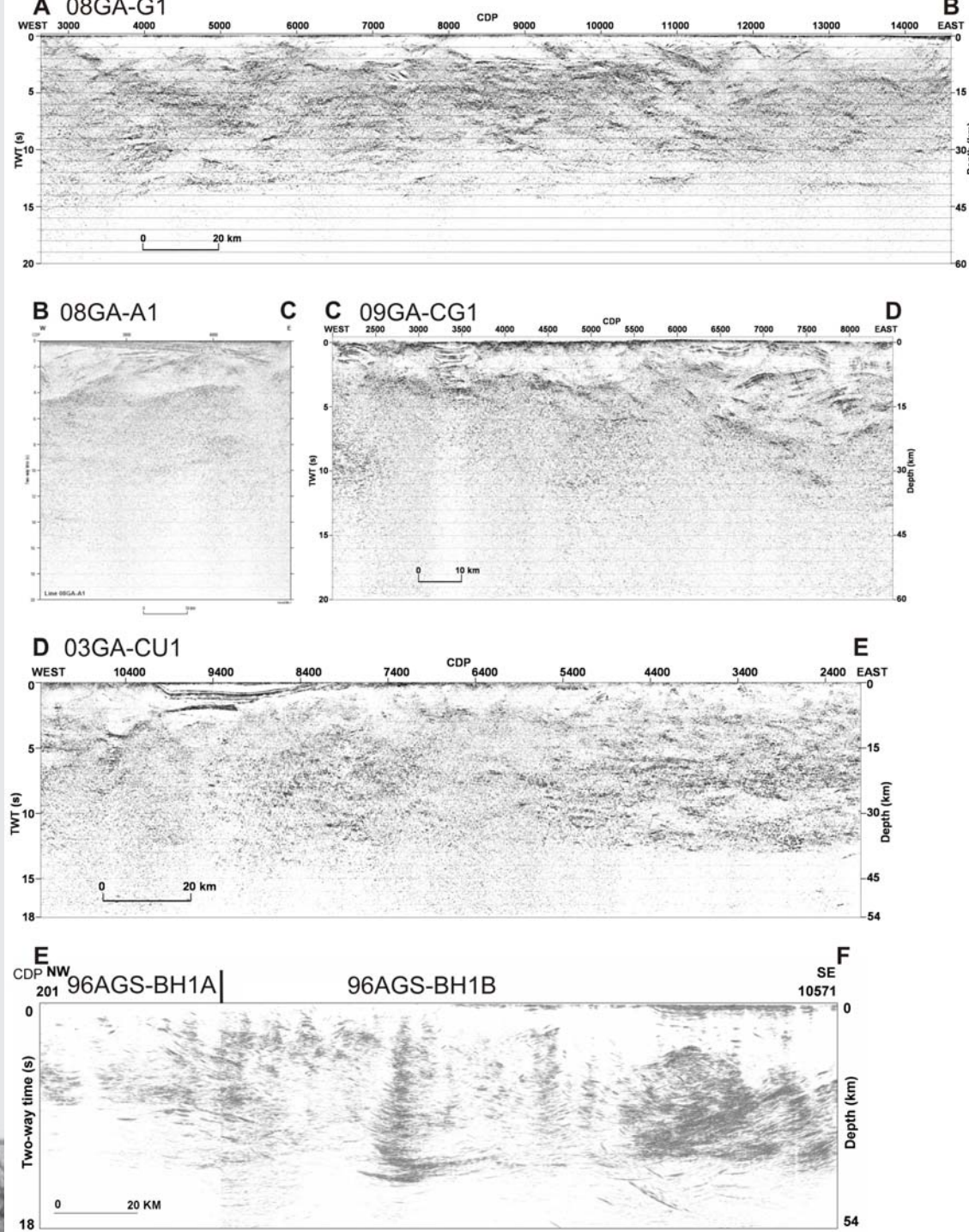
32°S

34°S



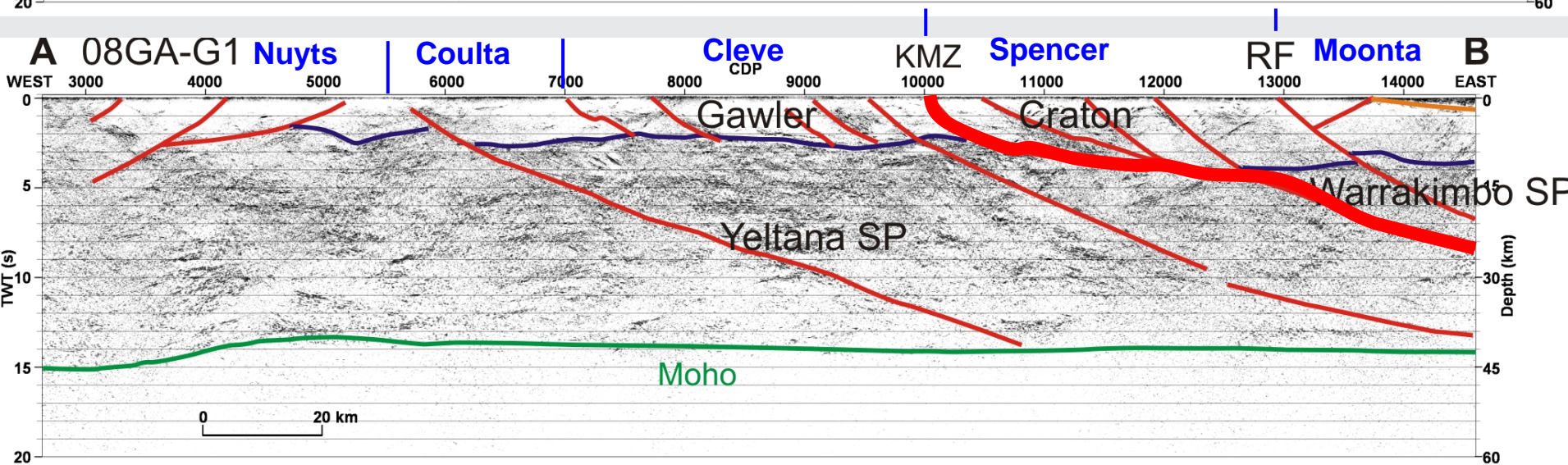
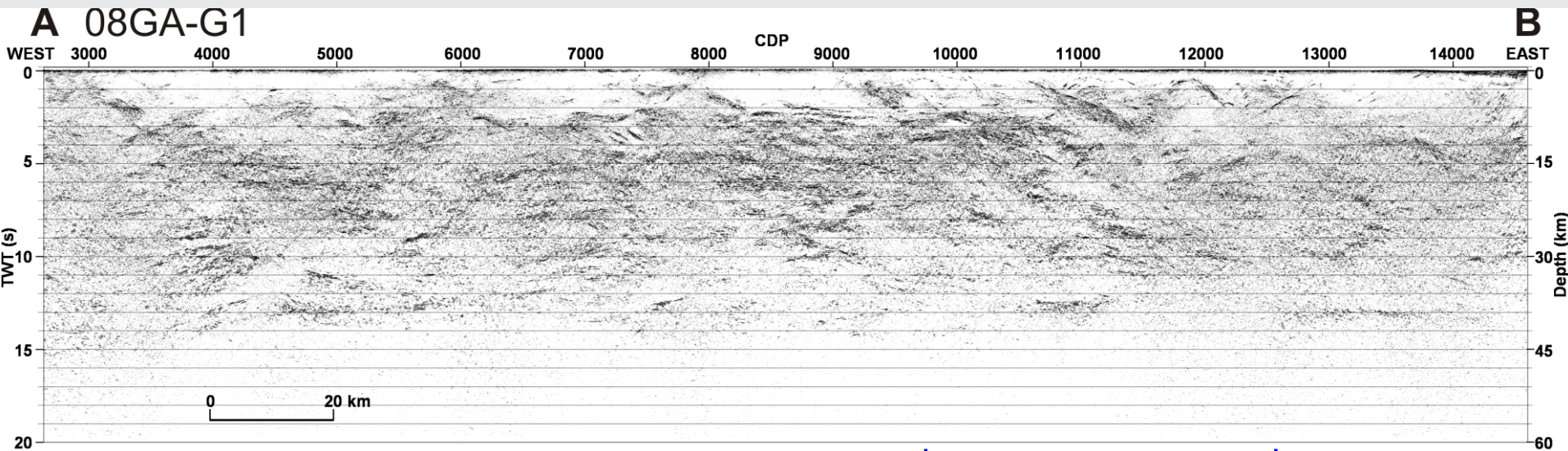
Components of Traverse

- Six seismic sections
- Different vintages (1996 to 2009)
- Dynamite source (low fold) v. Vibroseis source (higher fold)
- Different display parameters (migration; semblance filtering)



Seismic Line 08GA-G1

Gawler Line

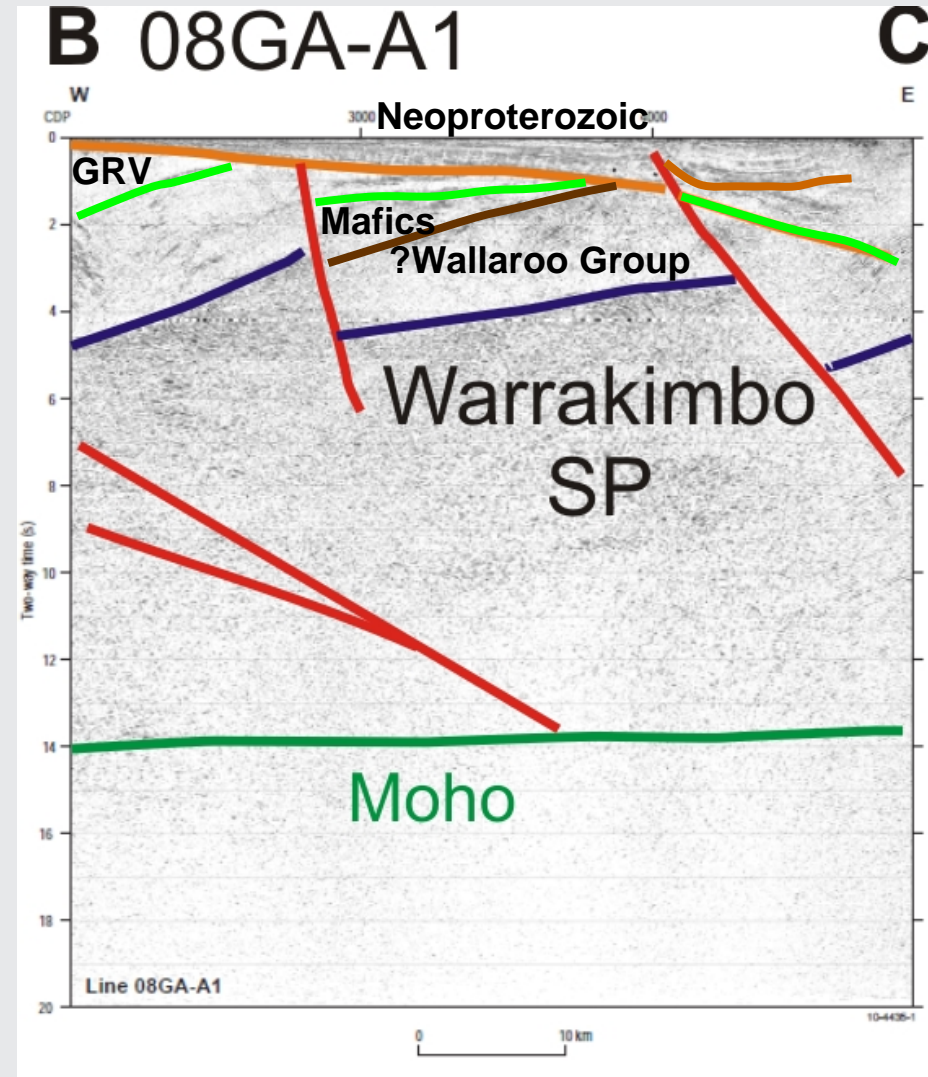
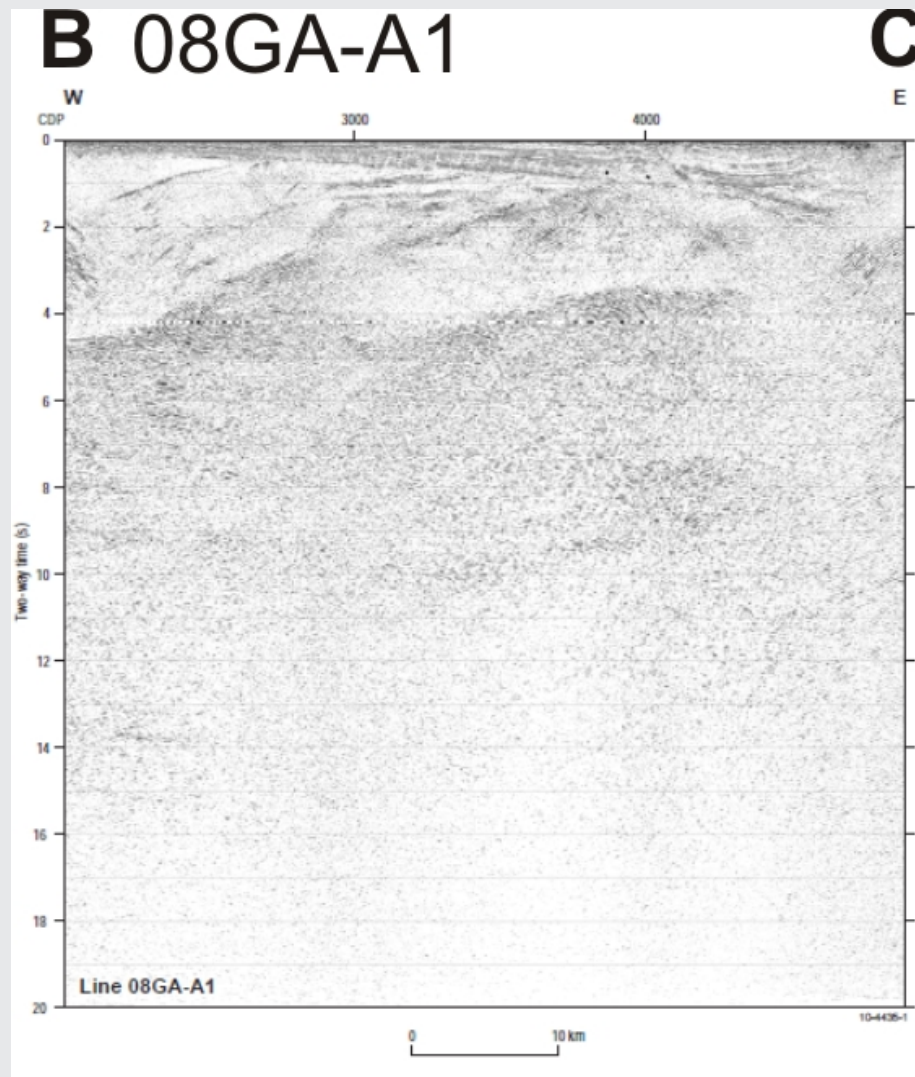


Seismic Line 08GA-G1

- Moho defined as base of reflections above nonreflective upper mantle
- Reflective middle to lower crust (Yeltana Seismic Province)
- Weakly reflective upper crust
- Mainly east-dipping faults
- Kalinjala Mylonite Zone
 - boundary between the Cleve and Spencer Domains
 - crustal-scale, east-dipping fault zone
 - separates upper crust of different seismic character (fast velocity rocks closer to surface to east of fault)

Seismic Line 08GA-A1

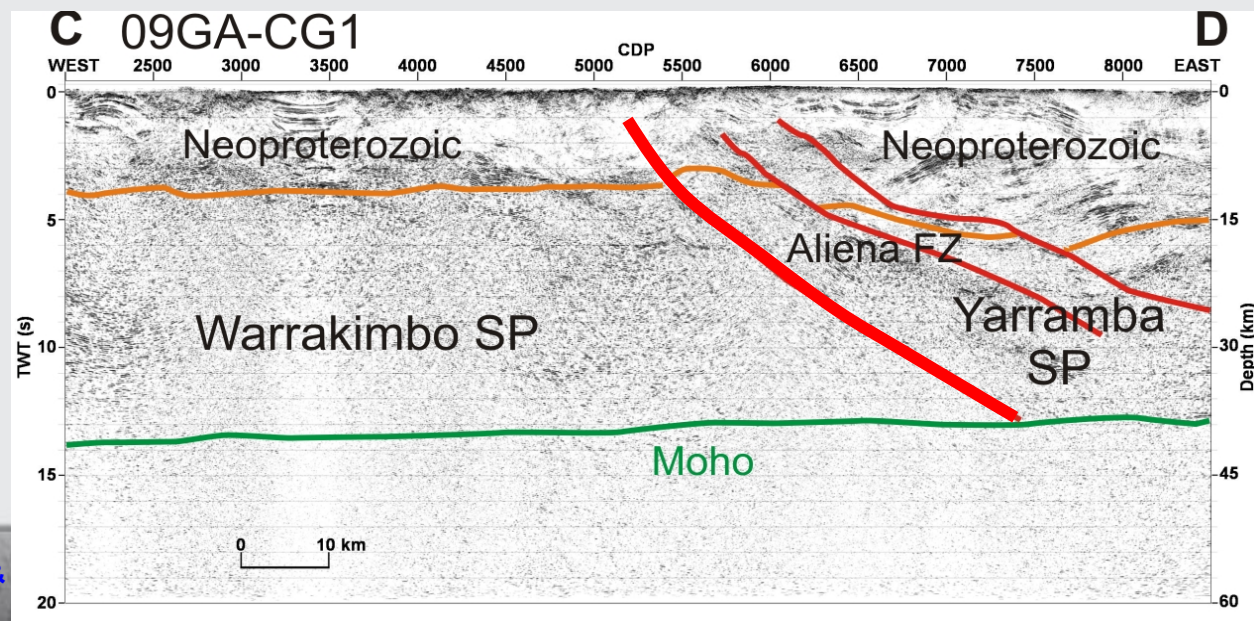
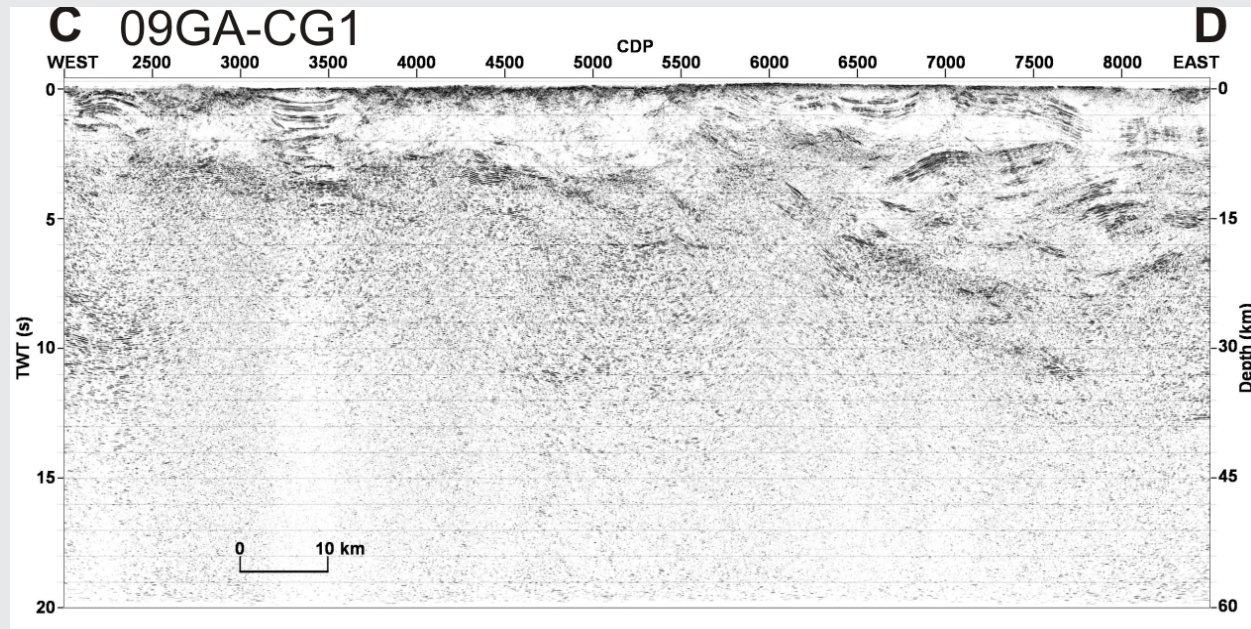
Arrowie Basin Line



Seismic Line 08GA-A1

- Moho poorly defined
- Warrakimbo Seismic Province
 - forms middle and lower crust
 - reflective upper surface
 - intensity of reflectivity decreases downwards
- ?Wallaroo Group (weakly reflective) (up to 9 km thick) ± Hiltaba granites
- Gawler Range Volcanics
- Neoproterozoic basin – thickens to east

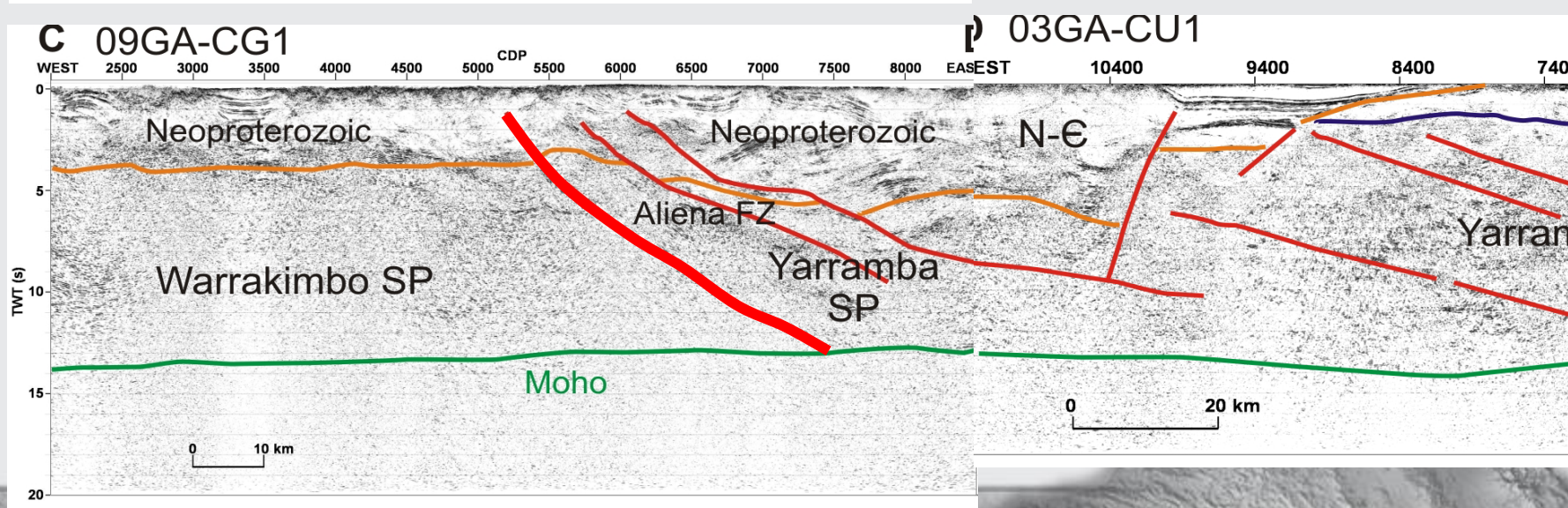
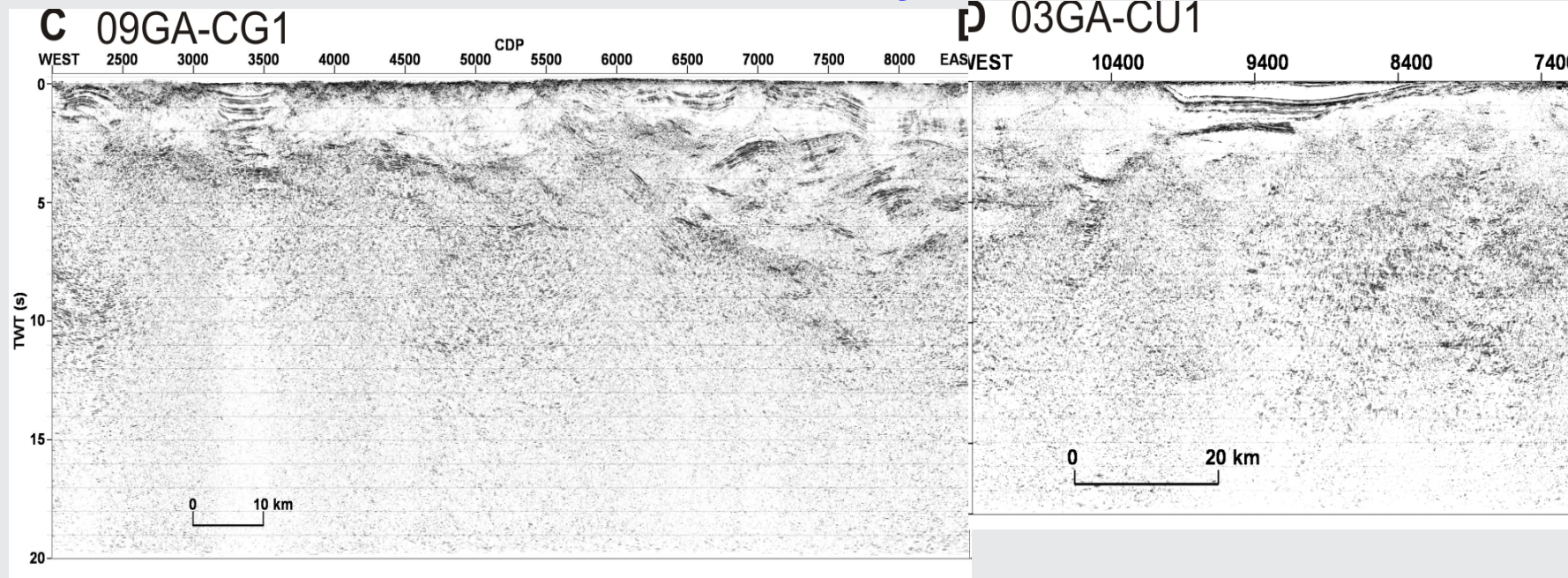
09GA-CG1 – Curnamona-Gawler Link Line



Seismic Line 09GA-CG1

- Moho very poorly defined
- Middle to lower crust poorly reflective
(Warrakimbo Seismic Province)
- Crustal-penetrating, east-dipping fault zone
(Aliena Fault Zone)
- Absence of inferred Wallaroo Group on this section
- Neoproterozoic basin

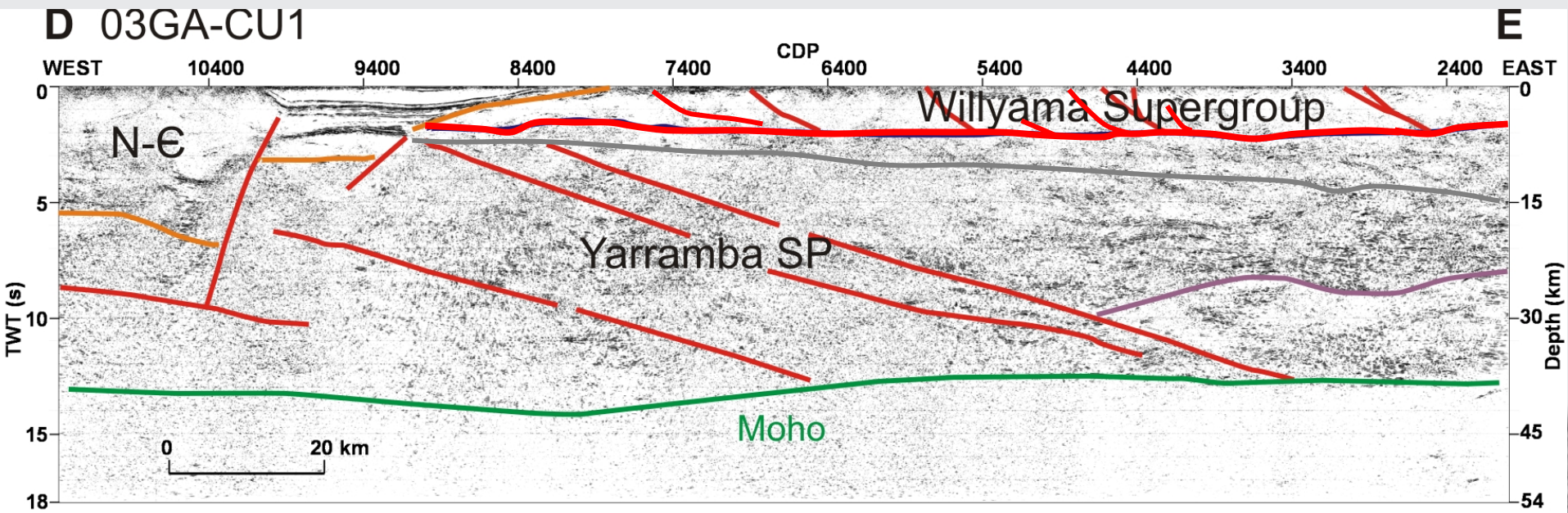
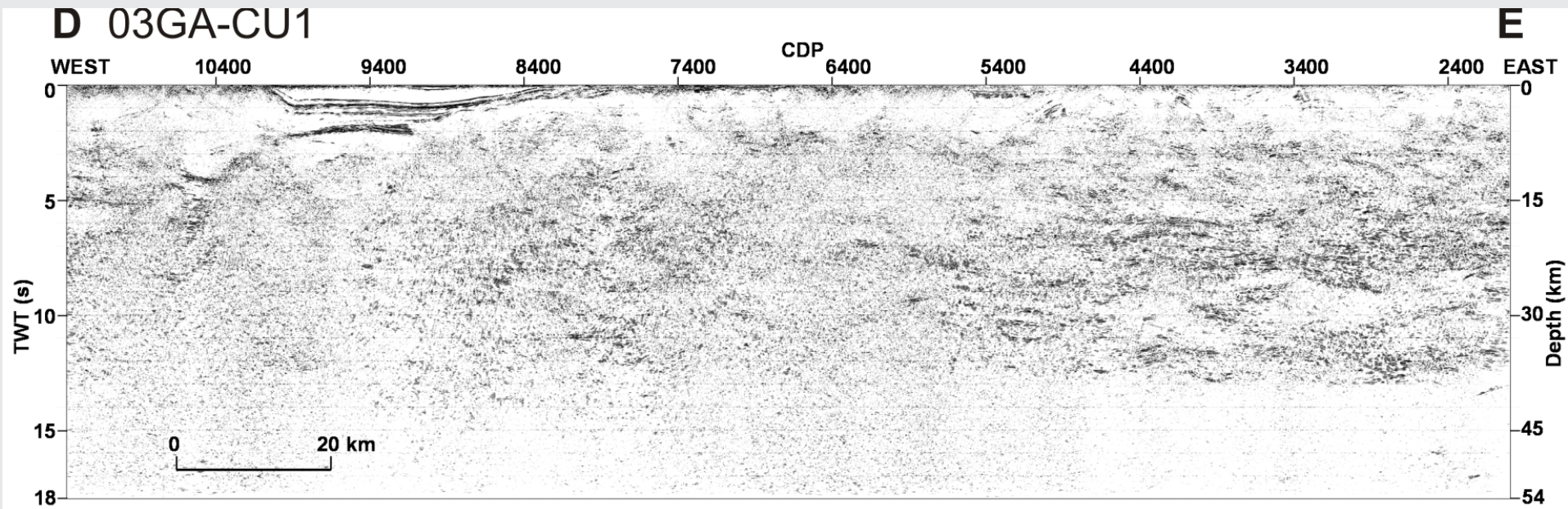
Adelaide Rift System



Adelaide Rift System

- Very thick Neoproterozoic succession in middle (>15 km)
- Aliena Fault Zone (boundary between Warrakimbo and Yarramba Seismic Provinces) reactivated as extensional basin-bounding fault zone
- Delamerian deformation (strain partitioning – no deformation in east)

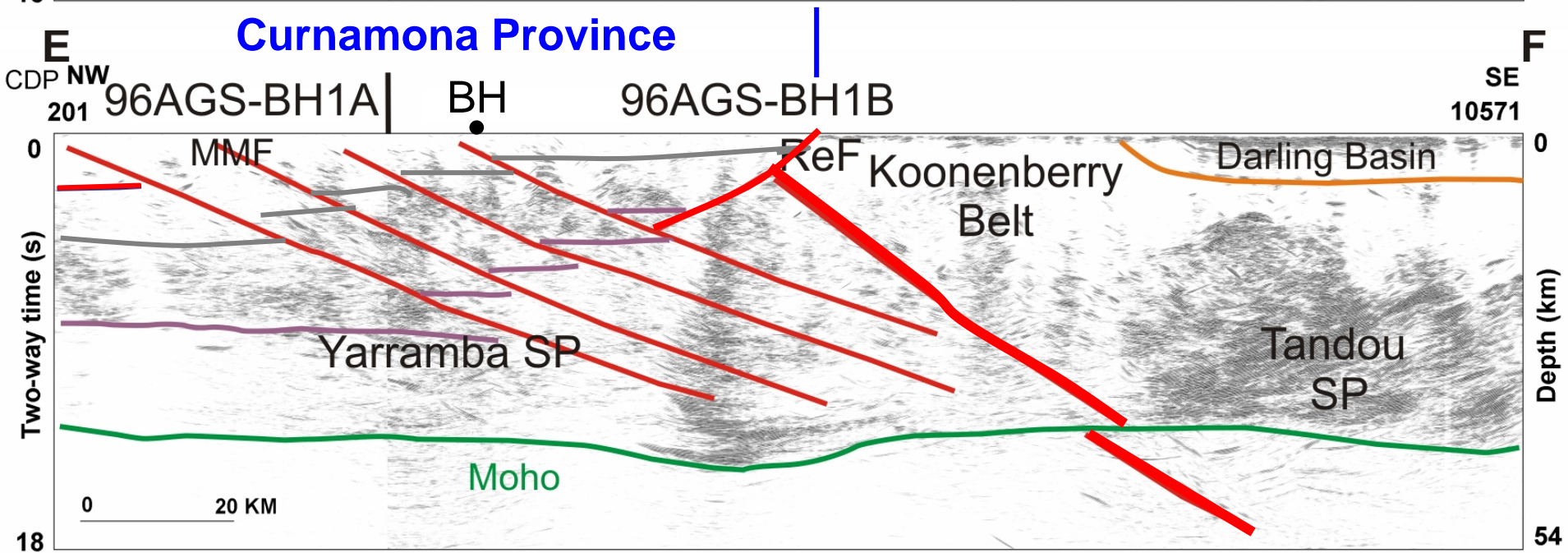
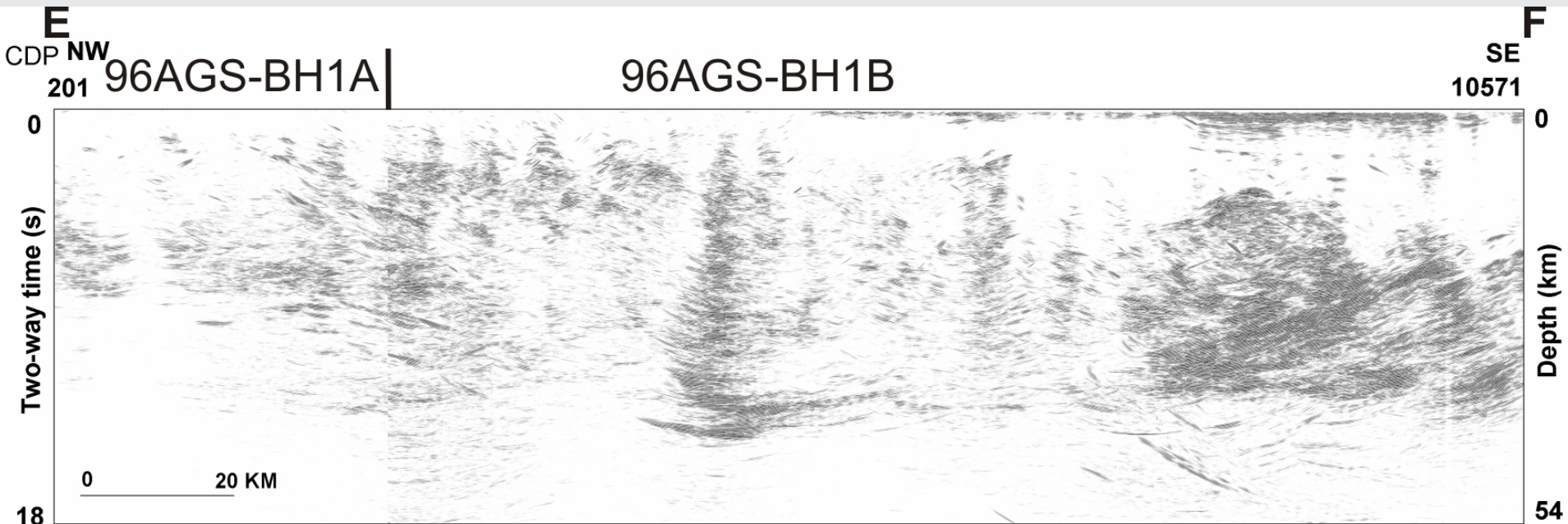
Seismic Line 03GA-CU1 – Curnamona Line



Seismic Line 03GA-CU1

- Moho well defined (in east)
- Reflective middle to lower crust - subhorizontal layering (Yarramba Seismic Province)
- Willyama Supergroup
- Upper crustal, thin-skinned thrust belt (westward-propagating)
- Neoproterozoic-Cambrian basins

Seismic Lines 96AGS-BH1A & 96AGS-BH1B



Seismic Lines 96AGS-BH1A & 96AGS-BH1B

- Moho reasonably well defined
- Middle to lower crustal reflectivity in western 2/3 (Yarramba Seismic Province) differs to eastern 1/3 (Tandou Seismic Province)
- Curnamona Province: thick-skinned crustal-scale shear zones (bring granulites to surface)
- Redan Fault - southeast limit of Curnamona Province at surface

136°E

138°E

140°E

142°E

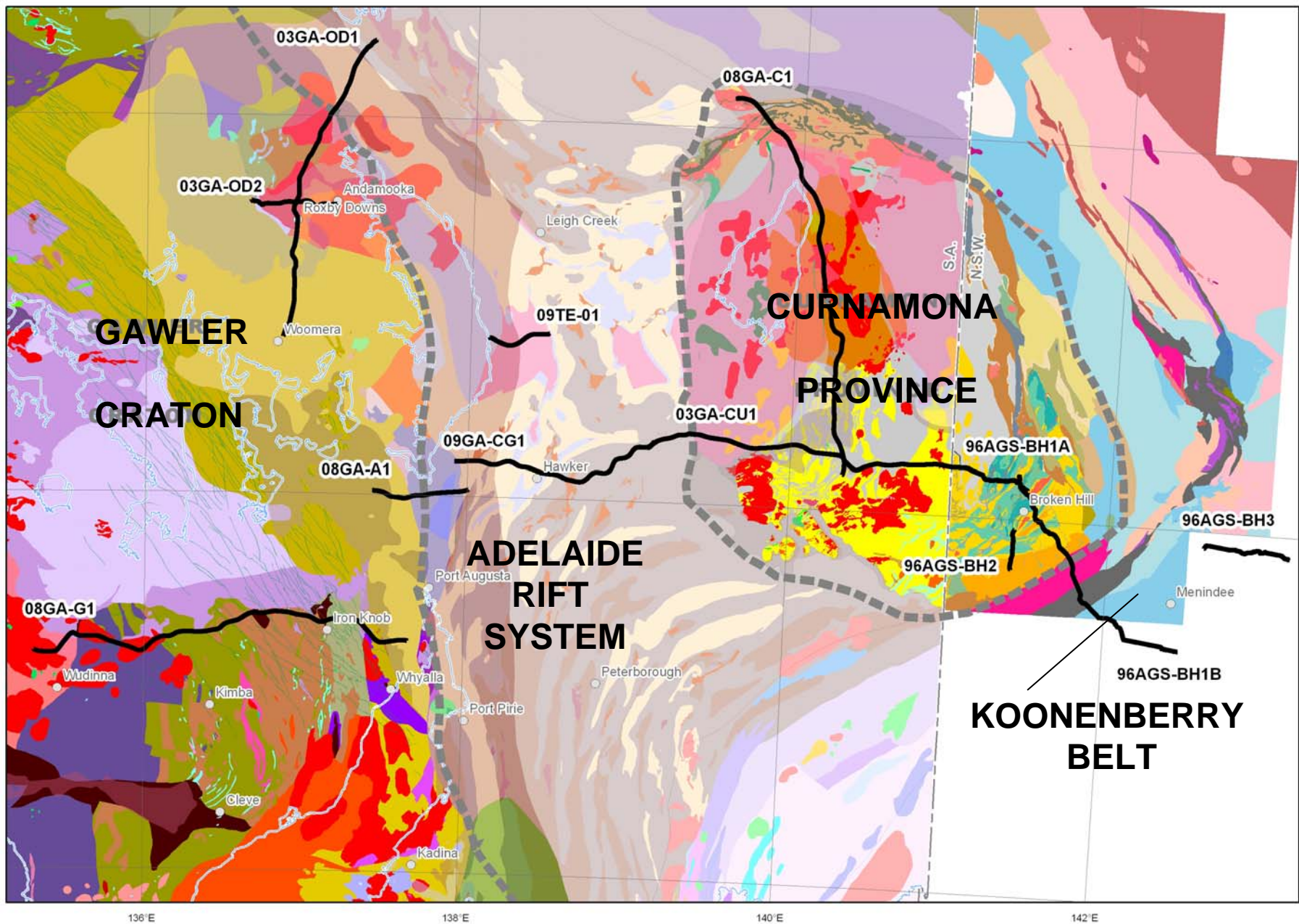
30°S

30°S

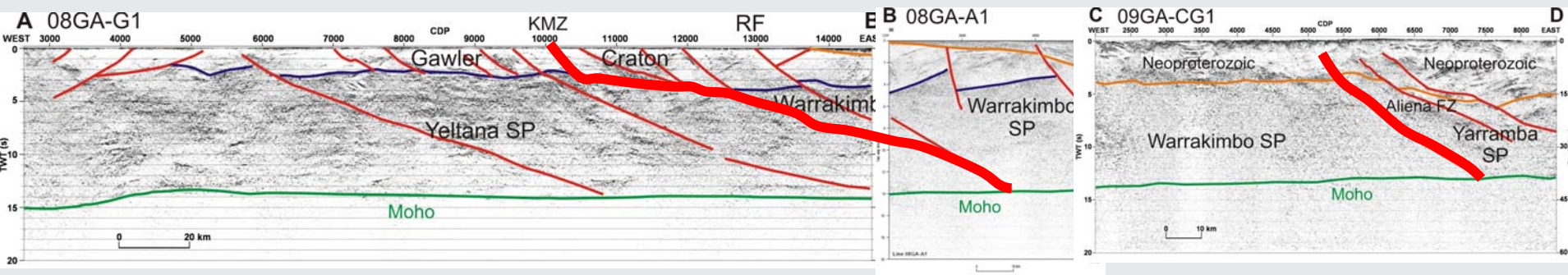
32°S

32°S

34°S

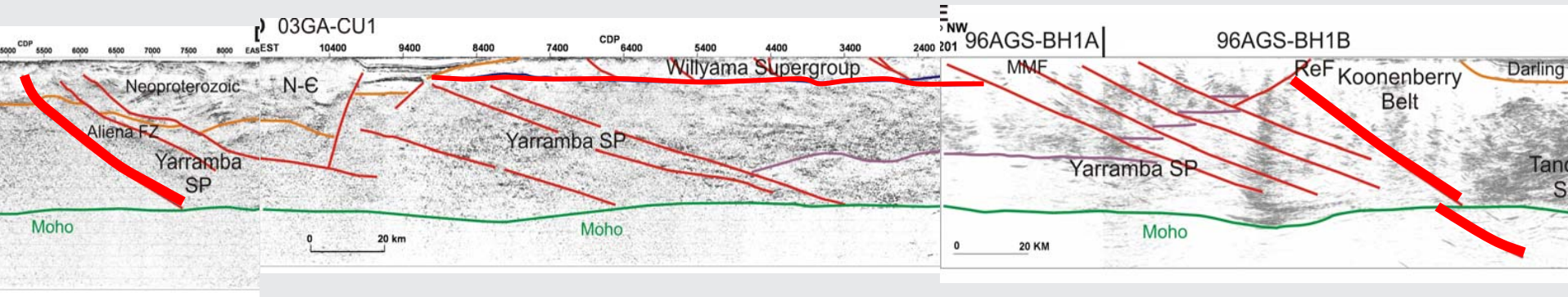


Yeltana and Warrakimbo Seismic Provinces



- Middle and lower crust not tracked to the surface
- Yeltana Seismic Province – west of Kalinjala Mylonite Zone
 - Reflective crust
- Warrakimbo Seismic Province - east of Kalinjala Mylonite Zone
 - Much less reflectivity than to west

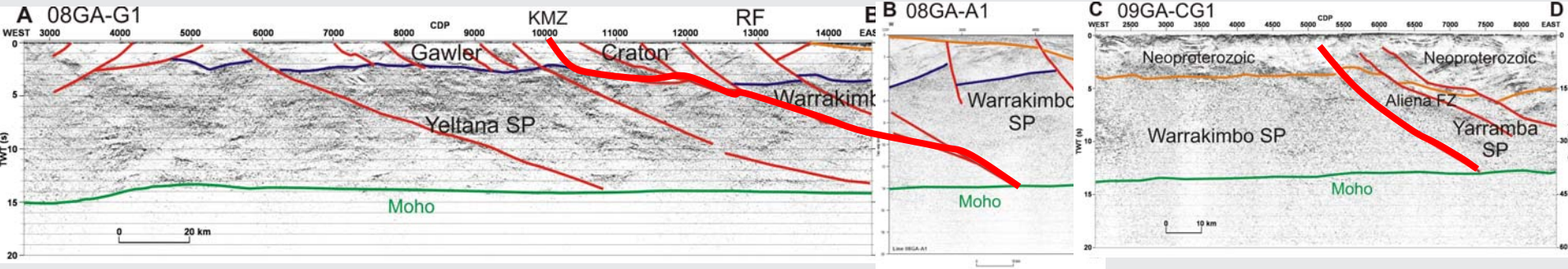
Yarramba Seismic Province



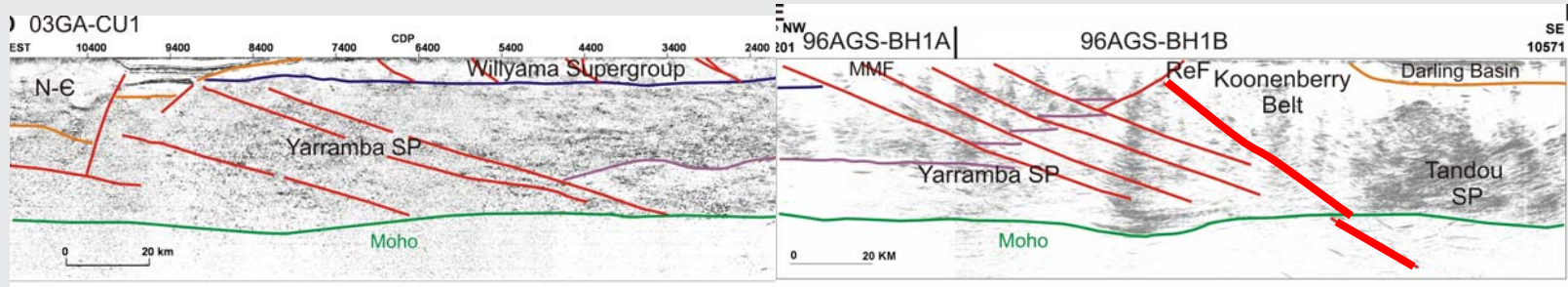
- Yarramba Seismic Province underlies eastern Flinders Ranges and Curnamona Province
- Upper crust (Curnamona Province) dominated by linked, northwest-propagating thick-skinned and thin-skinned thrust belts (core of orogen in east)
 - Similar to retroforeland thrust belts in Phanerozoic orogenic settings (driven by push from east or southeast)

Eyre Peninsula-Darling Basin Transect

West

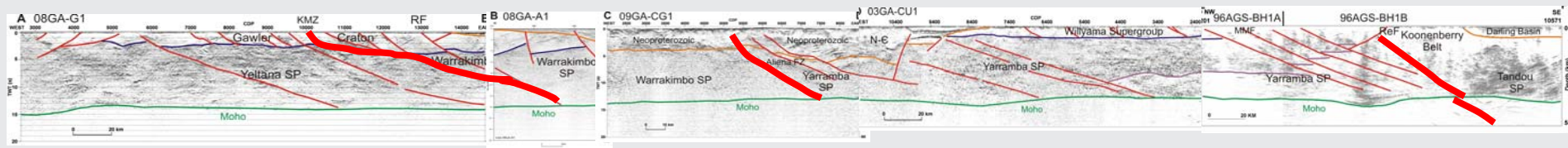


X



East

Eyre Peninsula-Darling Basin Transect



Yeltana

Warrakimbo

Yarramba

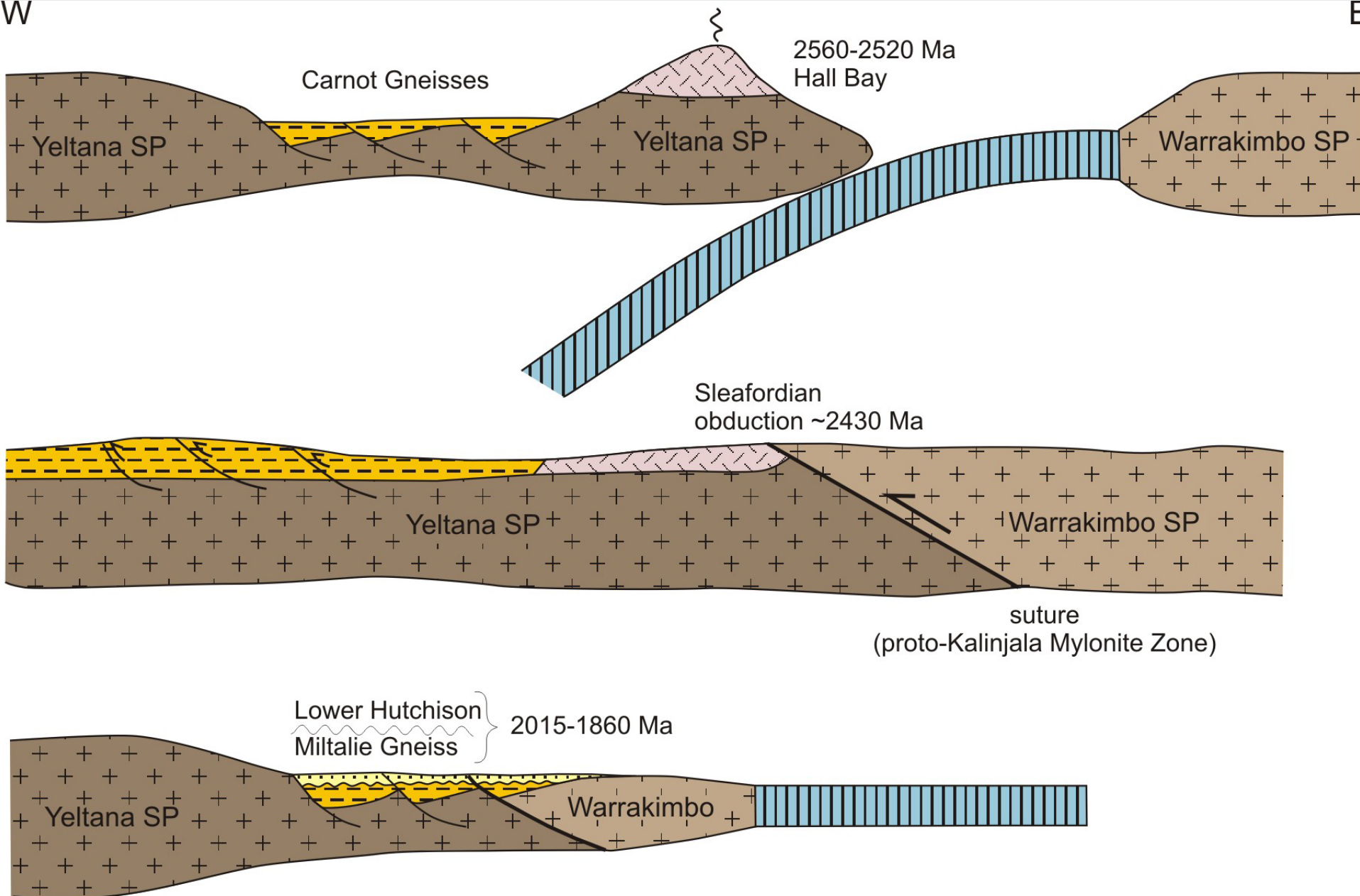
Tandou

- Transect dominated by east-dipping, crustal scale faults
- Four middle to lower crustal seismic provinces (based on character of reflectivity)
- Upper crustal faults – often early extensional faults
 - Commonly reactivated later as thrusts
- How was the crust in this region assembled?

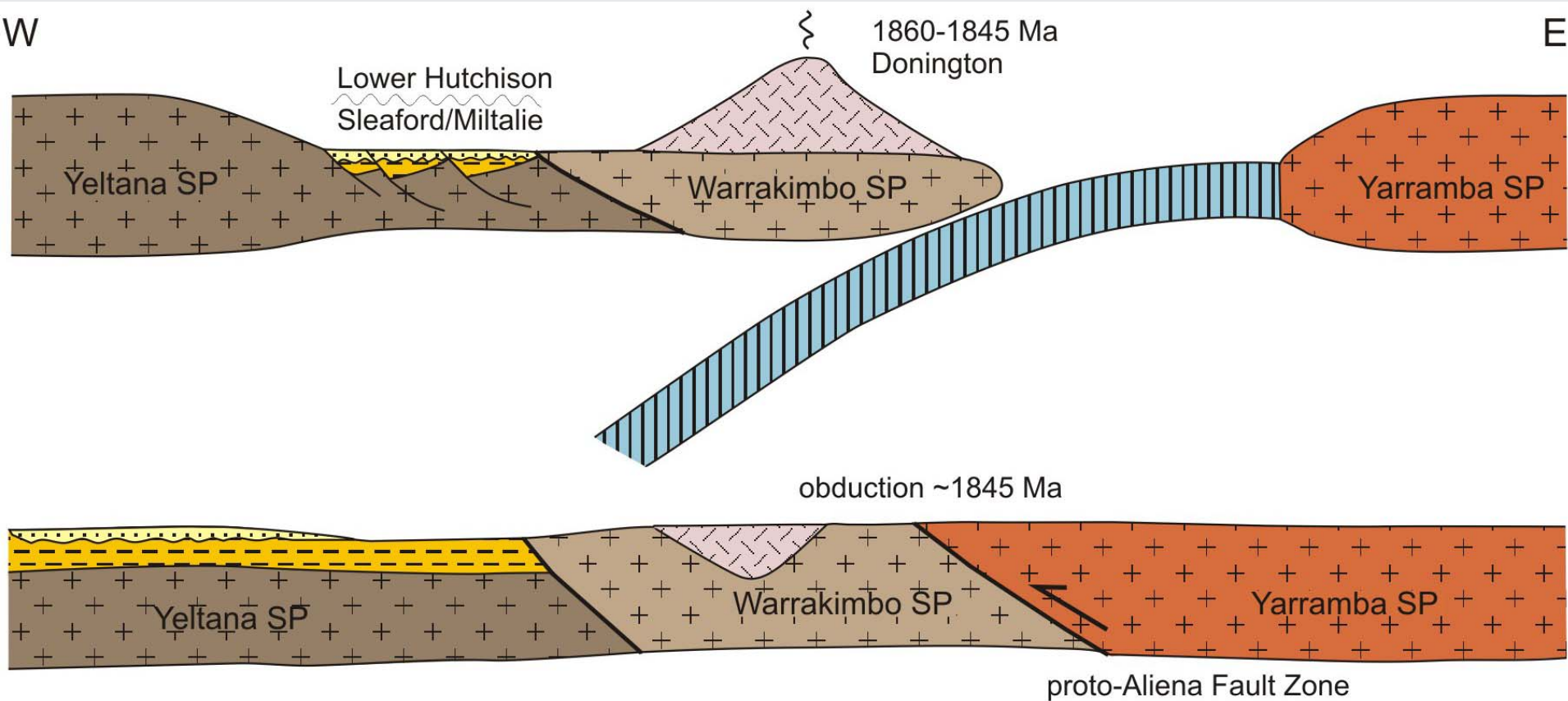
~2560-~1860 Ma

W

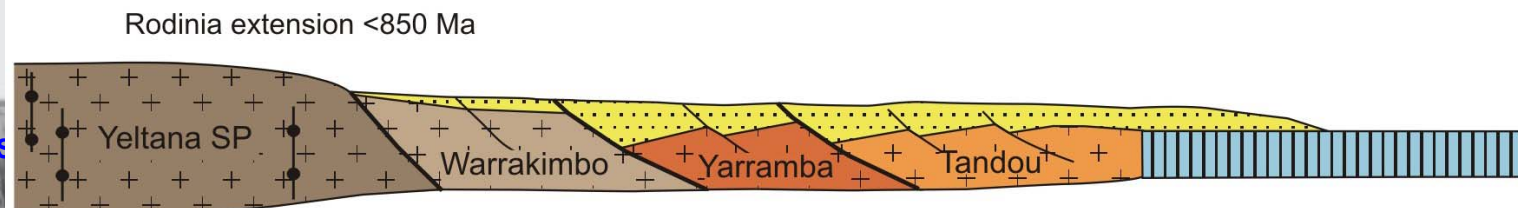
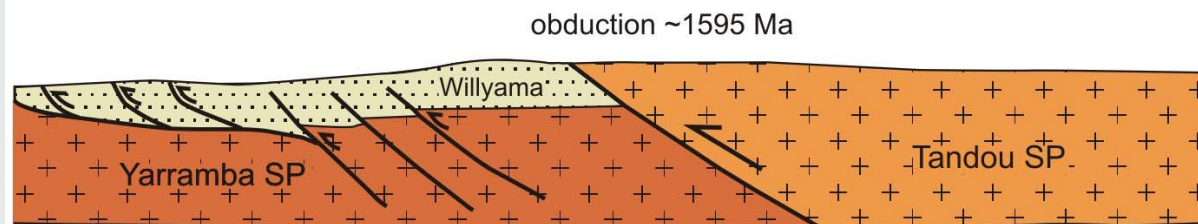
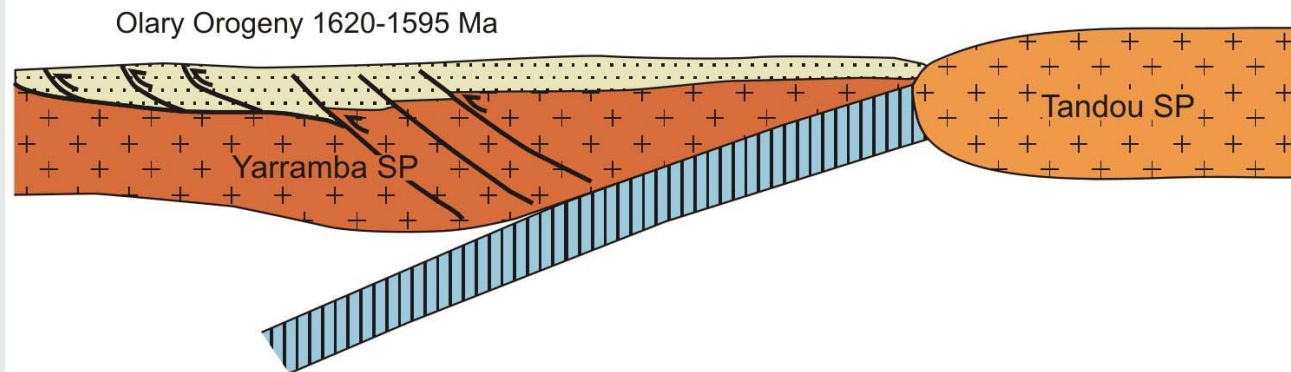
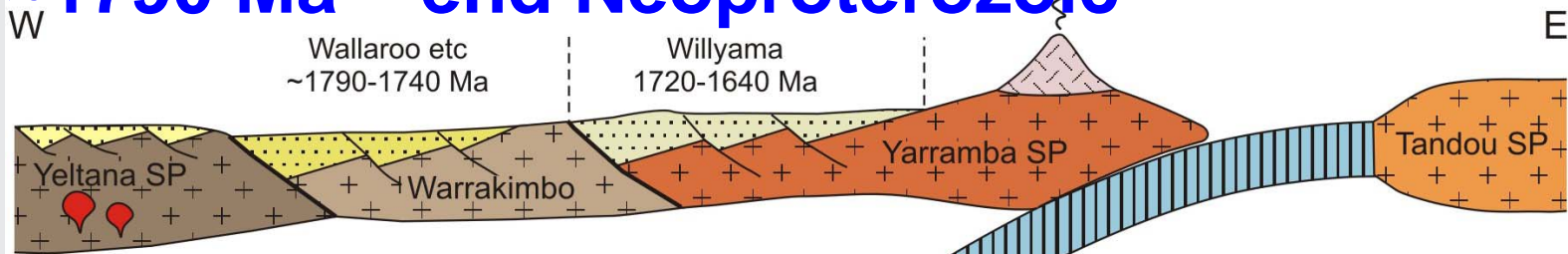
E



~1860-~1840 Ma

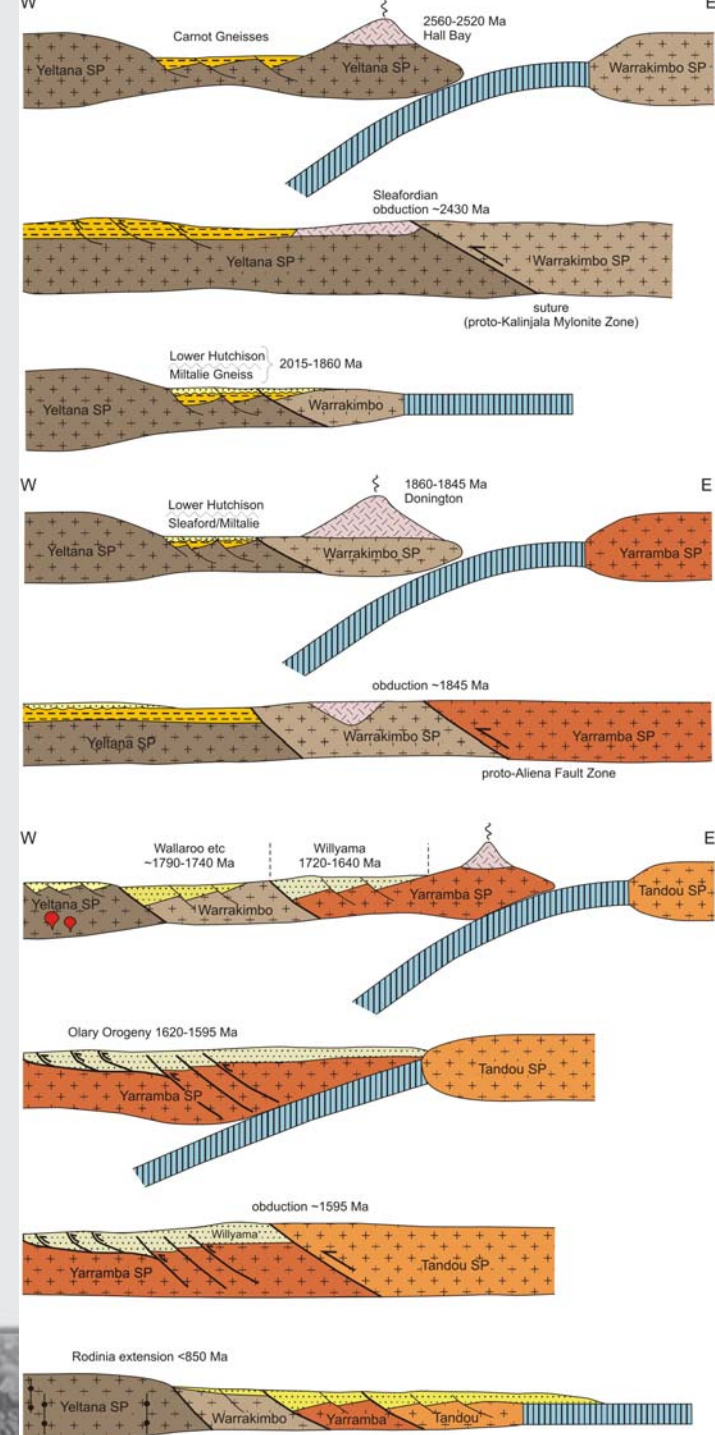


~1790 Ma – end Neoproterozoic



Southeast South Australian Craton

- Growth of SAC by accretion of three seismic provinces to eastern margin through time



Summary

- 870 km long east-west transect imaging whole of crust
- Four discrete seismic provinces recognised in middle to lower crust
 - All bounded by east-dipping, crustal-penetrating fault zones
 - Probably extend to Moho
 - very different seismic reflectivity to adjacent seismic province
 - each is a unique piece of middle to lower crust
 - with different geological history and structural architecture
- ?Eastward accretion to build the South Australian Craton through time
- Upper crust dominated by east-dipping faults
 - some are early extensional faults, later thrust reactivation
 - Thin-skinned and thick-skinned thrusts

Acknowledgements:

Natalie Kositcin

Tanya Fomin, Daniel Connolly, Malcolm Nicoll

Lindsay Highet

Seismic data available at:

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