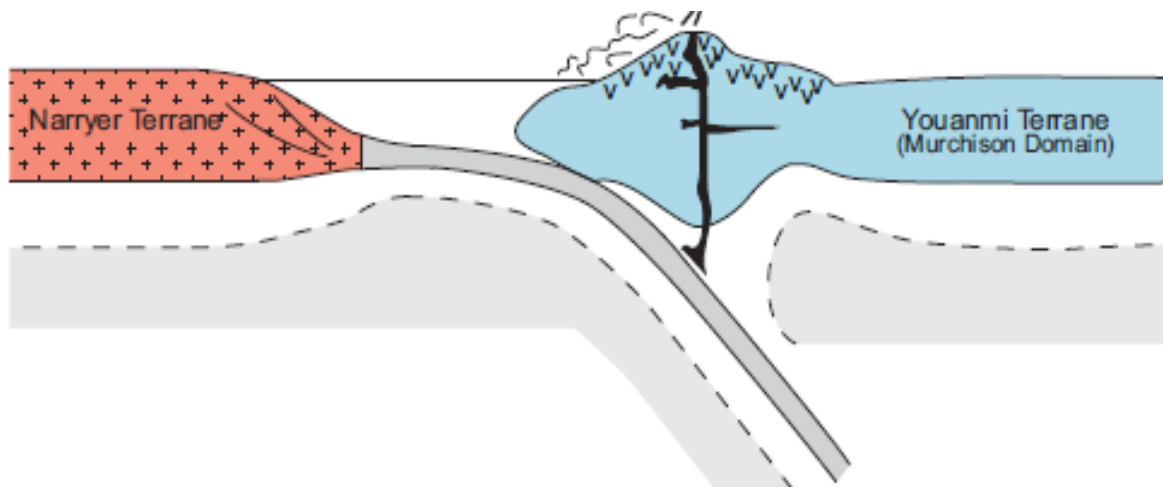




Geodynamic implications of the Youanmi and Southern Carnarvon deep seismic surveys

Russell Korsch, R Blewett, S Wyche, I Zibra, T Ivanic, M Doublier, S Romano, M Pawley, S Johnson, M Van Kranendonk, L Jones, N Kositcin, K Gessner, C Hall, S Chen, N Patison, B Kennett, T Jones, J Goodwin, P Milligan & R Costelloe

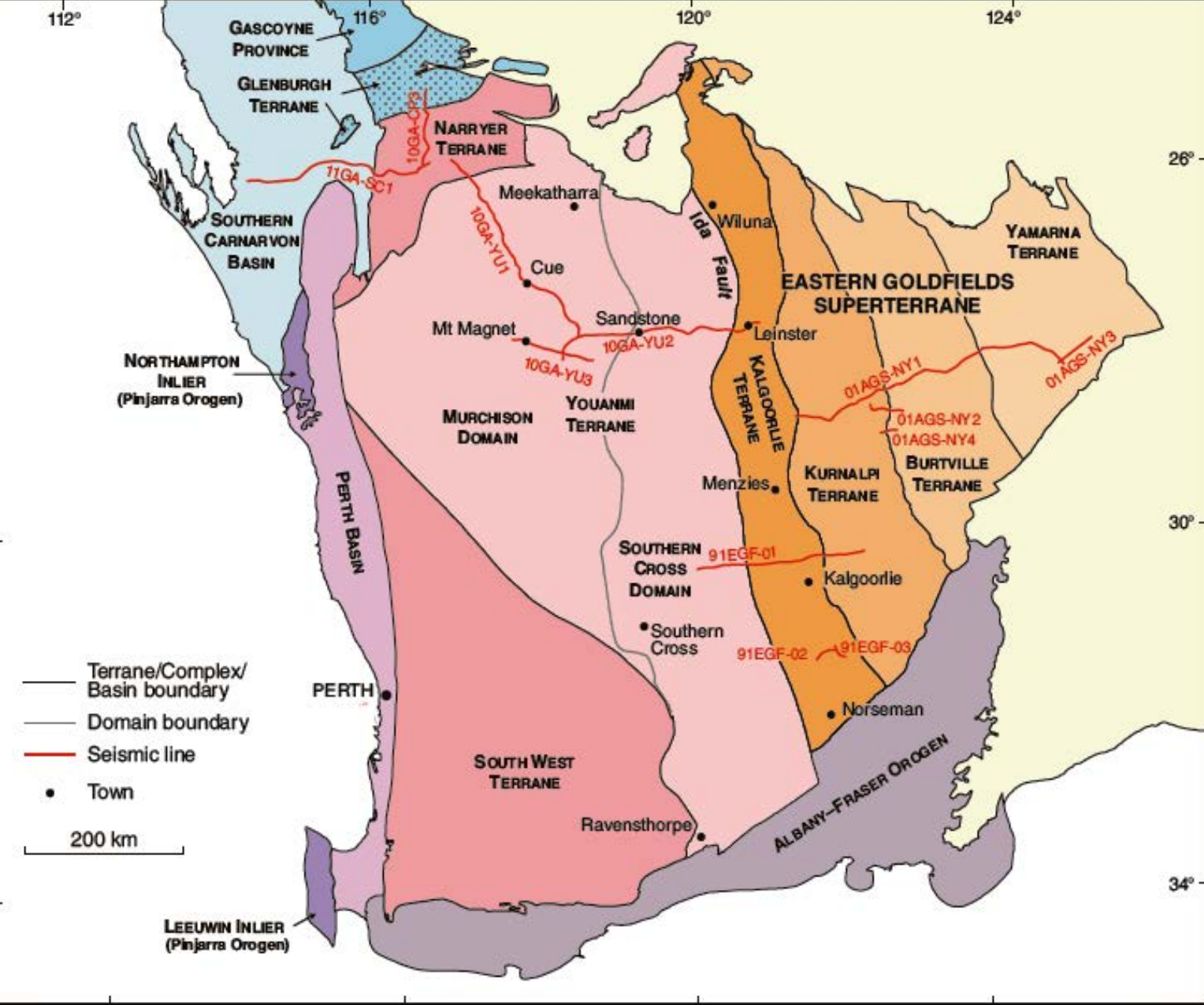


AIMS

Crustal
Architecture

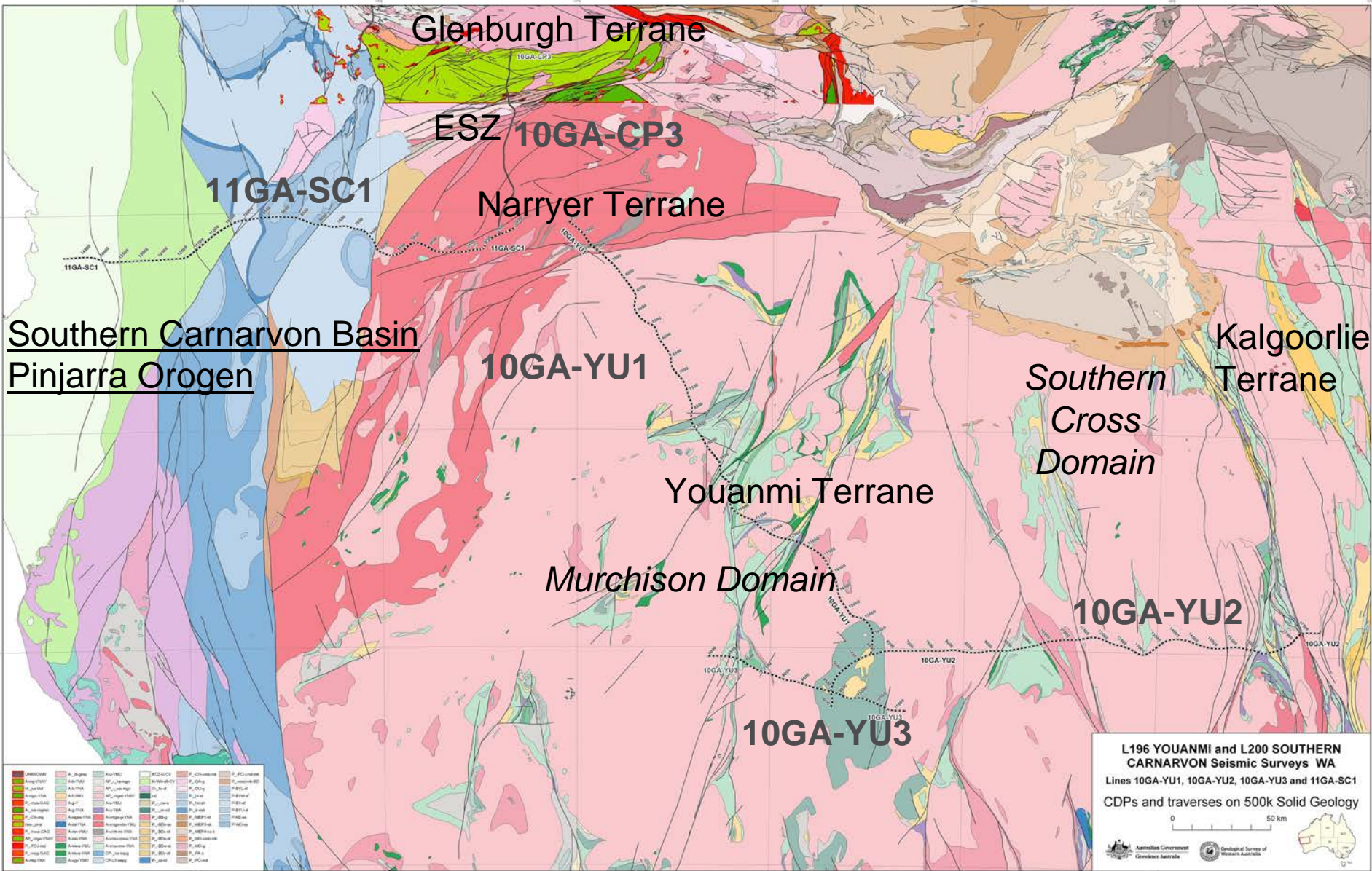
Geodynamic
Speculations

Link with
previous
seismic
lines



SW223c

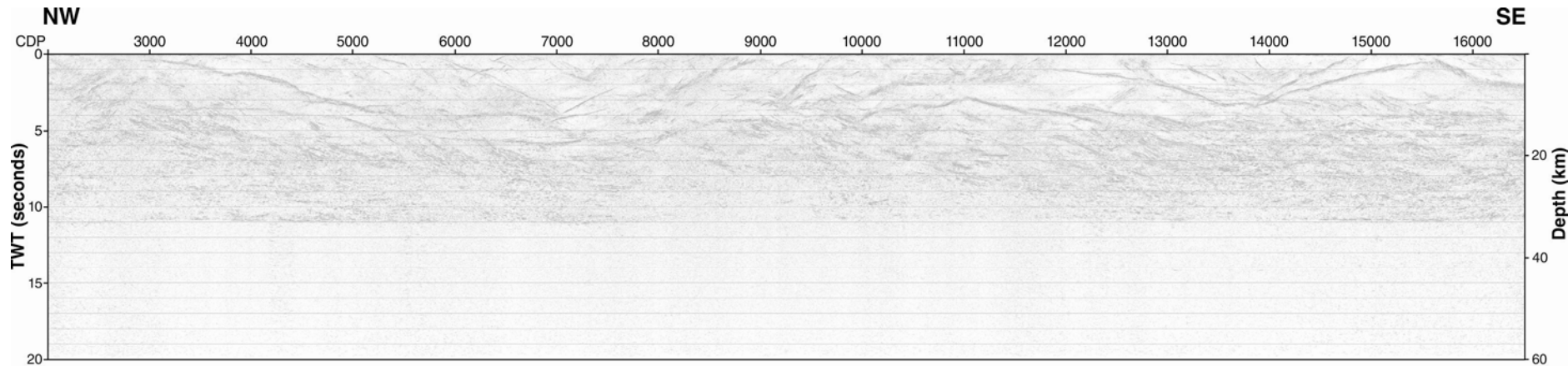
12.02.13



Basement Terranes

ESZ = Errabiddy Shear Zone

Crustal architecture -10GA-YU1

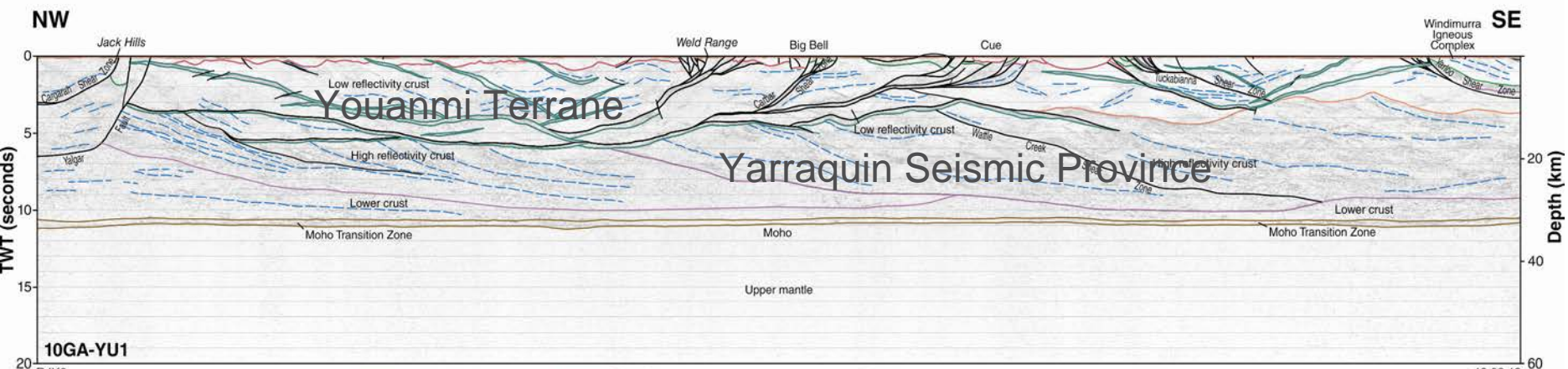
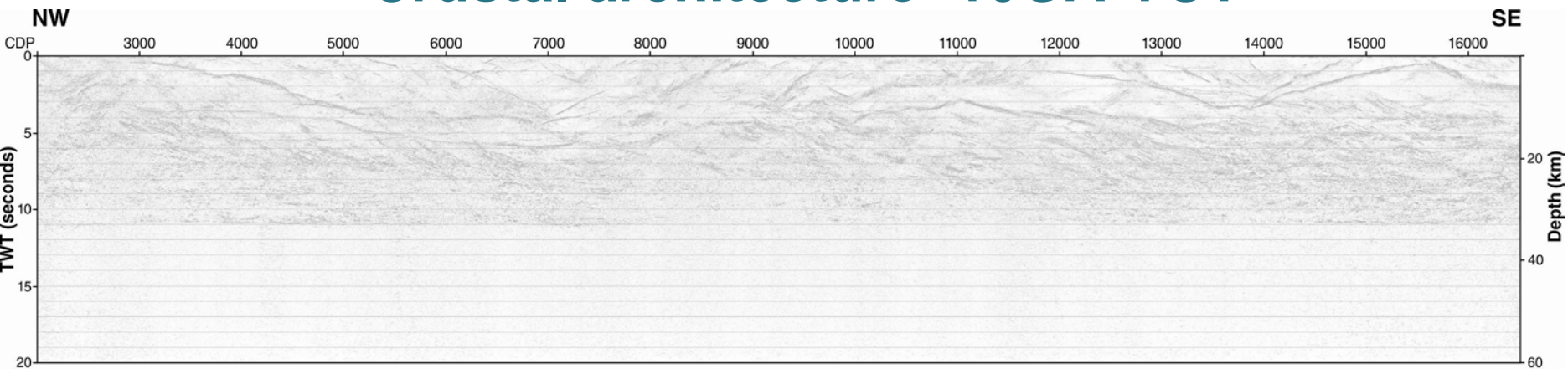


Note: $V = H$ (assuming average crustal velocity = 6000 ms⁻¹)

Moho – very well defined

- interpreted at ~11 s TWT (~33 km depth)
- thin transition zone between lower crust and upper mantle
- 3-layer crust
 - upper, weakly to moderately reflective
 - middle, strongly reflective, listric to SE
 - lower, moderately to strongly reflective, subhorizontal

Crustal architecture -10GA-YU1

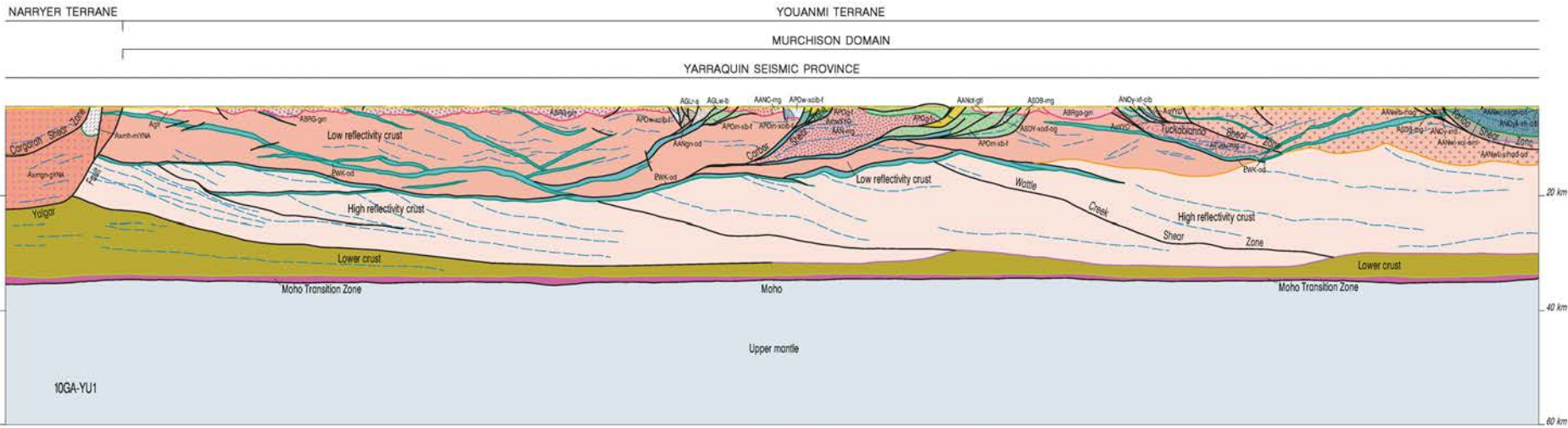


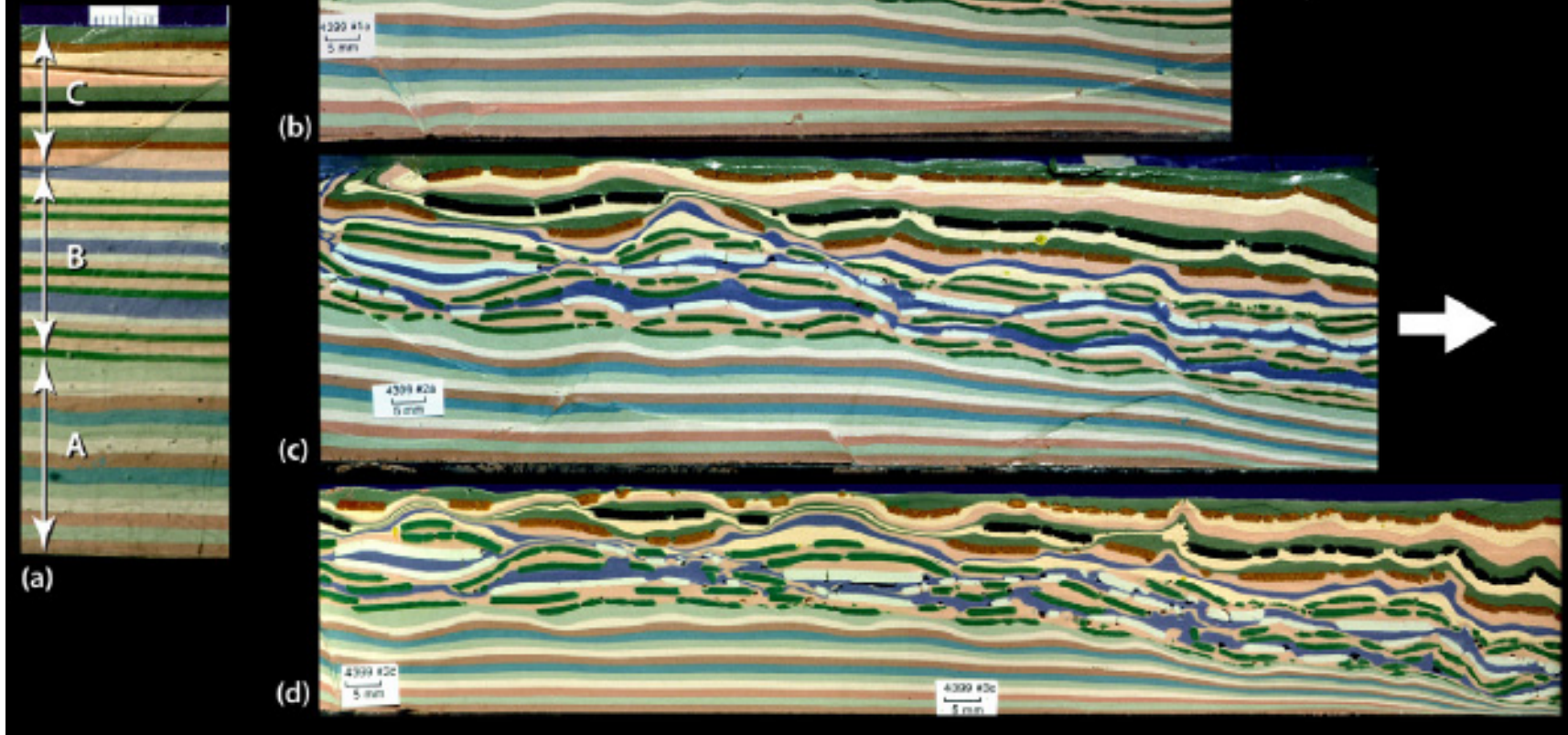
- | | | |
|-------------------|---------------------------|--------------------------|
| Dyke or sill | Granite | Fault |
| Form line | Base felsic volcanic rock | Base ultramafic rocks |
| Base middle crust | Base mafic rocks | Base upper crust |
| Base Regolith | Base Roof Zone | Top Moho Transition Zone |
| Moho | | |

20 km

Youanmi Terrane – confined to weakly to moderately reflective upper crust
 Yarraquin Seismic Province* - middle and lower crust combined

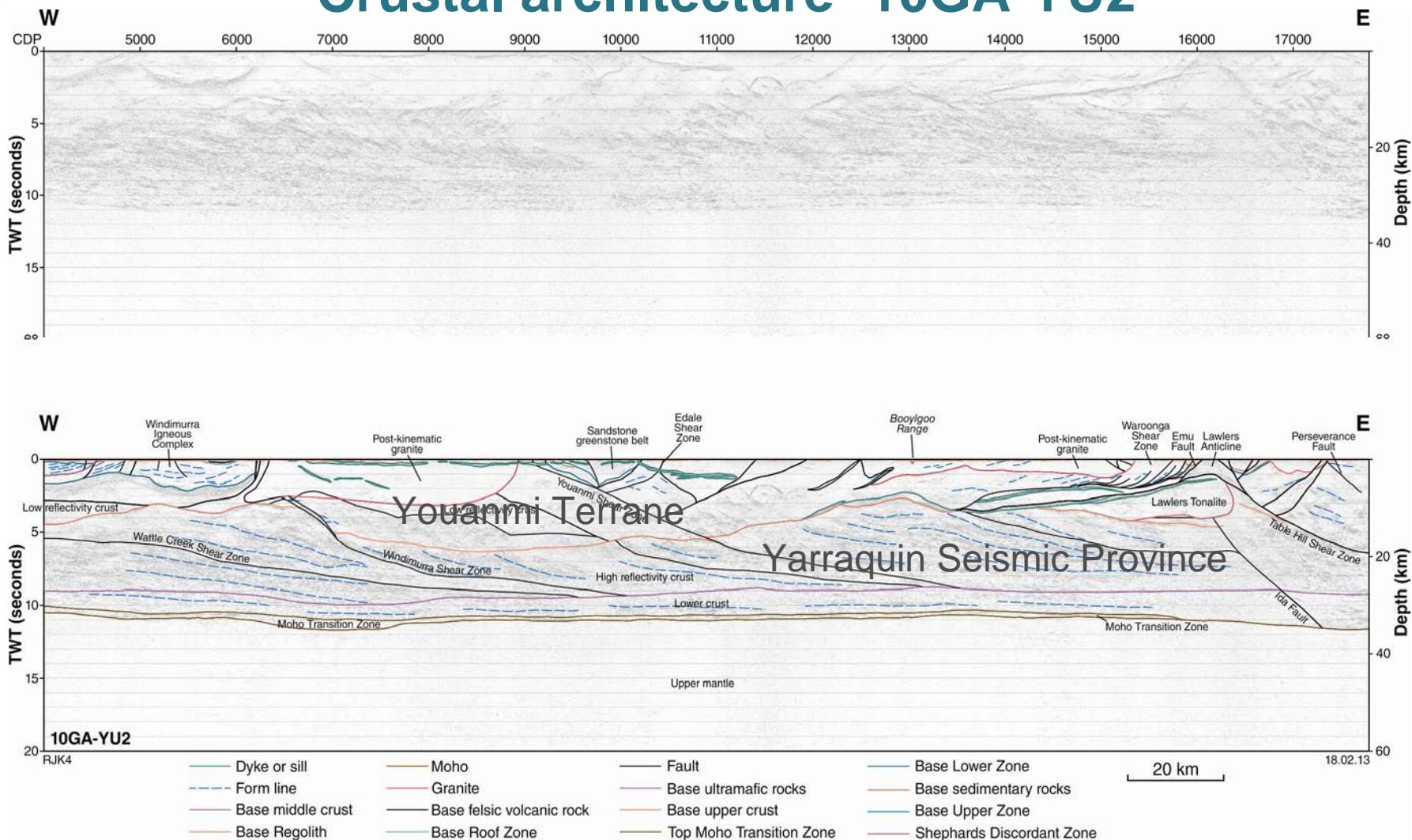
Crustal architecture -10GA-YU1





Could the fabric of the Yarraquin Seismic Province be due to crustal scale extension?
 Analogue model – but crust now thinned to 25 km would have been originally 65 km
 Possible solution – extension followed by later contraction to thicken crust

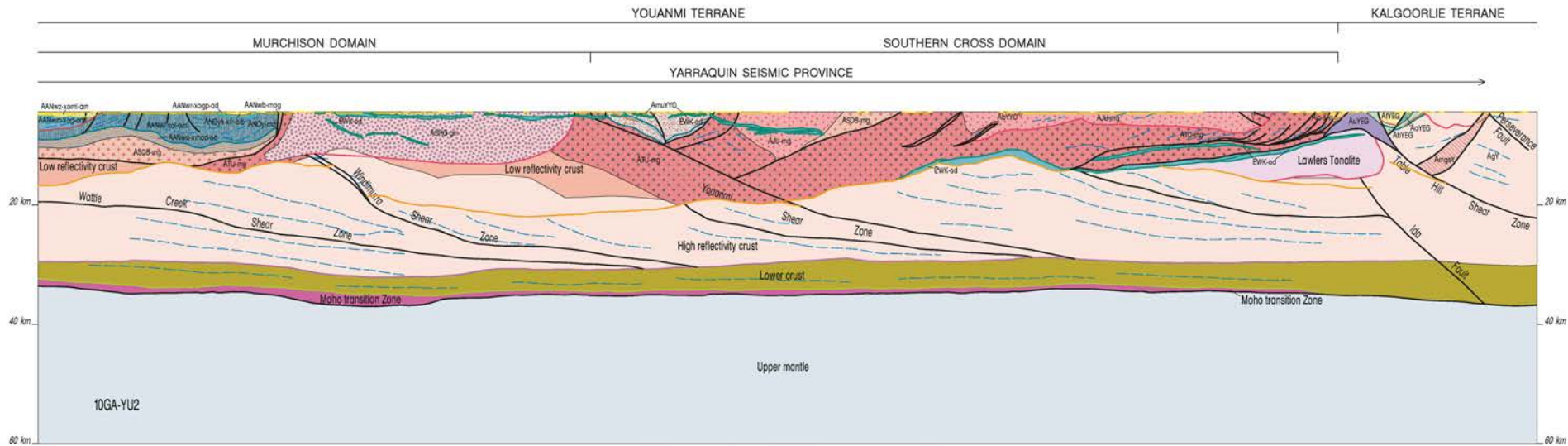
Crustal architecture -10GA-YU2



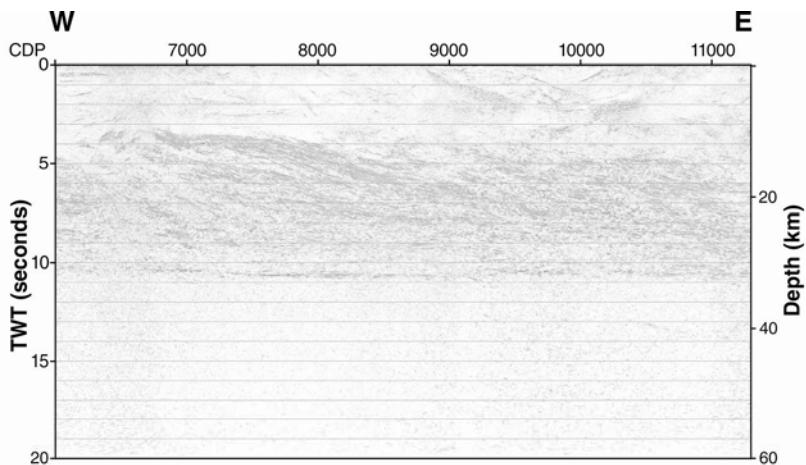
Same 3-layer crust as 10GA-YU1 (except for easternmost end)

Note: Murchison and Southern Cross Domains have same seismic character

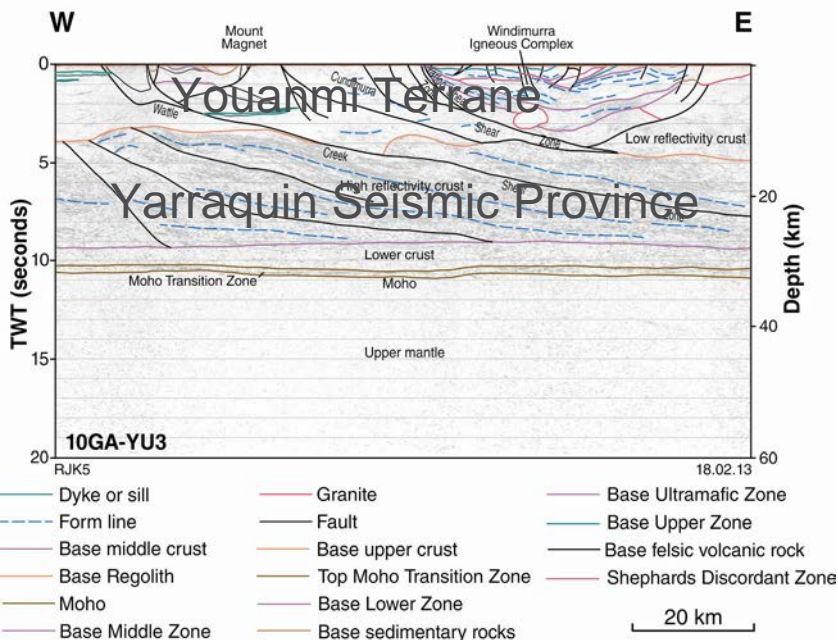
Crustal architecture -10GA-YU2



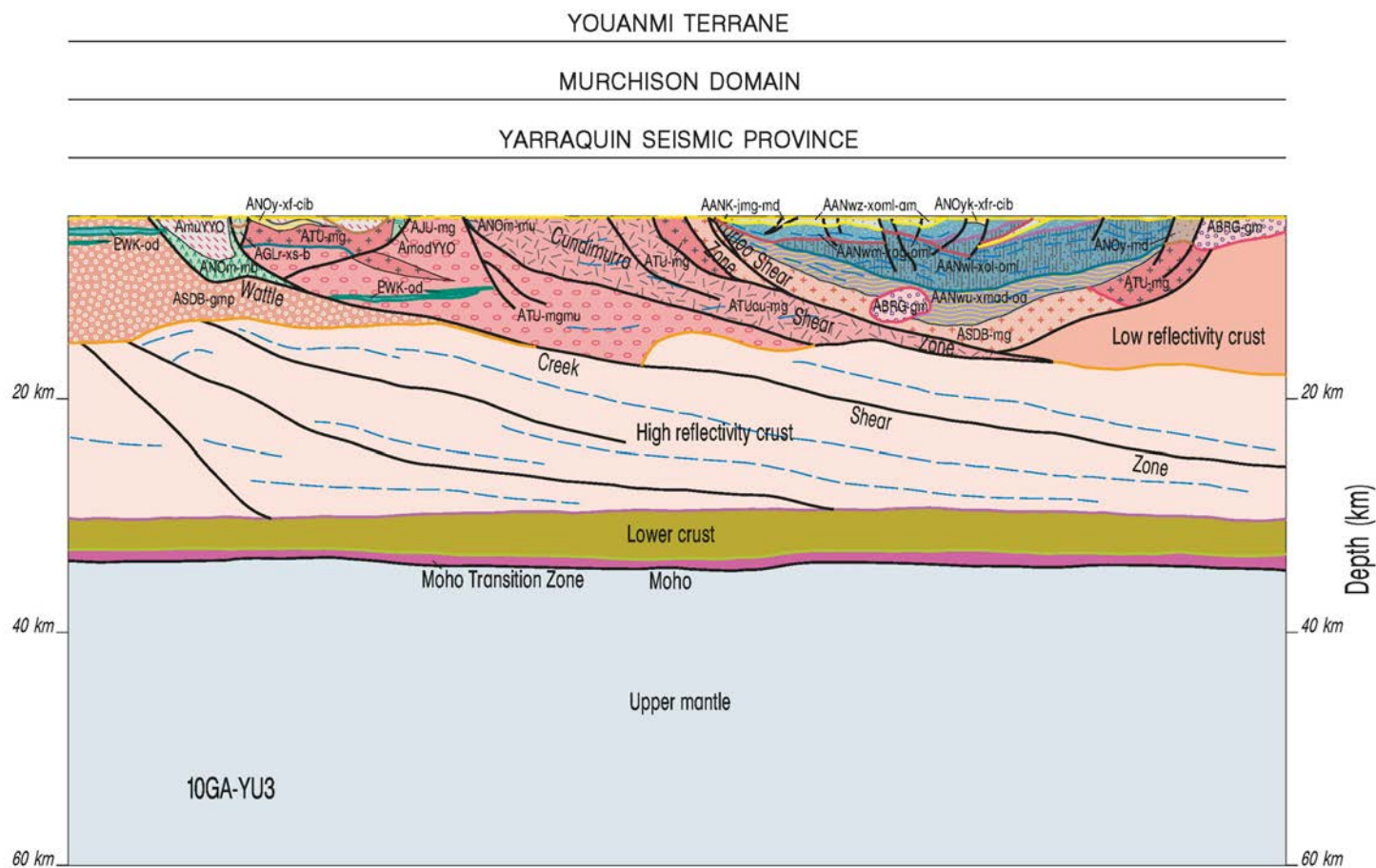
Crustal architecture -10GA-YU3



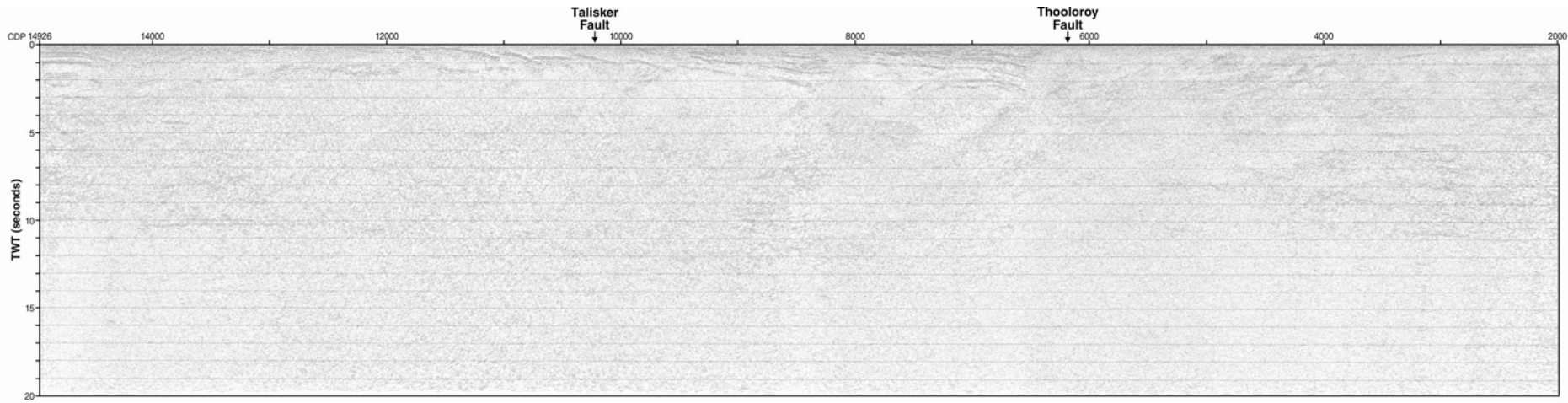
Same 3-layer crust as
10GA-YU1 & 10GA-YU2



Crustal architecture -10GA-YU3



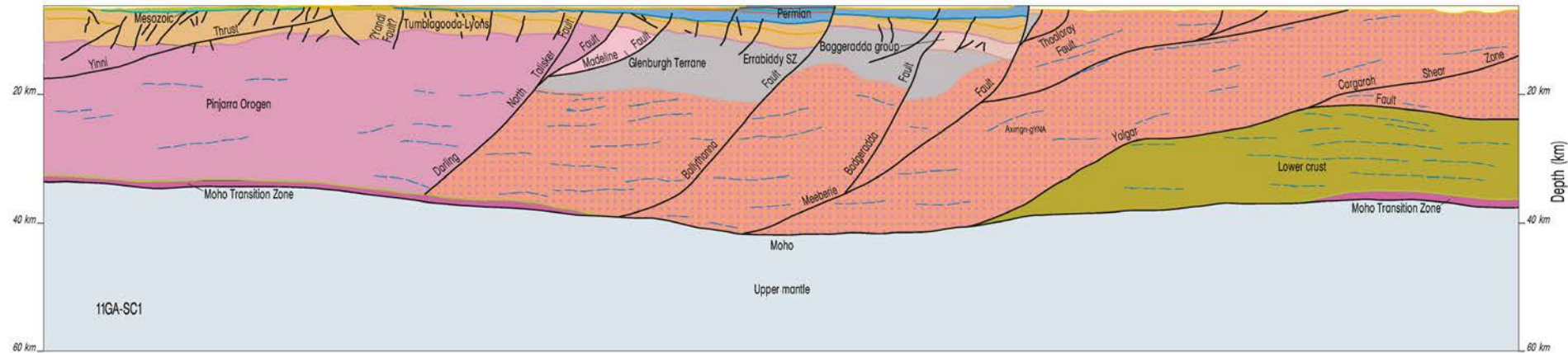
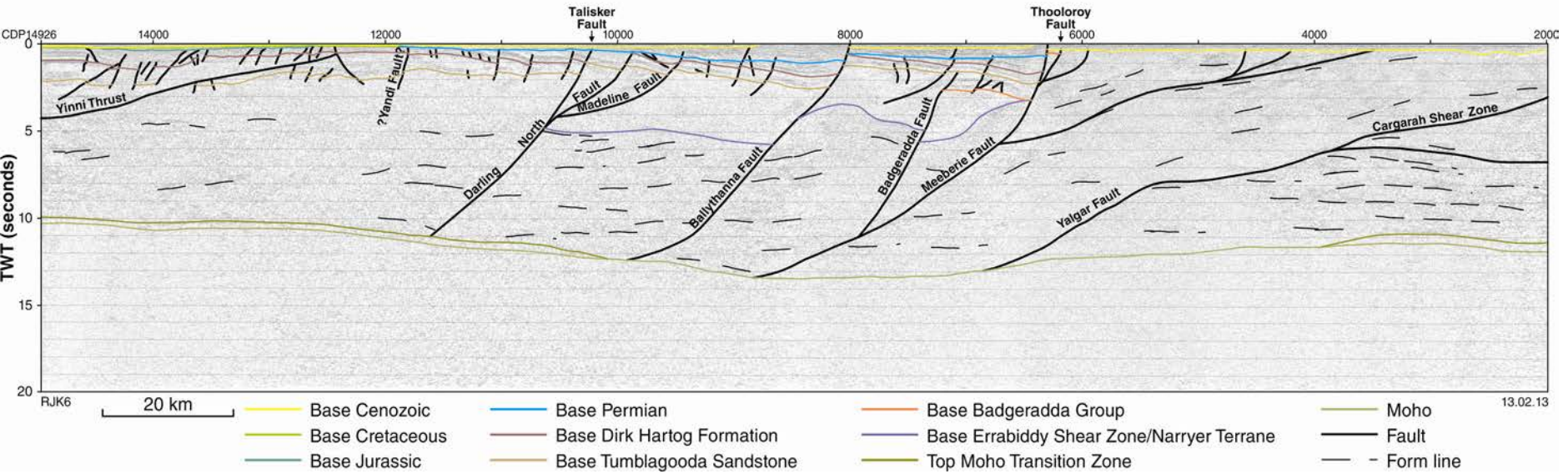
Crustal architecture -11GA-SC1



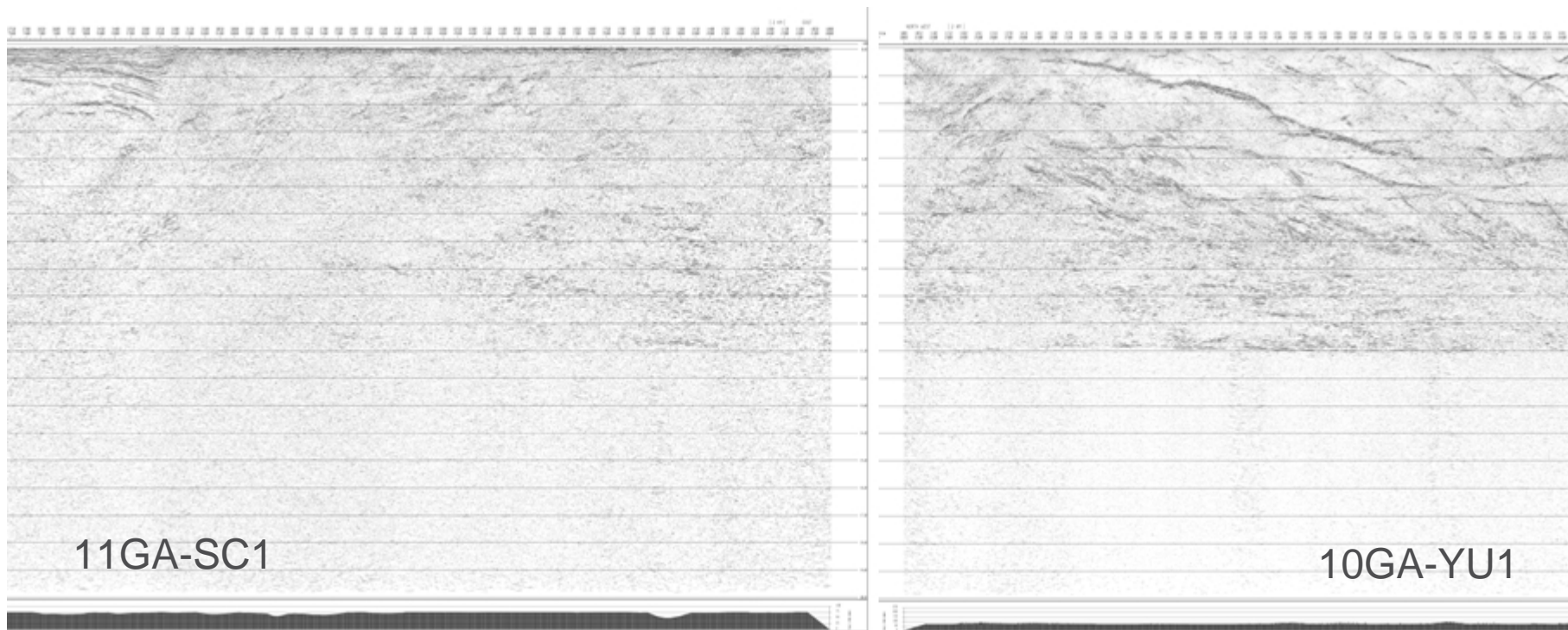
- Moho** – poorly defined (except in west and east)
- undulating
 - 10 s TWT (~30 km depth) in west
 - >13 s TWT (nearly 40 km depth) in centre

- Crust** – only weakly to moderately reflective
- very different to architecture of Youanmi seismic lines

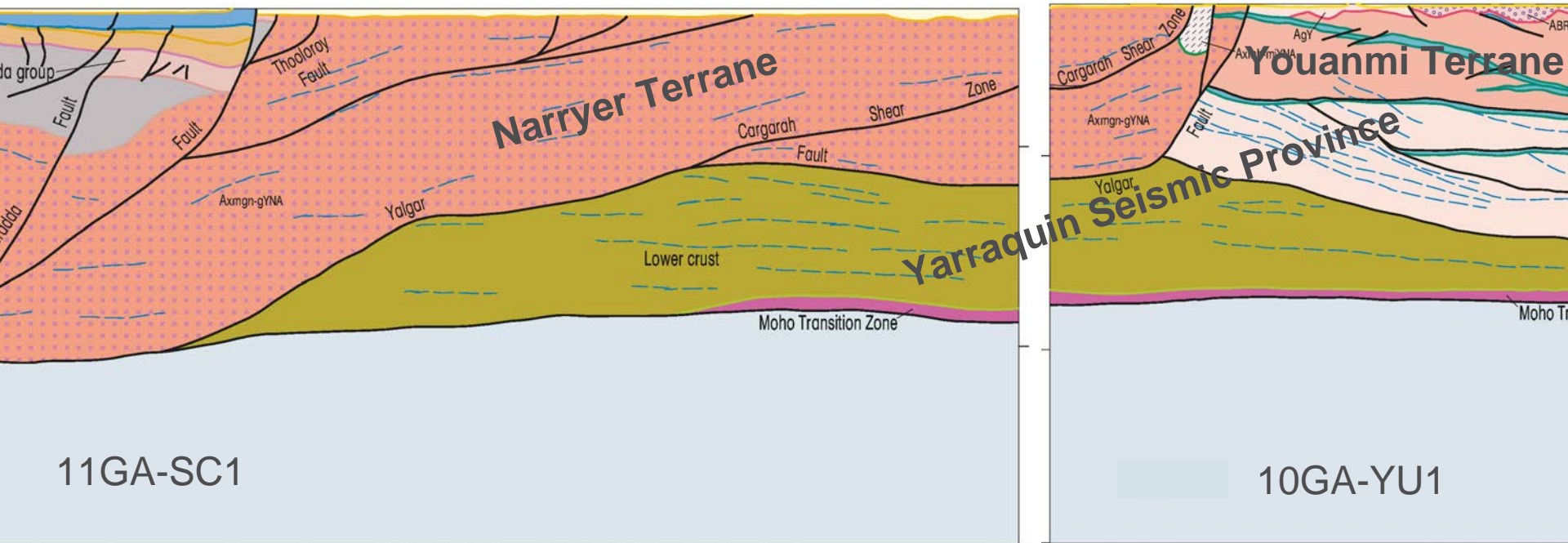
Crustal architecture -11GA-SC1



Relationship between Narryer Terrane & Youanmi Terrane Combined 11GA-SC1 and 10GA-YU1



Relationship between Narryer Terrane & Youanmi Terrane Combined 11GA-SC1 and 10GA-YU1

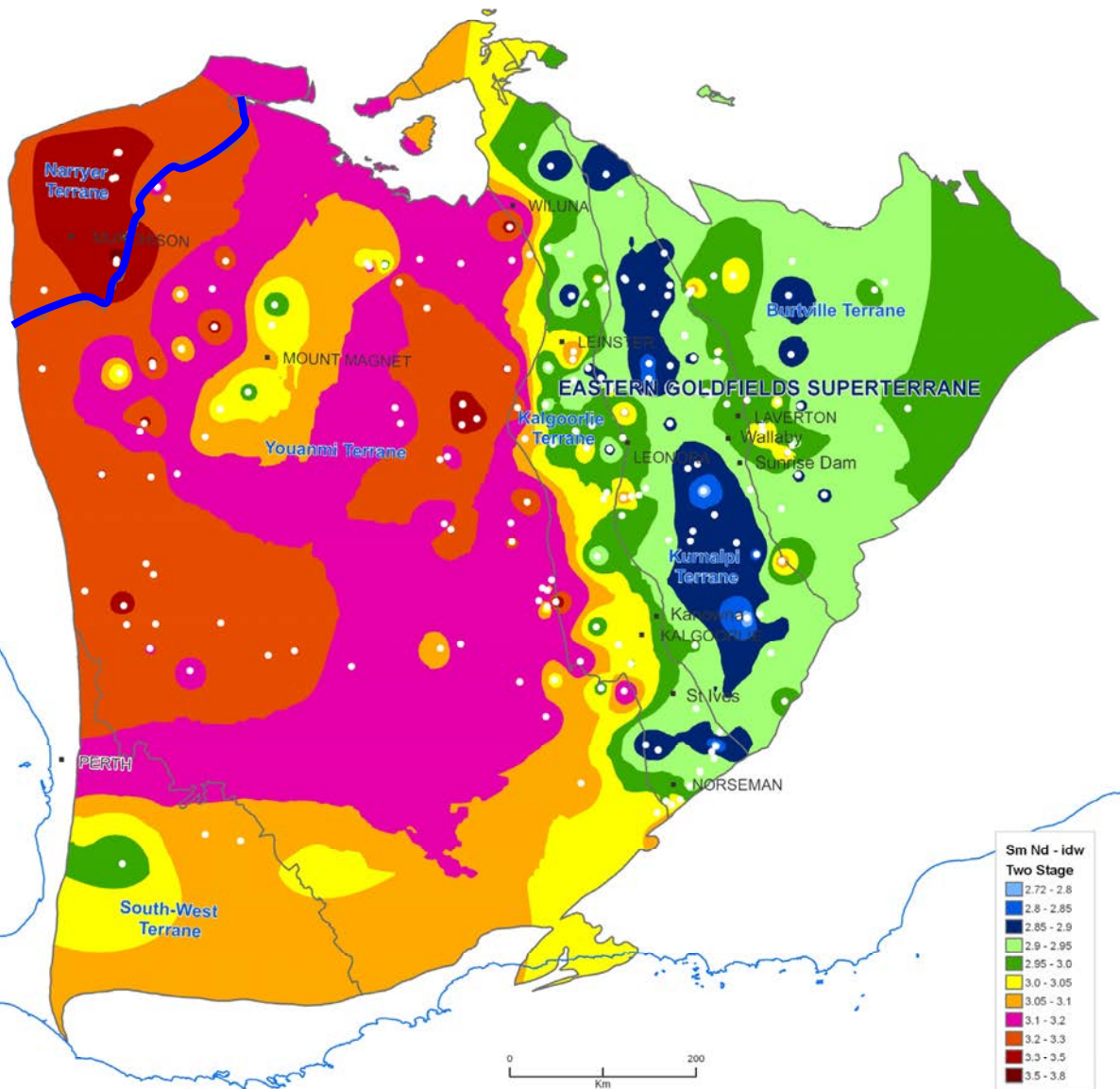


Does the Yalgar Fault represent the site of a suture zone?

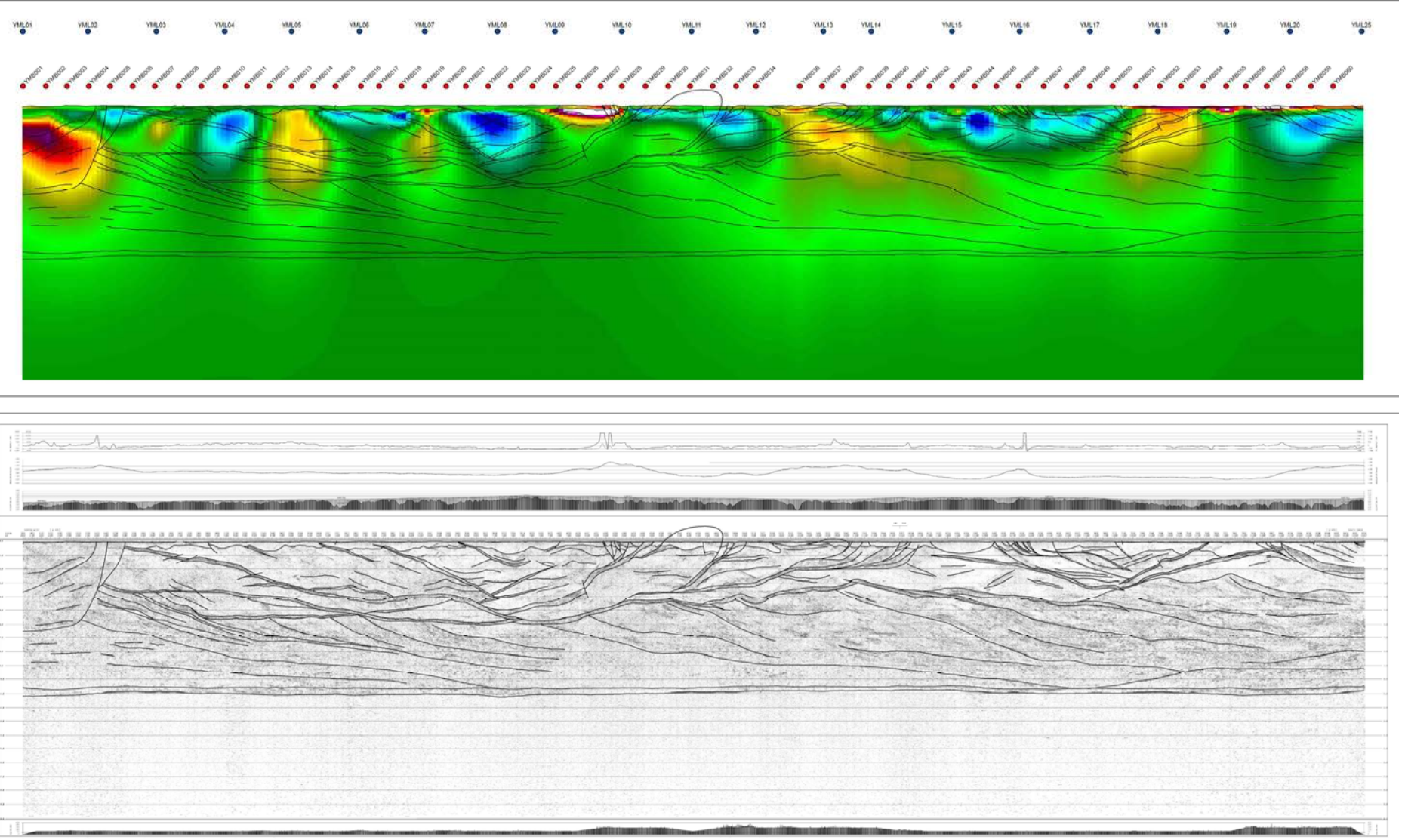
Nd model ages for granites - Champion & Cassidy (2007)

Distinctive pattern
between terranes,
but coherent pattern
within terranes

Note difference
between Narryer
and Youanmi
terranes



10GA-YU1 – seismic interpretation & MT



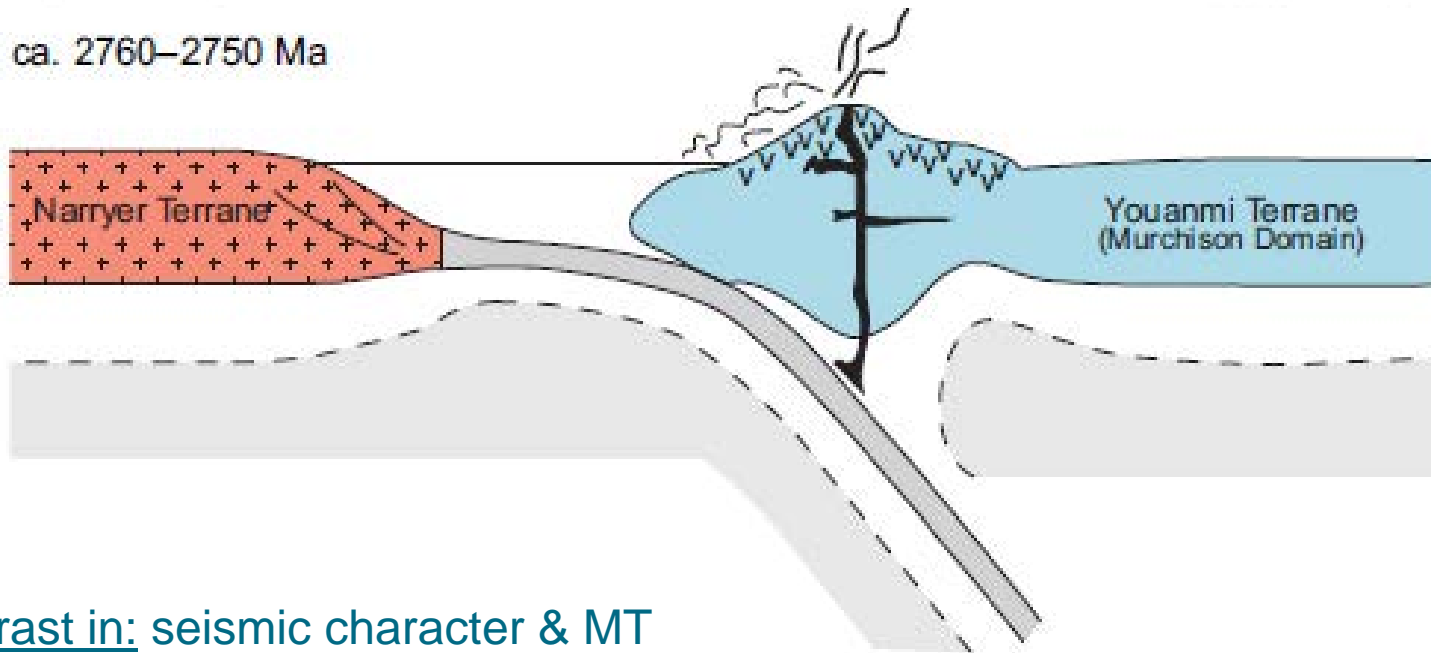
NOTE: Contrast in MT across the Yalgar Fault

Collision between Narryer Terrane and Youanmi Terrane?

NORTHWEST

SOUTHEAST

ca. 2760–2750 Ma



Contrast in: seismic character & MT

Nd model ages (older in Narryer Terrane)

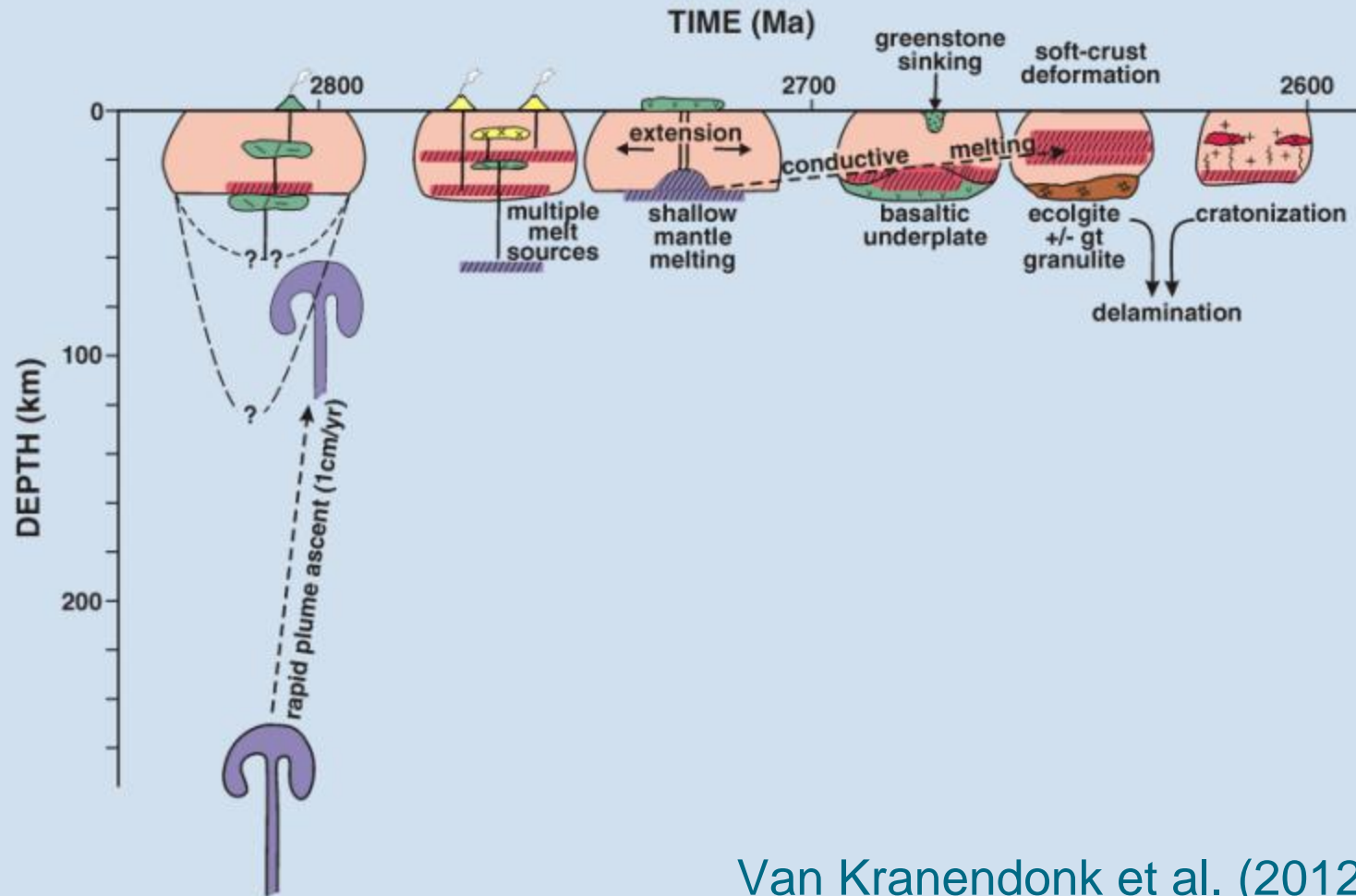
Timing – Northern Murchison Domain contains sanukitoid-like rocks (Champion et al. 2002) and boninites (Wyman & Kerrich 2012), both ca. 2780–2740 Ma – arc-forearc setting?

Polarity of subduction – arc-related rocks on upper plate are in Youanmi Terrane

Yalgar Fault – suture possibly represents collision-related opposite polarity

Stitching plutons – 2750–2620 Ma (Spaggiari et al. (2007))

Alternative model for Murchison Domain – plume-driven autochthonous setting



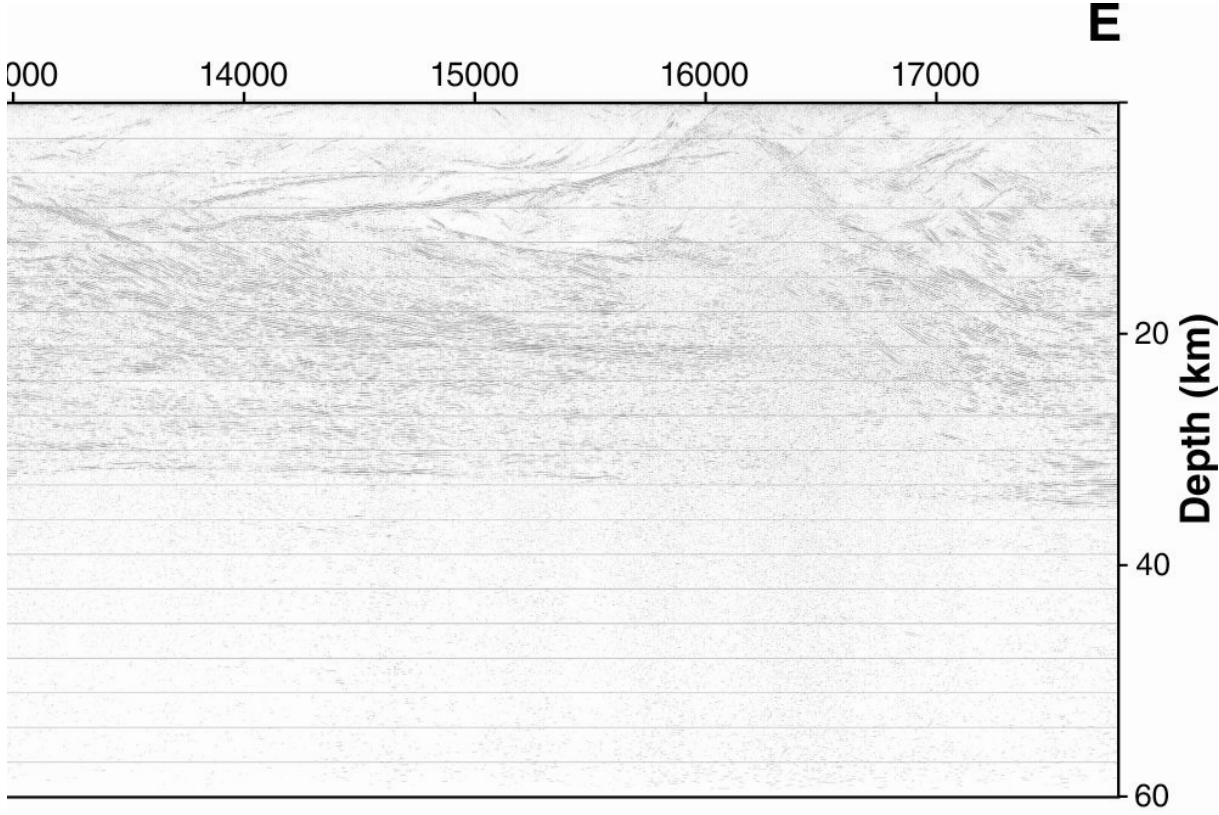
Van Kranendonk et al. (2012)
Ivanic et al. (2012)

5/14/11

20.01.10

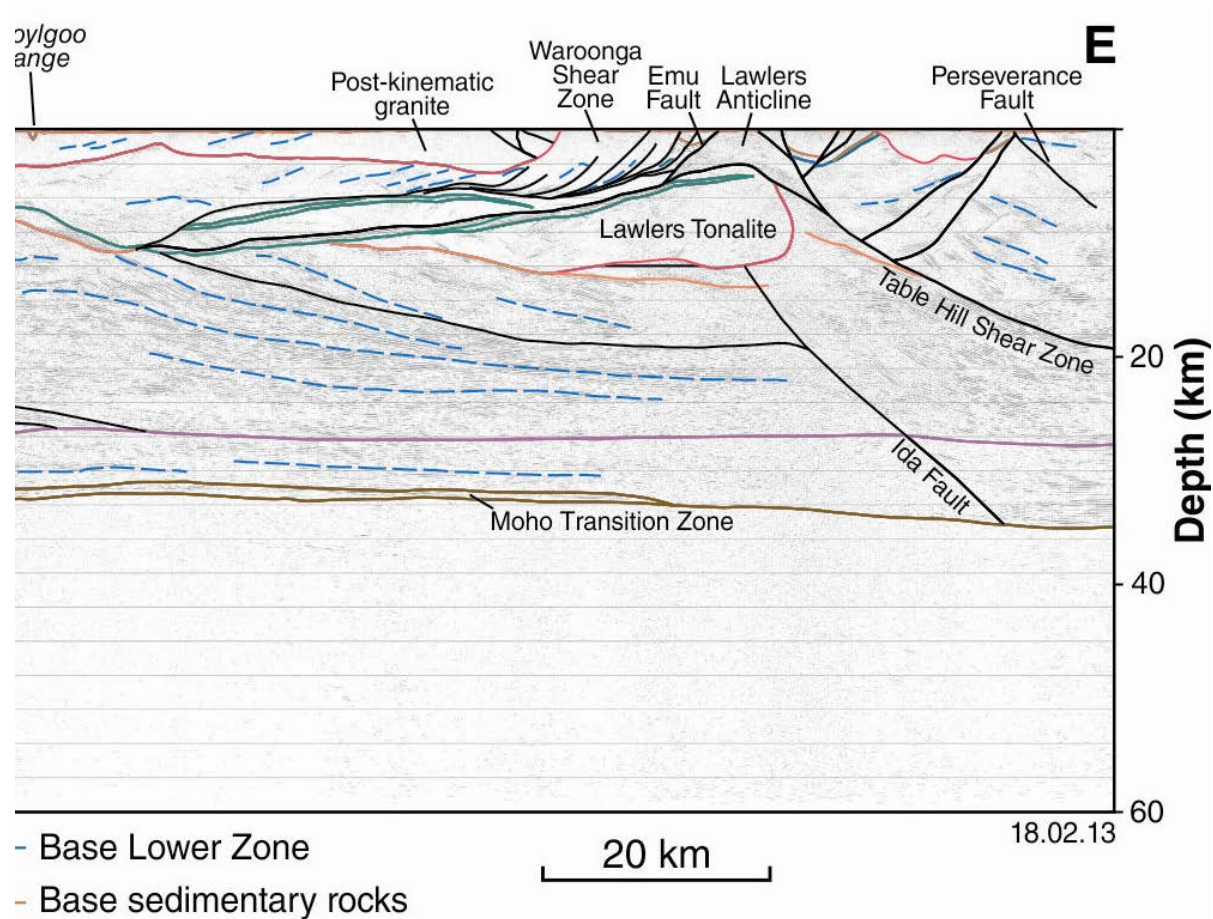
Relationship Between Youanmi Terrane & Kalgoorlie Terrane

Eastern end of 10GA-YU2



Relationship Between Youanmi Terrane & Kalgoorlie Terrane

Eastern end of 10GA-YU2

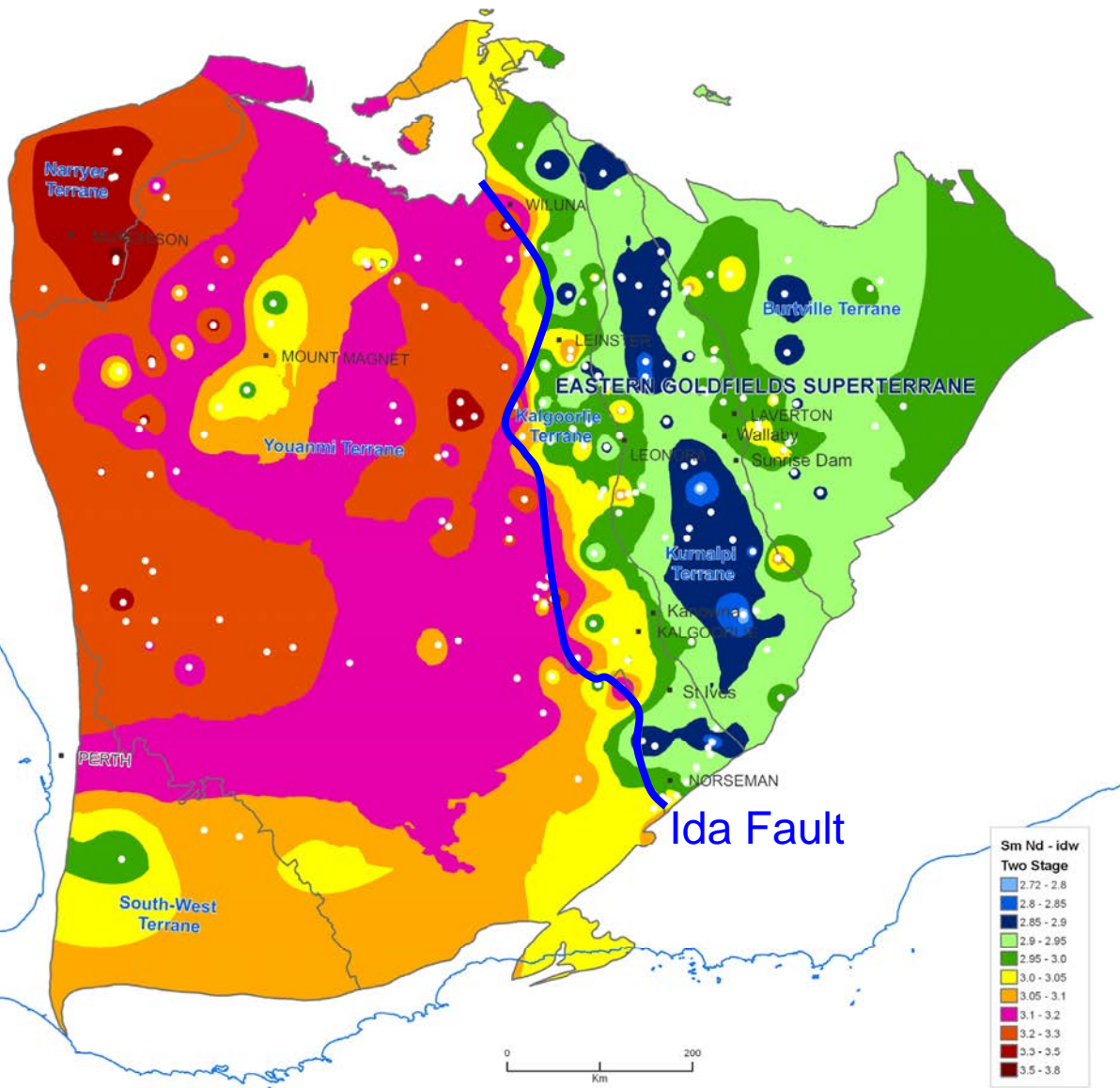


Does the Ida Fault represent the site of a suture zone?

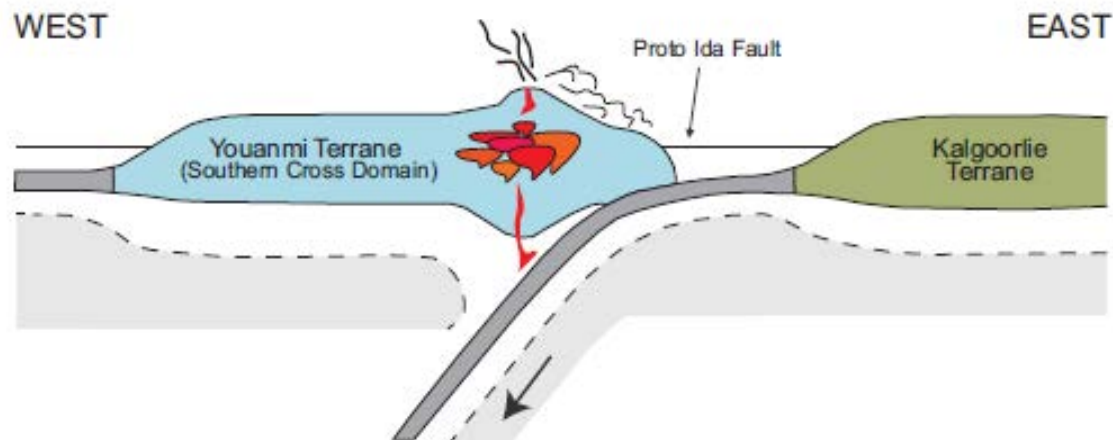
Nd model ages for granites - Champion & Cassidy (2007)

Distinctive pattern
between terranes,
but coherent pattern
within terranes

Note big difference
between Youanmi
and Kalgoorlie
terranes



Collision between Youanmi Terrane and Kalgoorlie Terrane?



Contrast in: seismic character

Nd model ages (older in Youanmi Terrane)

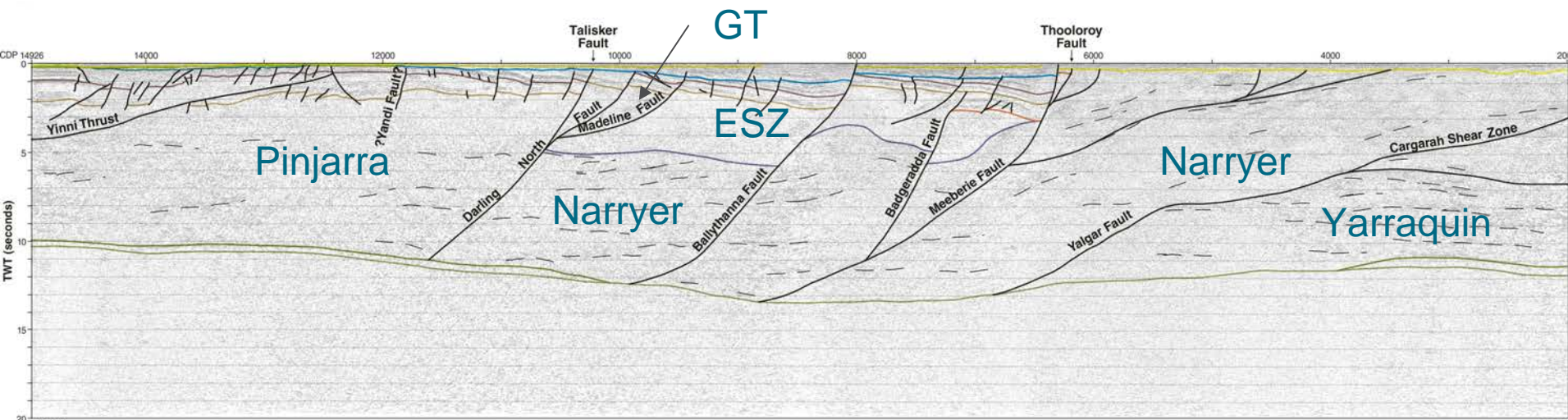
Timing – Southern Cross Domain contains boninites (Angerer et al. 2013)
– interpreted as intraoceanic arc

Age – not directly dated, possibly ca. 2800 Ma

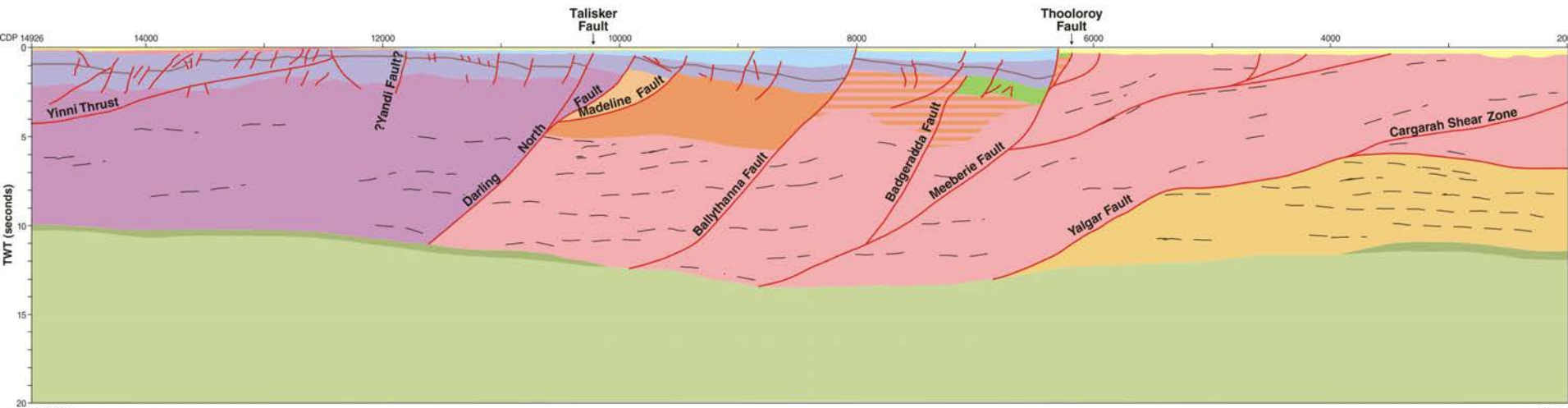
Polarity of subduction – arc-related rocks on upper plate are in Youanmi Terrane

Ida Fault – suture possibly represents collision-related opposite polarity

Relationship between Narryer Terrane and Glenburgh Terrane, and between Narryer Terrane and Pinjarra Orogen

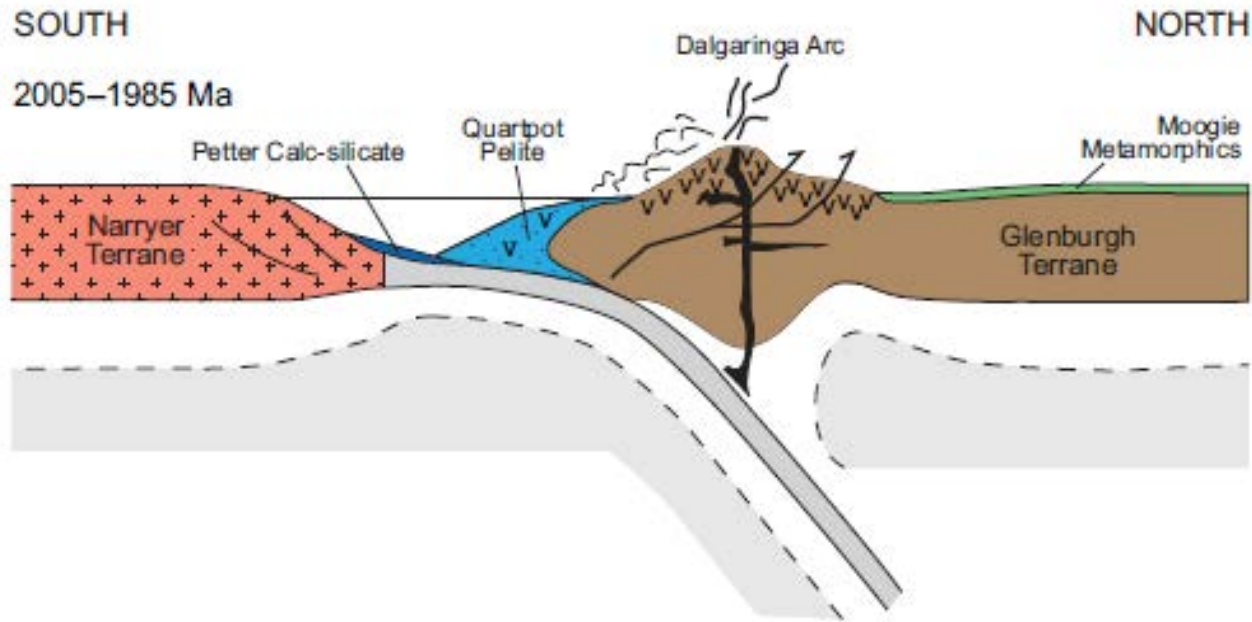


- Base Cenozoic
- Base Permian
- Base Badgeradda Group
- Moho
- Base Cretaceous
- Base Dirk Hartog Formation
- Base Errabiddy Shear Zone/Narryer Terrane
- Fault
- Base Jurassic
- Base Tumblagooda Sandstone
- Top Moho Transition Zone
- Form line



- Regolith/Cenozoic
- Ordoevician/Devonian
- Errabiddy SZ
- Yarraquin Seismic Province
- Mesozoic
- Baggeradda Group
- Narryer Terrane
- Moho transition zone
- Carboniferous/Permian
- Glenburgh Terrane
- Pinjarra Orogen
- Upper mantle
- Base Dirk Hartog Formation
- Fault
- Form line

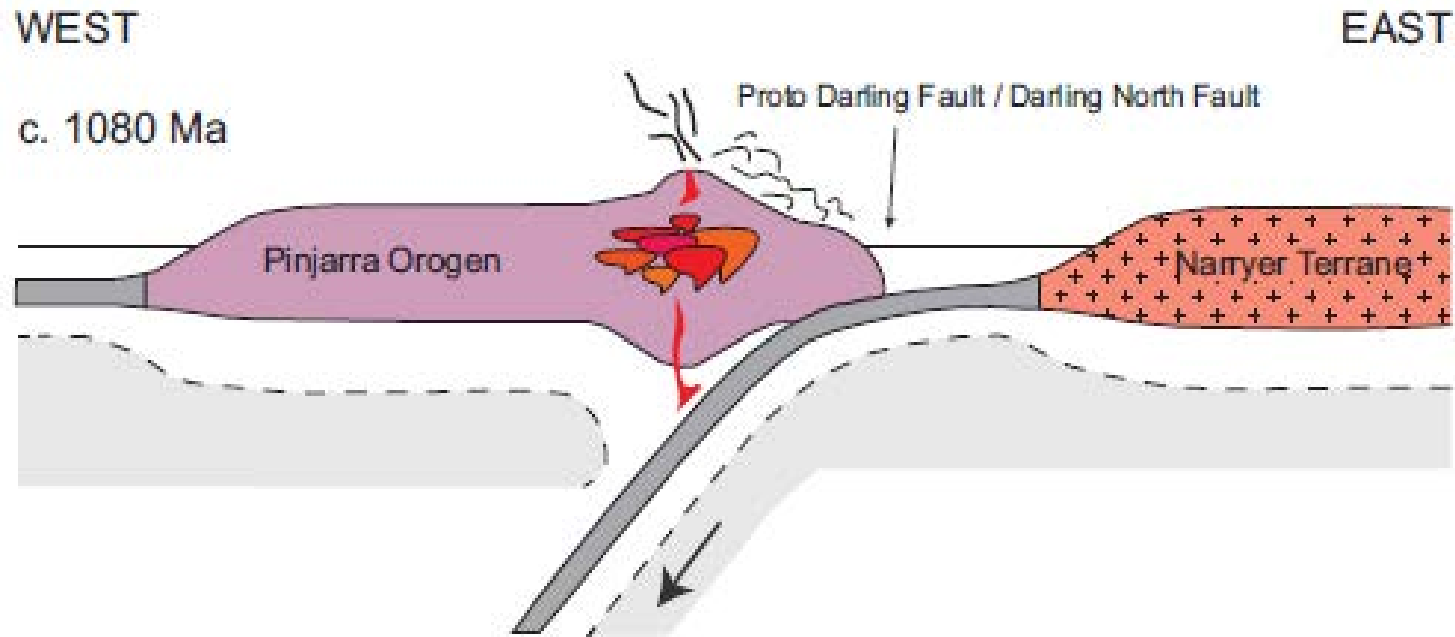
Collision between Glenburgh Terrane and Narryer Terrane



Dalgaringa magmatic arc (2005-1975 Ma) gives polarity of subduction
Collision - 1965-1950 Ma = Glenburgh Orogeny

After Johnson et al. (2011); Korsch et al. (2011)

Relationship between Narryer Terrane and Pinjarra Orogen



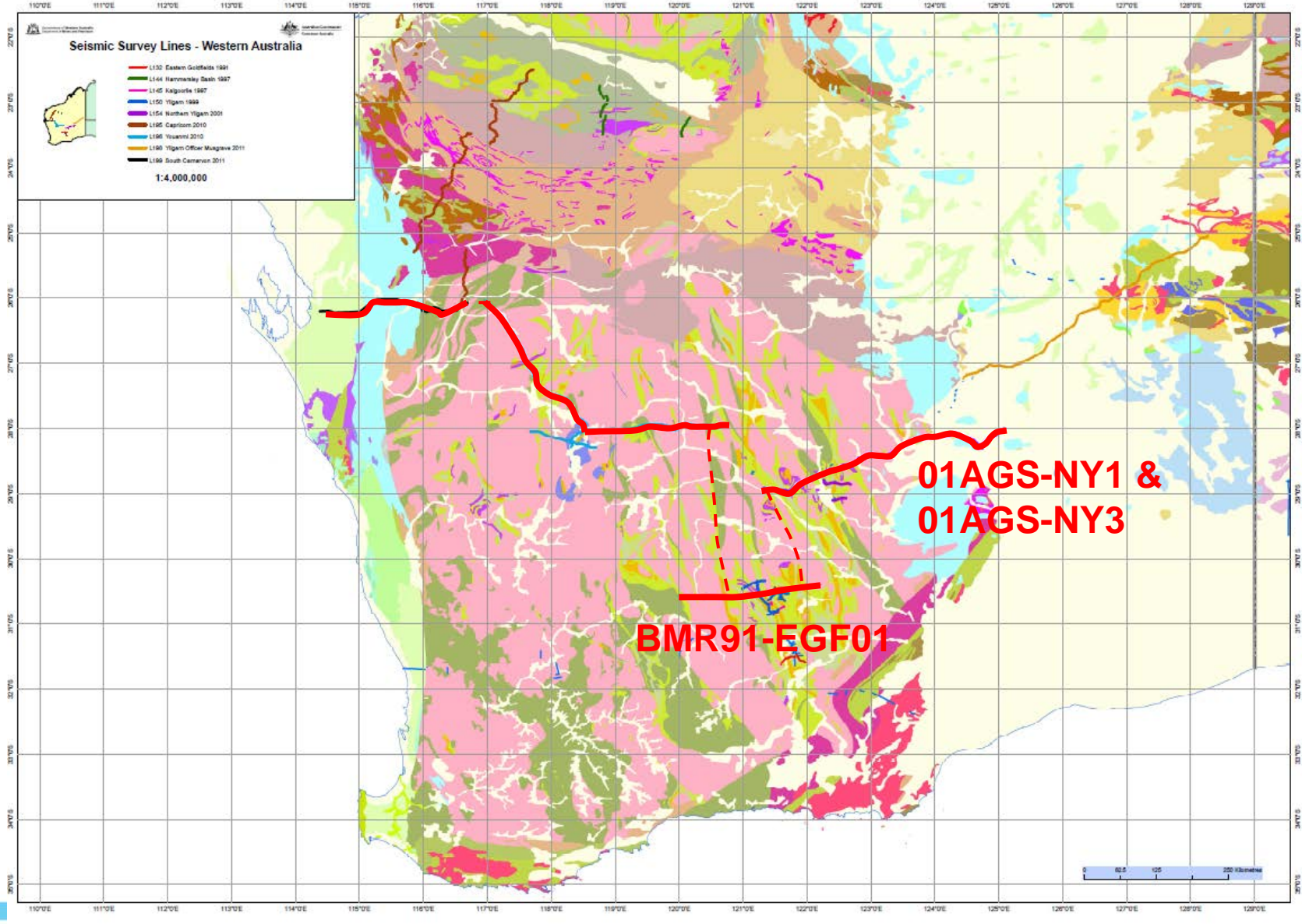
Contrast in metamorphic and magmatic ages (Archean v Late Mesoproterozoic)

Timing – poorly constrained, but 1080 Ma granulites In Pinjarra Orogen interpreted to be result of collision

Polarity of subduction – poorly constrained, but no Mesoproterozoic magmatic rocks found in Narryer Terrane – suggests west-dipping subduction

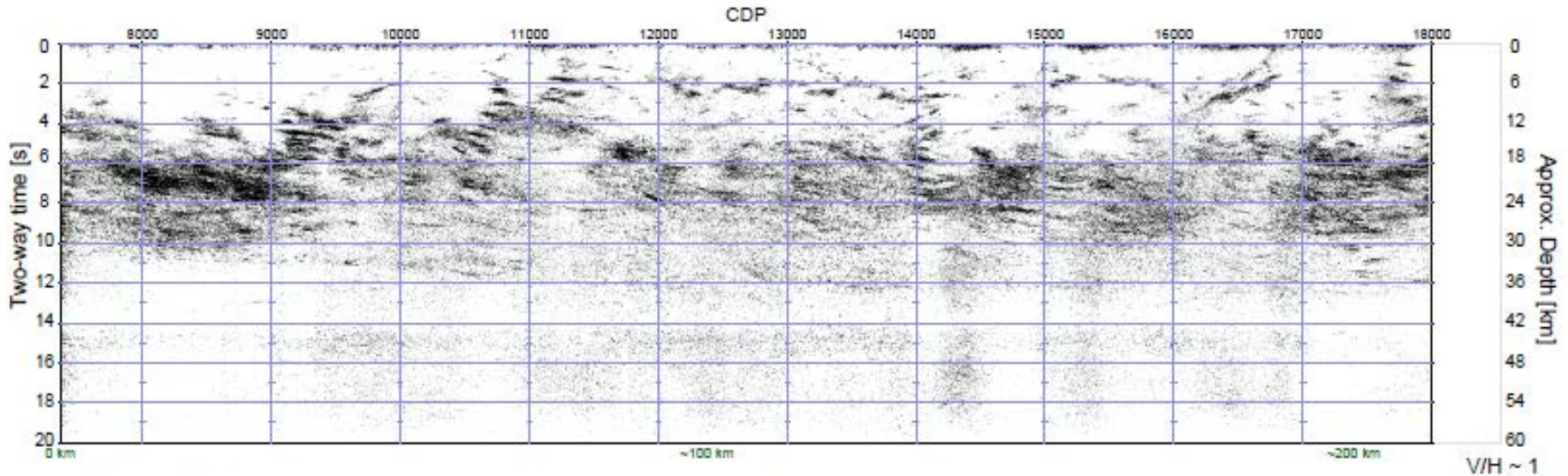
Darling Fault & Darling North Fault – possible suture, with Paleozoic extensional reactivation

Link with previous seismic lines in Yilgarn Craton



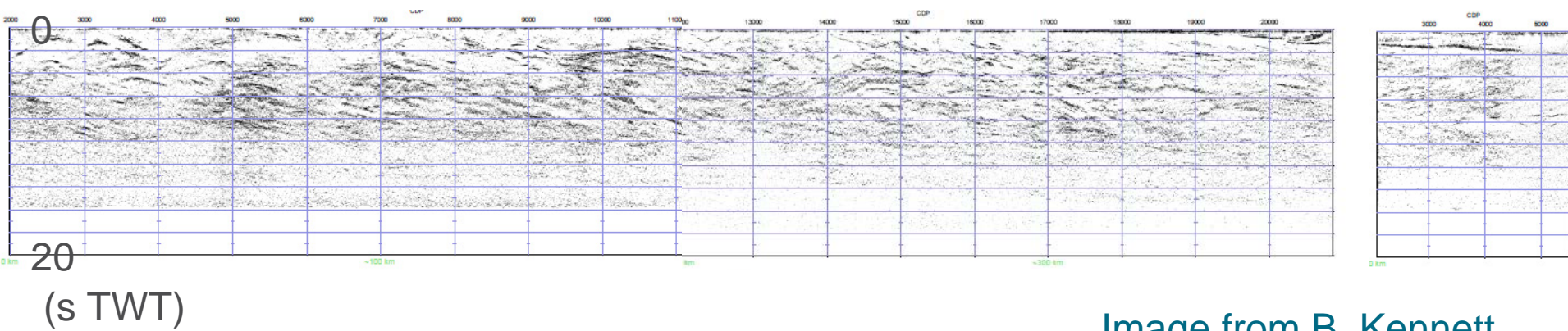
BMR91-EGF01

1991 AL132 EGF1	WESTERN AUSTRALIA Eastern Gold Fields	Geoscience Australia
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Migrated Section	Source: Explosives, 240 m interval	Image from B. Kennett
	Spread: 3 km, 40 m group interval	
	Fold: 12 nominal	

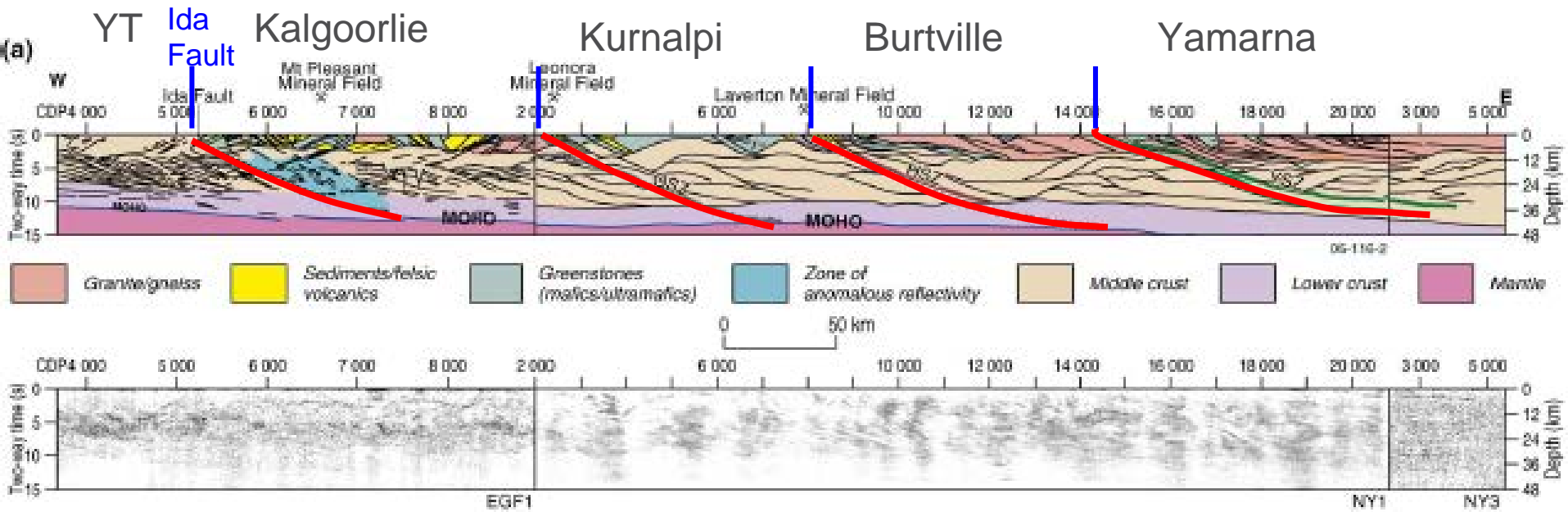
01AGS-NY1 and 01AGS-NY3



(s TWT)

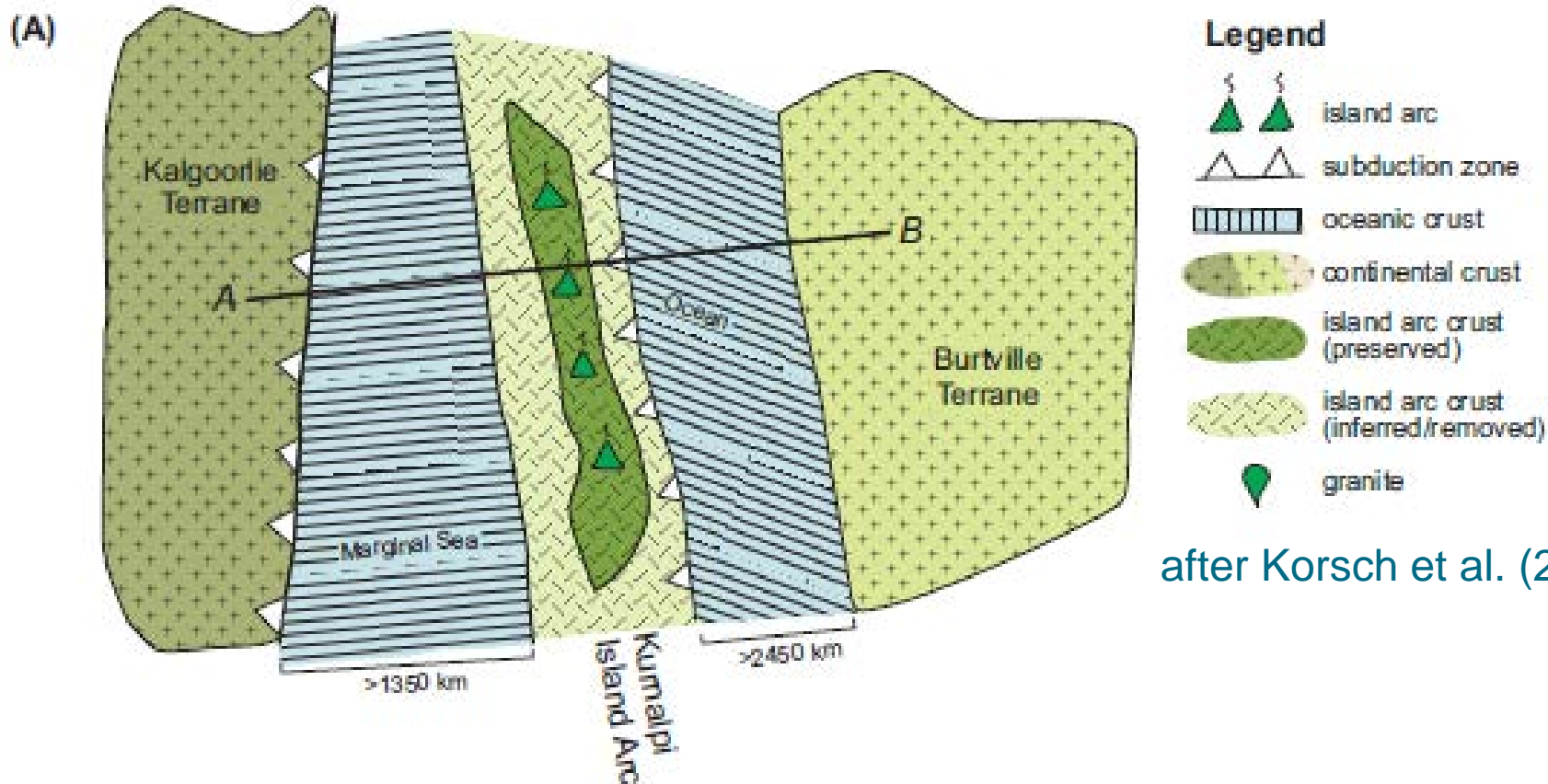
Image from B. Kennett

Combined section – relationship between Youanmi Terrane and terranes in Eastern Goldfields Superterrane



Goleby et al. (2006)

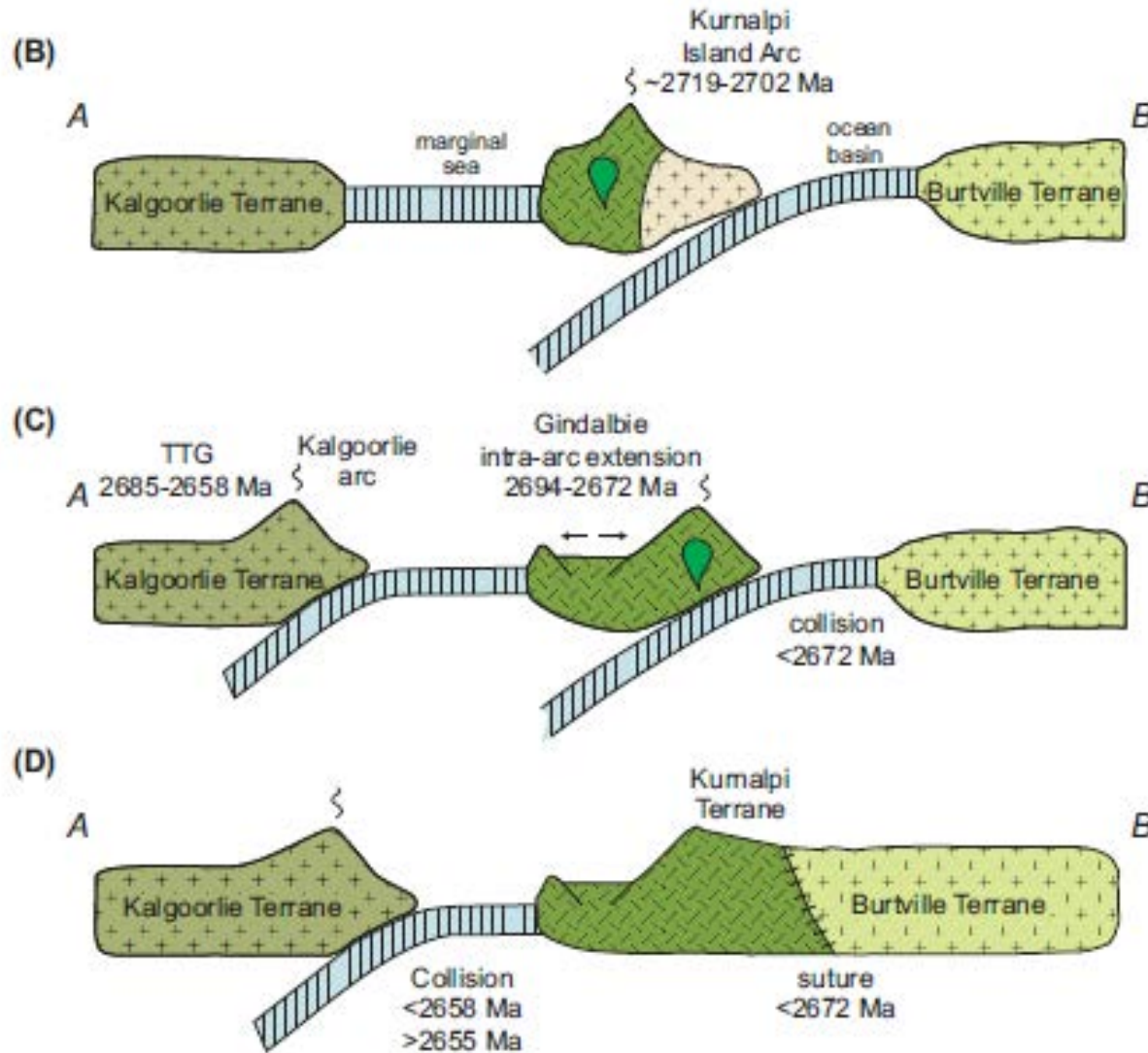
Possible tectonic scenario for formation of Kurnalpi island arc



Contrast in: Nd model ages (Kurnalpi Terrane is most juvenile)

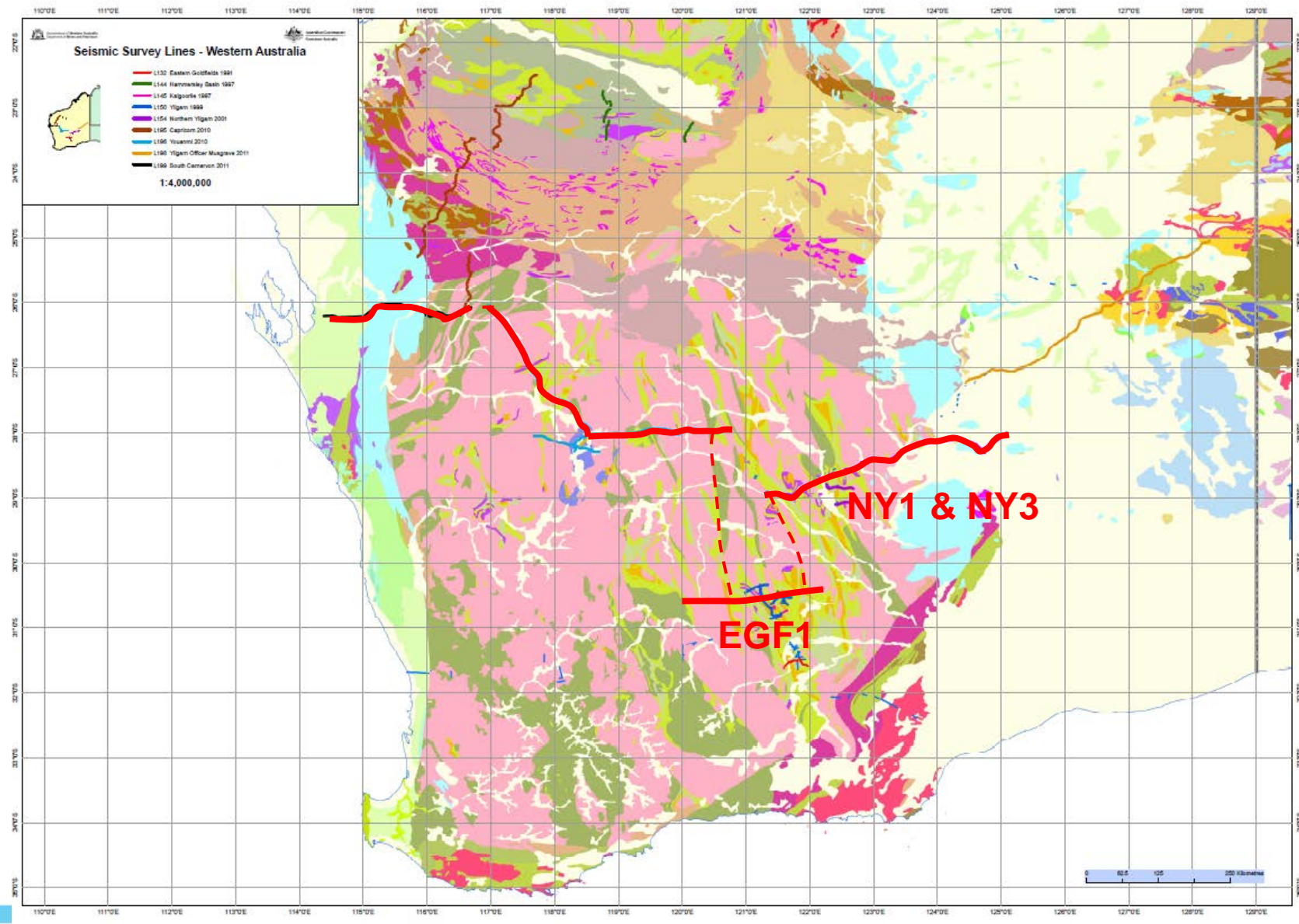
Timing – Kurnalpi Terrane volcanic rocks 2719-2702 Ma – interpreted as intraoceanic arc (Barley et al. 2008; Kositcin et al. 2008)

Schematic cross sections for accretion of eastern Yilgarn terranes

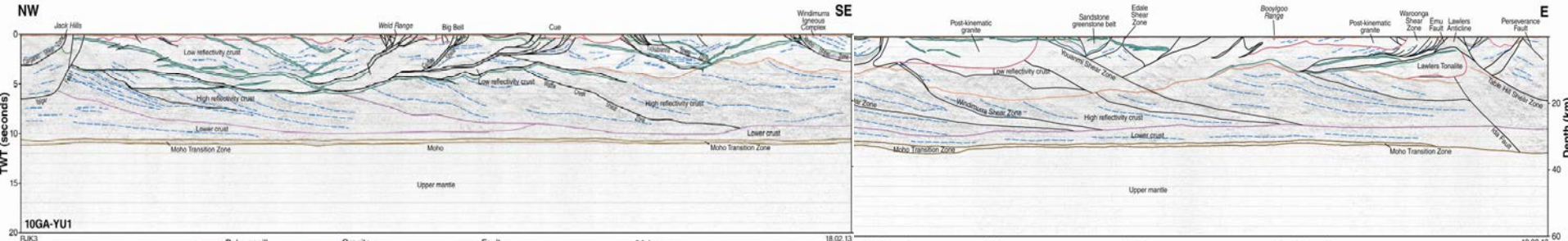
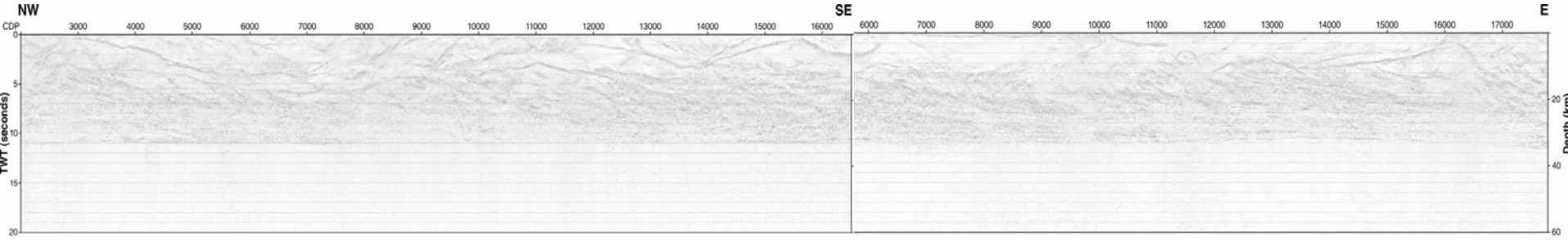


after Korsch et al. (2011)

Transect from Pinjarra orogen to eastern Yilgarn Craton

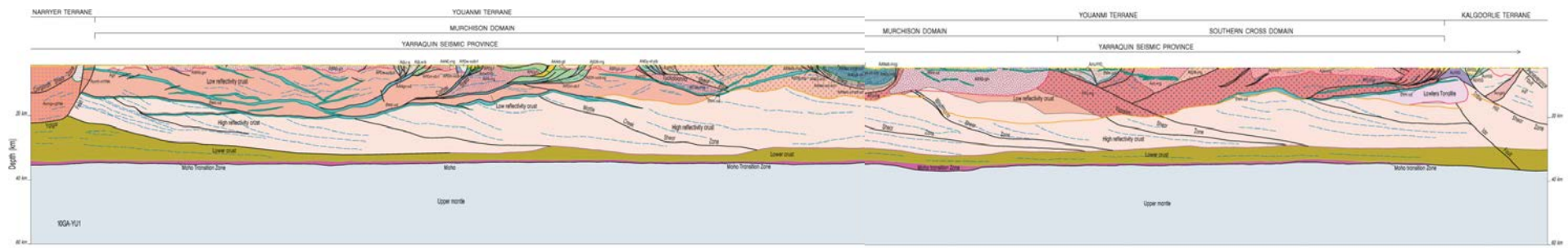


Composite section - Youanmi Terrane

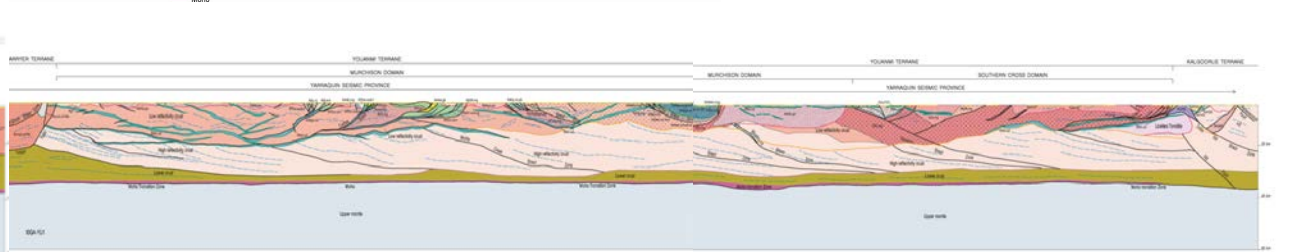
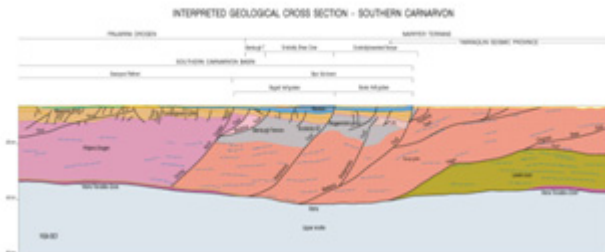
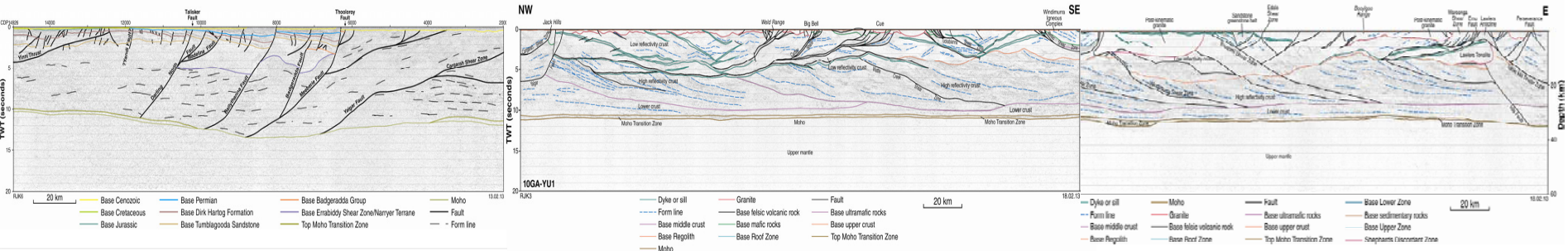
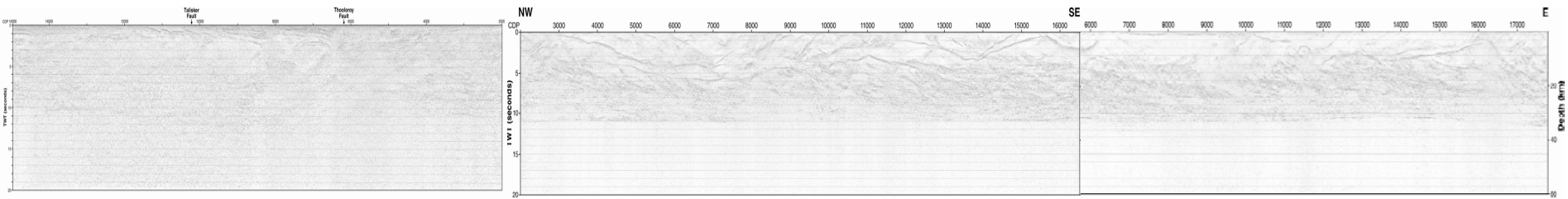


- Dyke or sill
- - - Form line
- Base felsic volcanic rock
- Base mafic rocks
- Base middle crust
- Base Regolith
- Moho
- Granite
- Base ultramafic rocks
- Base felsic volcanic rock
- Base mafic rocks
- Base middle crust
- Base Regolith
- Moho
- Fault
- Base felsic volcanic rock
- Base mafic rocks
- Base middle crust
- Base Regolith
- Moho

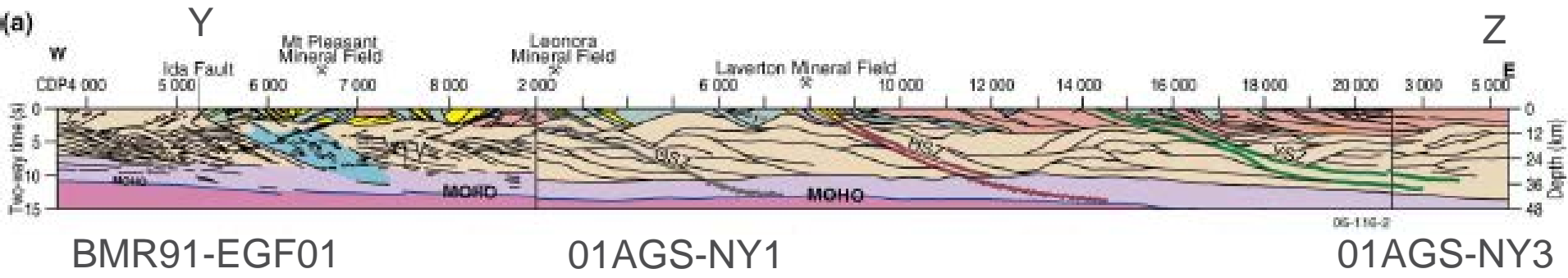
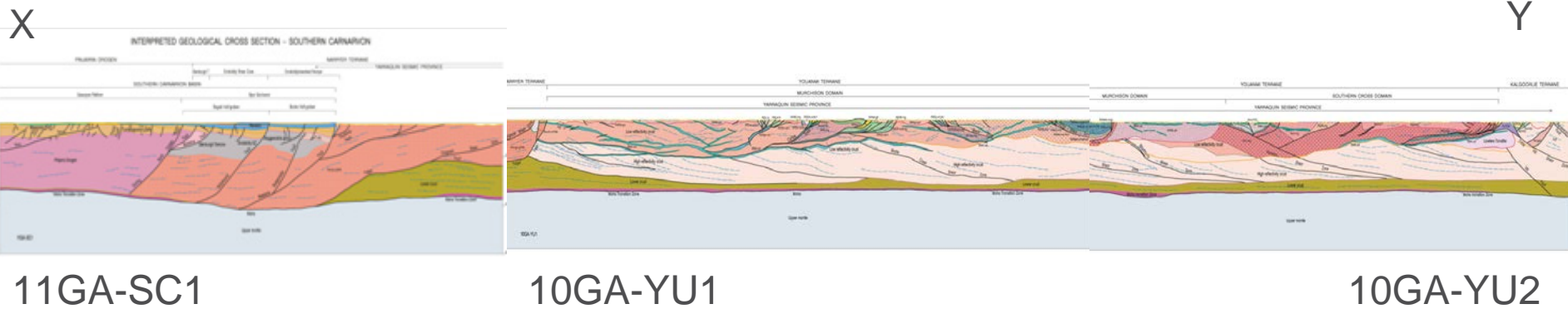
- Dyke or sill
- - - Form line
- Base felsic volcanic rock
- Base mafic rocks
- Base middle crust
- Base Regolith
- Moho
- Granite
- Base ultramafic rocks
- Base felsic volcanic rock
- Base mafic rocks
- Base middle crust
- Base Regolith
- Moho
- Fault
- Base felsic volcanic rock
- Base mafic rocks
- Base middle crust
- Base Regolith
- Moho
- Base Lower Zone
- Base sedimentary rocks
- Base Upper Zone
- Shephards Discordant Zone



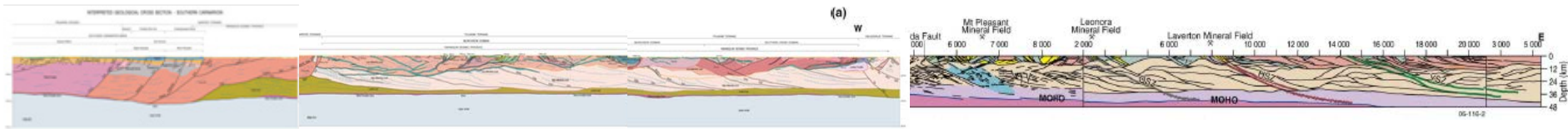
Pinjarra Orogen - Narryer Terrane – Youanmi Terrane



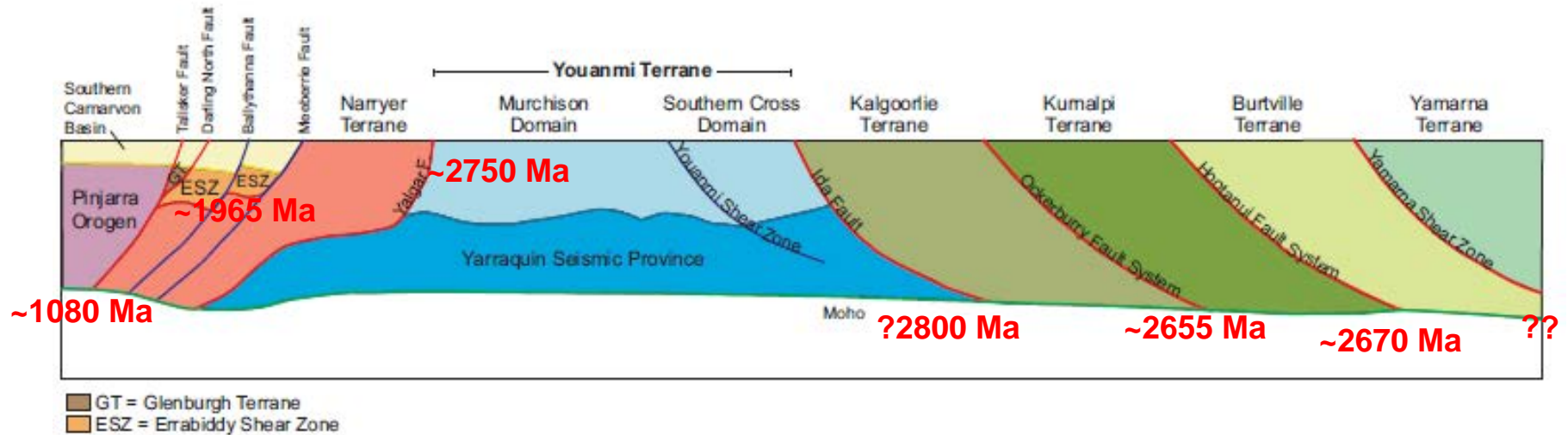
Composite section from Pinjarra orogen to eastern Yilgarn Orogen



Composite section from Pinjarra orogen to eastern Yilgarn Orogen



Cartoon cross section (not to scale) showing present day relationships between the crustal terranes



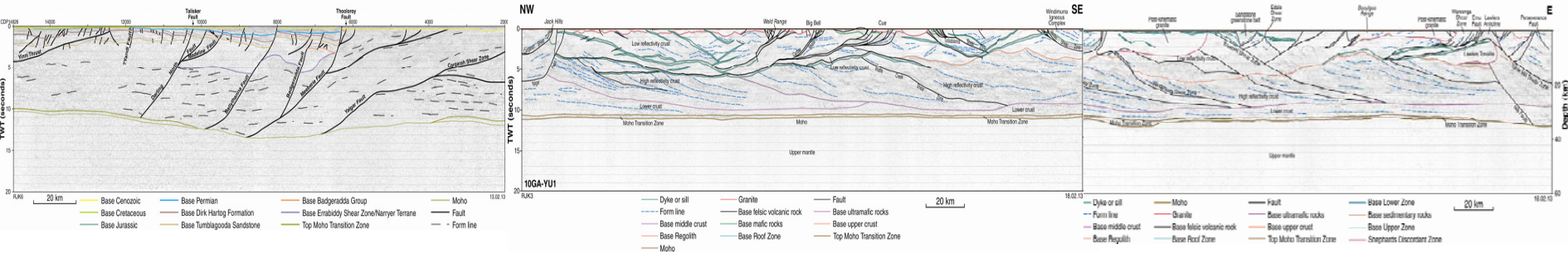
Youanmi Terrane + Yarraquin Seismic Province form a central nucleus, or protocraton of Yilgarn Craton

Narryer Terrane sutured to protocraton in northwest

Terranes of Eastern Goldfields Superterrane in east accreted to protocraton, to form part of the West Australian Craton

Summary 1

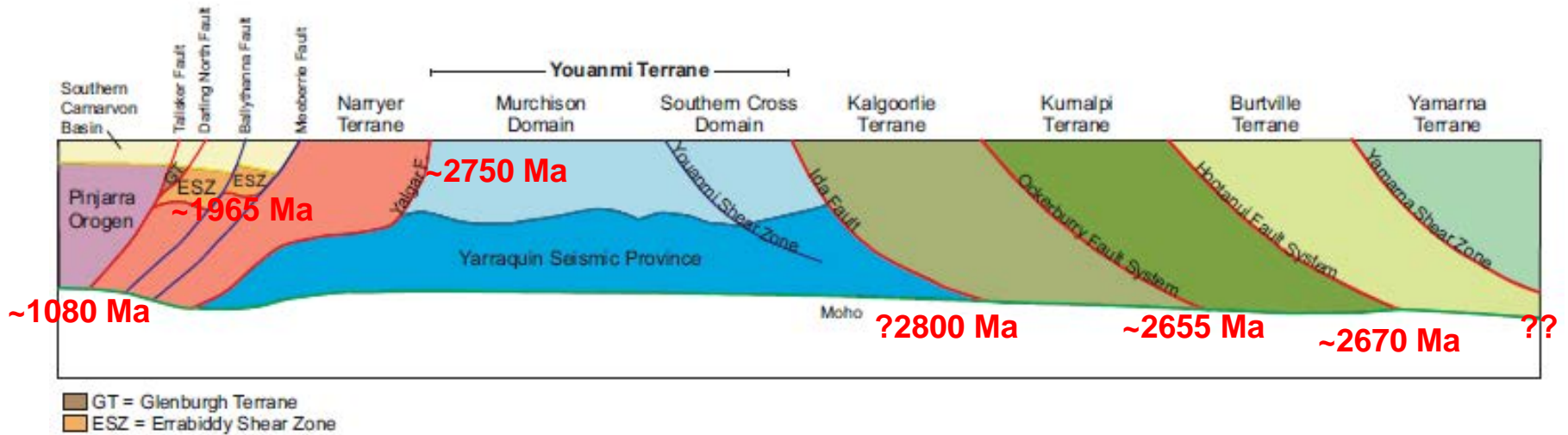
Crustal architecture of Pinjarra Orogen to Ida Fault



- First holistic view of the crustal architecture of the region (954 line km of new seismic data, 695 km of new MT)
- Several crustal-scale terranes
 - Including newly recognised seismic province
- Youanmi Terrane + Yarraquin SP = 3 layer crust
- Narryer Terrane – different seismic reflectivity & MT

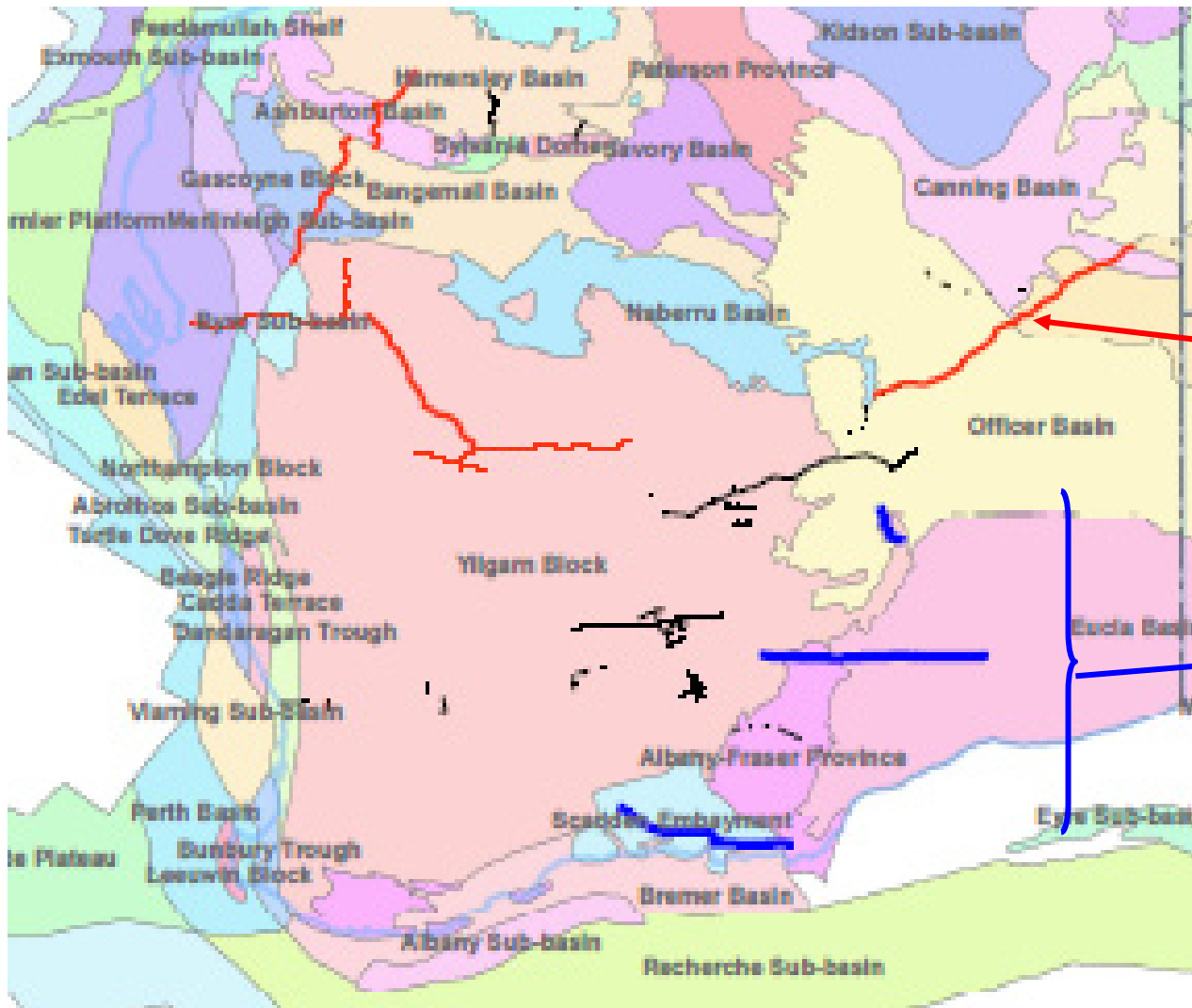
Summary 2

Assembly of part of West Australian Craton



- Several probable sutures recognised
- Progressive accretion of continental slivers onto protocraton (ie Youanmi Terrane and Yarraquin Seismic Province)

Coming soon: Transect across southern Western Australia



**YOM (484 km)
19 June 2013**

**Albany-Fraser &
Tropicana
(672 km)
March 2014**



Australian Government
Geoscience Australia



THANK YOU

Seismic data and interpretations can be downloaded from:
<http://www.ga.gov.au/minerals/projects/current-projects/seismic-acquisition-processing.html>

Phone: +61 2 6249 9111

Web: www.ga.gov.au

Email: Russell.Korsch@ga.gov.au

Address: Cnr Jerrabomberra Avenue and Hindmarsh Drive, Symonston ACT 2609

Postal Address: GPO Box 378, Canberra ACT 2601