



**Australian Government**  
**Geoscience Australia**

# **Geodynamic implications of the Capricorn deep seismic survey: From the Pilbara Craton to the Yilgarn Craton**

Russell Korsch, SP Johnson, IM Tyler, AM Thorne, RS Blewett, HN Cutten, A Joly, MC Dentith, ARA Aitken, J Goodwin and BLN Kennett

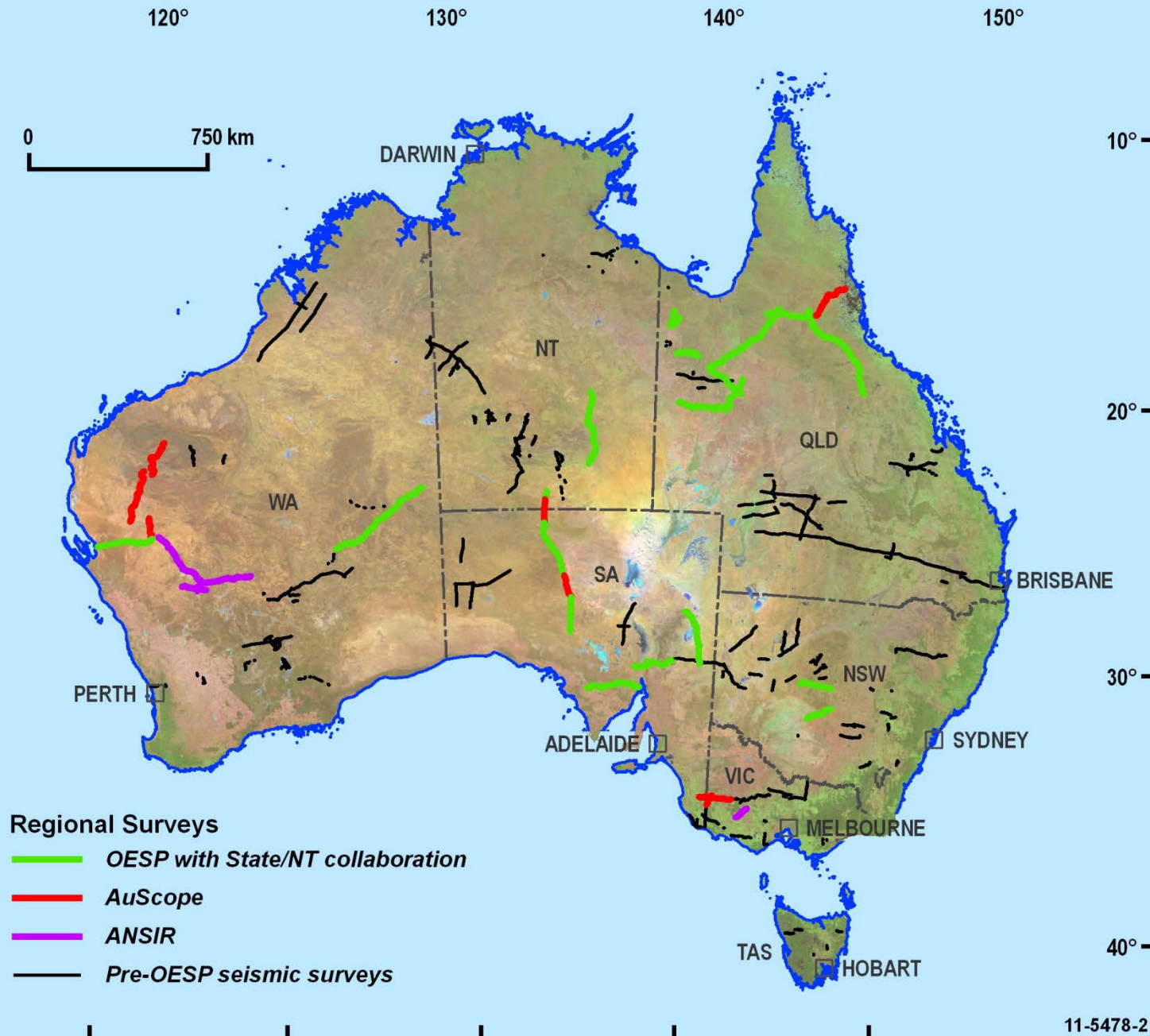


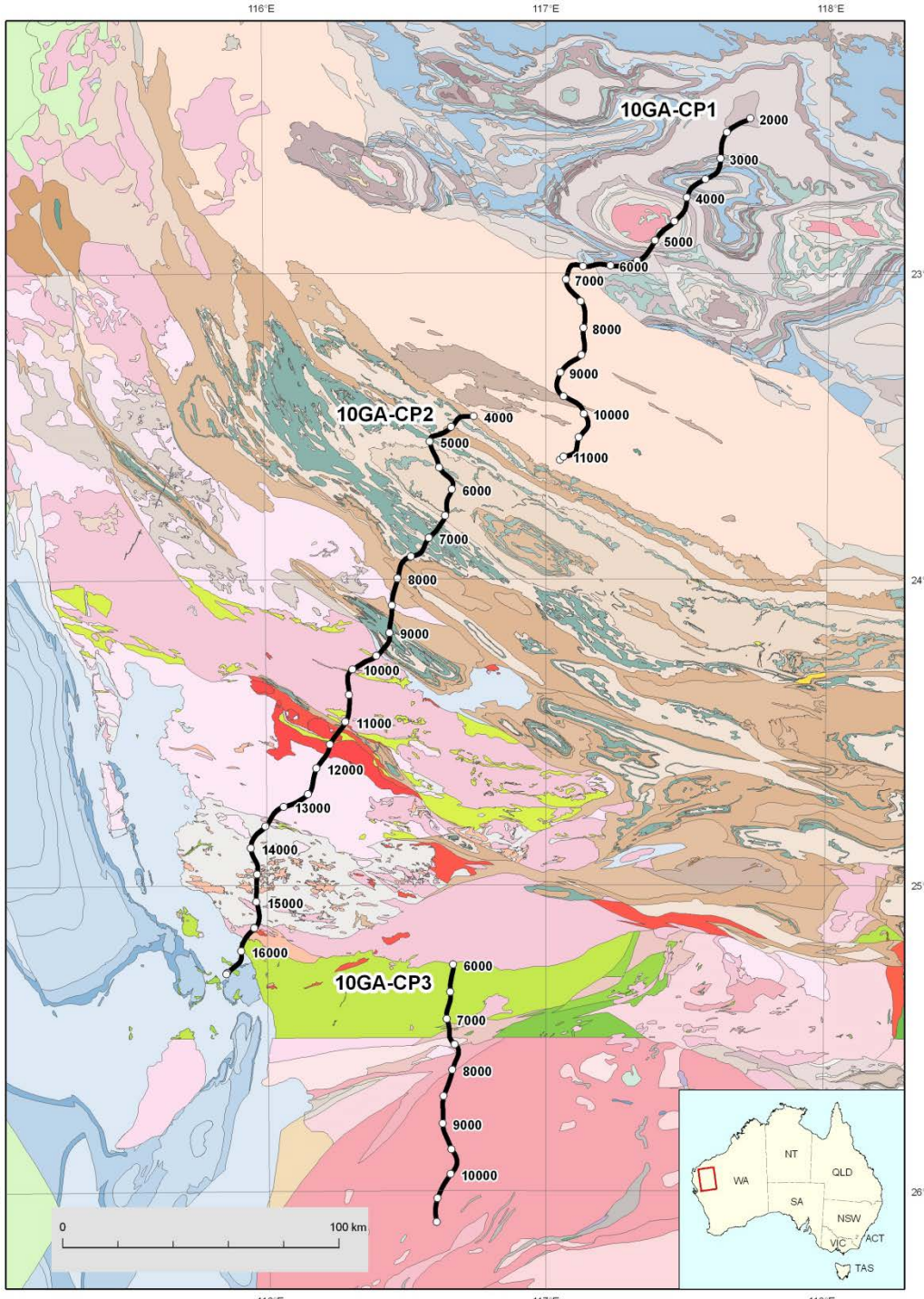
Government of **Western Australia**  
Department of **Mines and Petroleum**



THE UNIVERSITY OF  
WESTERN AUSTRALIA

# Deep seismic reflection lines in Australia





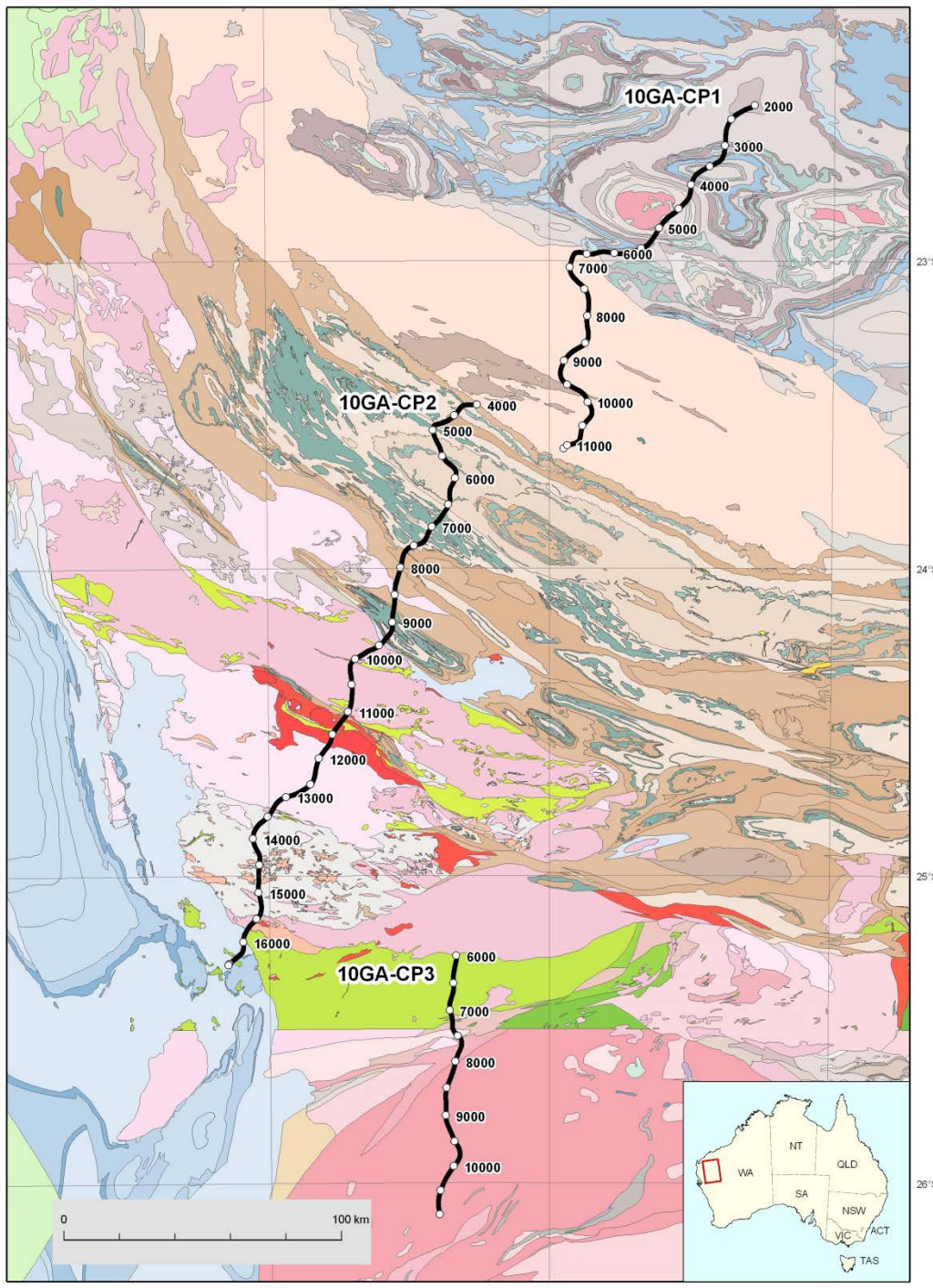
## Aims

**Crustal architecture  
(Series of discrete upper  
crustal and basement  
blocks)**

**Speculations on  
geodynamic evolution  
of the region**

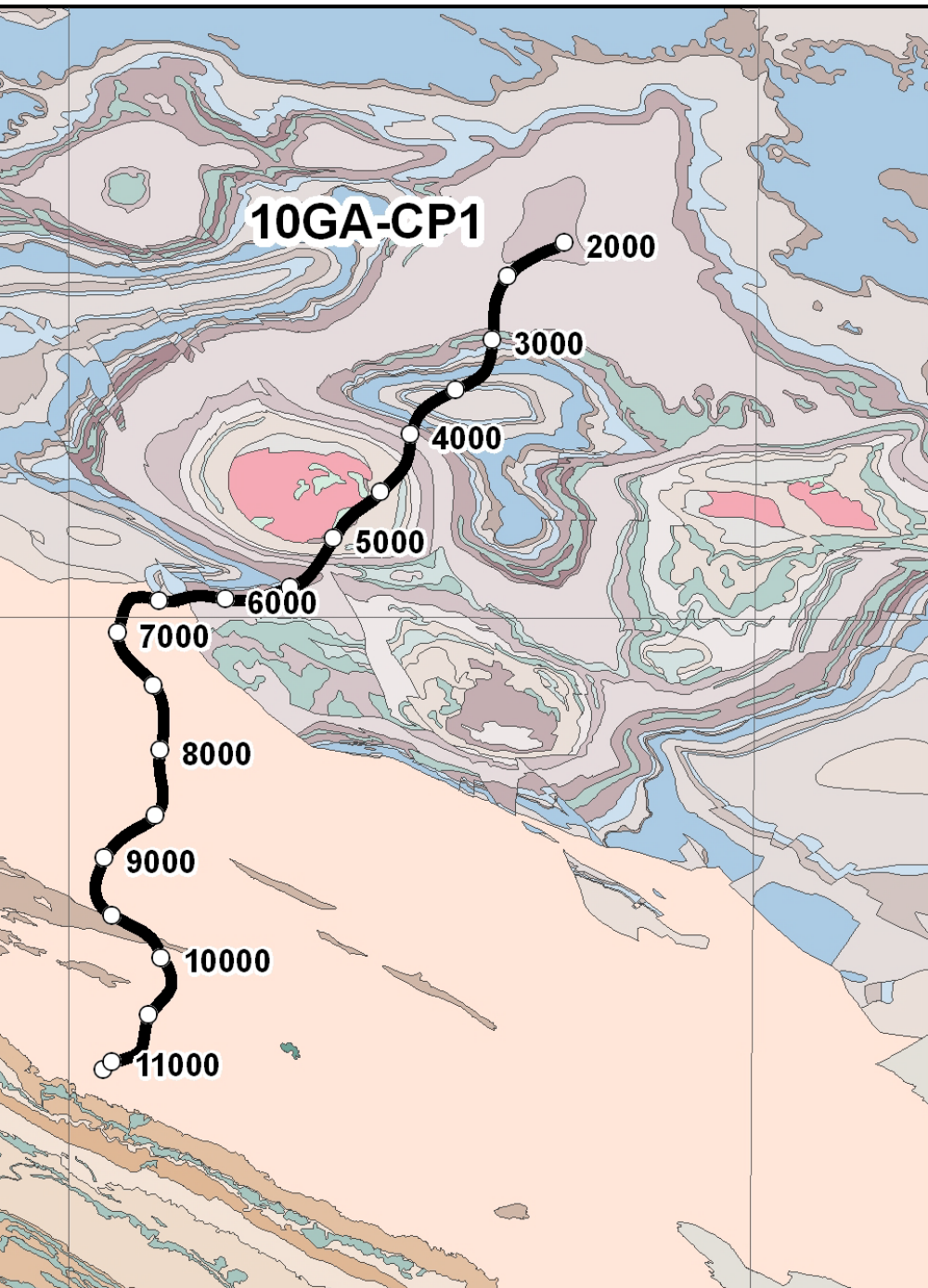
# Key Upper Crustal Provinces and Basins

**Fortescue Basin**  
**Hamersley Basin**  
**Pilbara Craton**  
**Ashburton Basin**  
**Edmund Basin**  
**Collier Basin**  
**Gascoyne Province**  
- Glenburgh Terrane  
**Yilgarn Craton**  
- Narryer Terrane



117°E

118°E



# 10GA-CP1

Fortescue Basin  
Hamersley Basin

Pilbara Craton

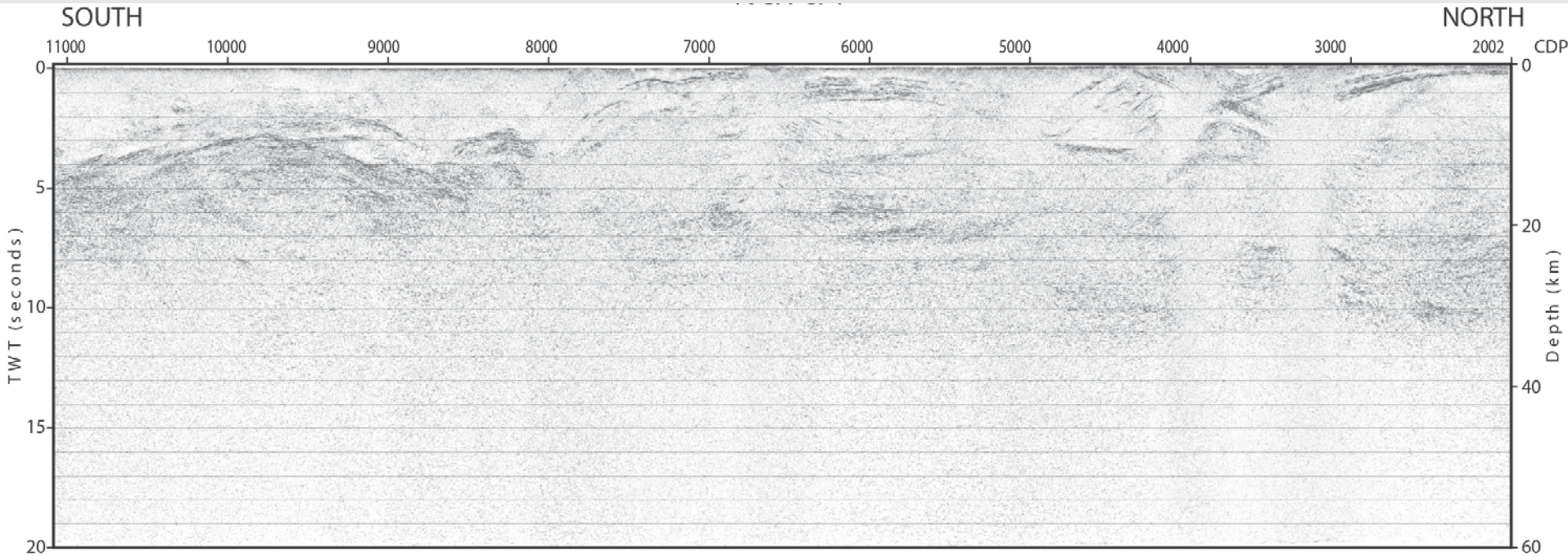
- Rocklea Dome

Ashburton Basin

23°S



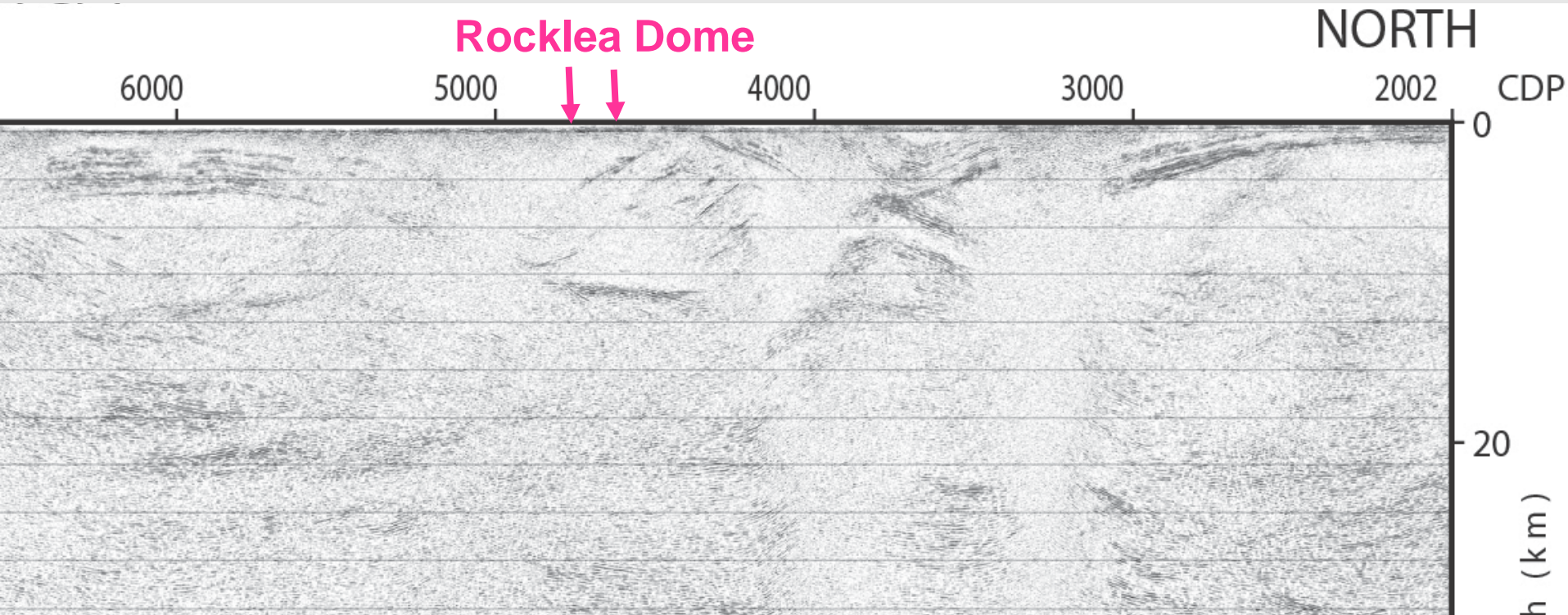
# 10GA-CP1



**Note:  $V = H$  (assuming average crustal velocity =  $6000 \text{ ms}^{-1}$ )**

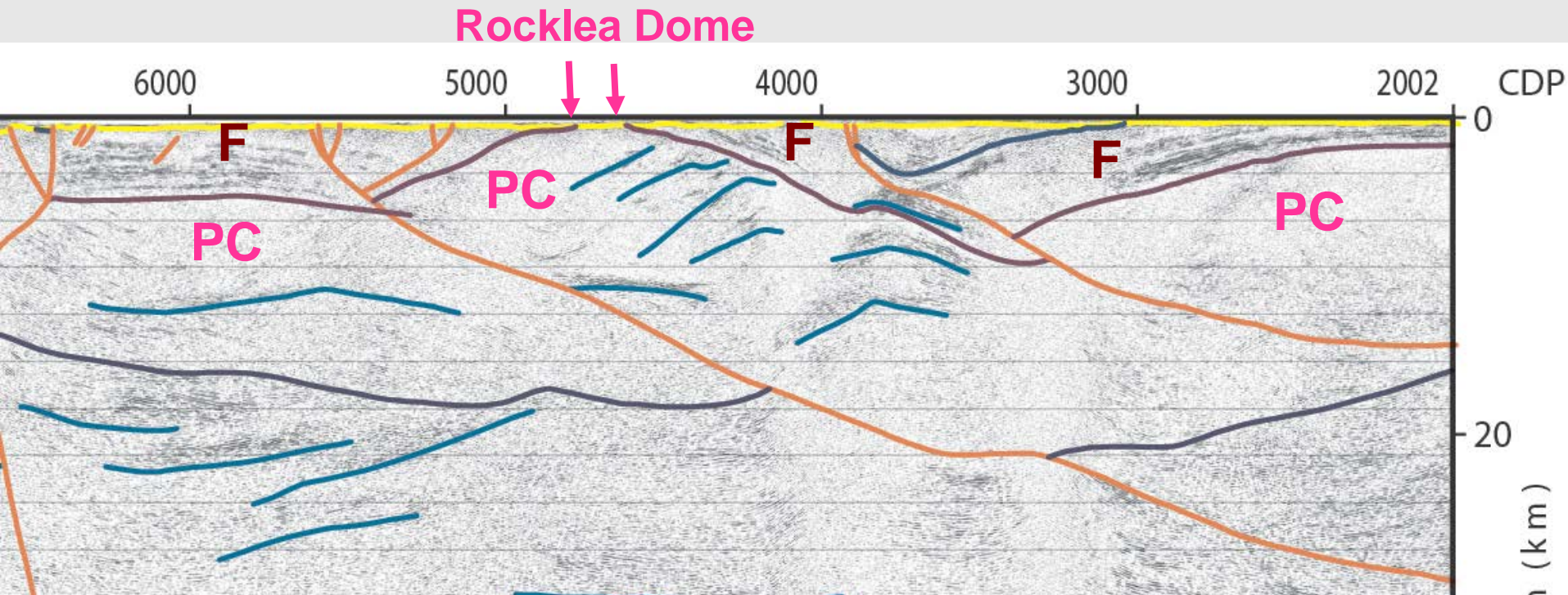
- Moho** – poorly defined
- transition zone between lower crust and upper mantle
  - interpreted at  $\sim 11.5\text{-}13 \text{ s TWT}$  ( $\sim 34\text{-}39 \text{ km depth}$ )

# 10GA-CP1 (northern end) Pilbara Craton



**Oldest rocks at surface along the seismic lines occur in Rocklea Dome (Pilbara Craton) (>2775 Ma)**

# 10GA-CP1 (northern end) Pilbara Craton

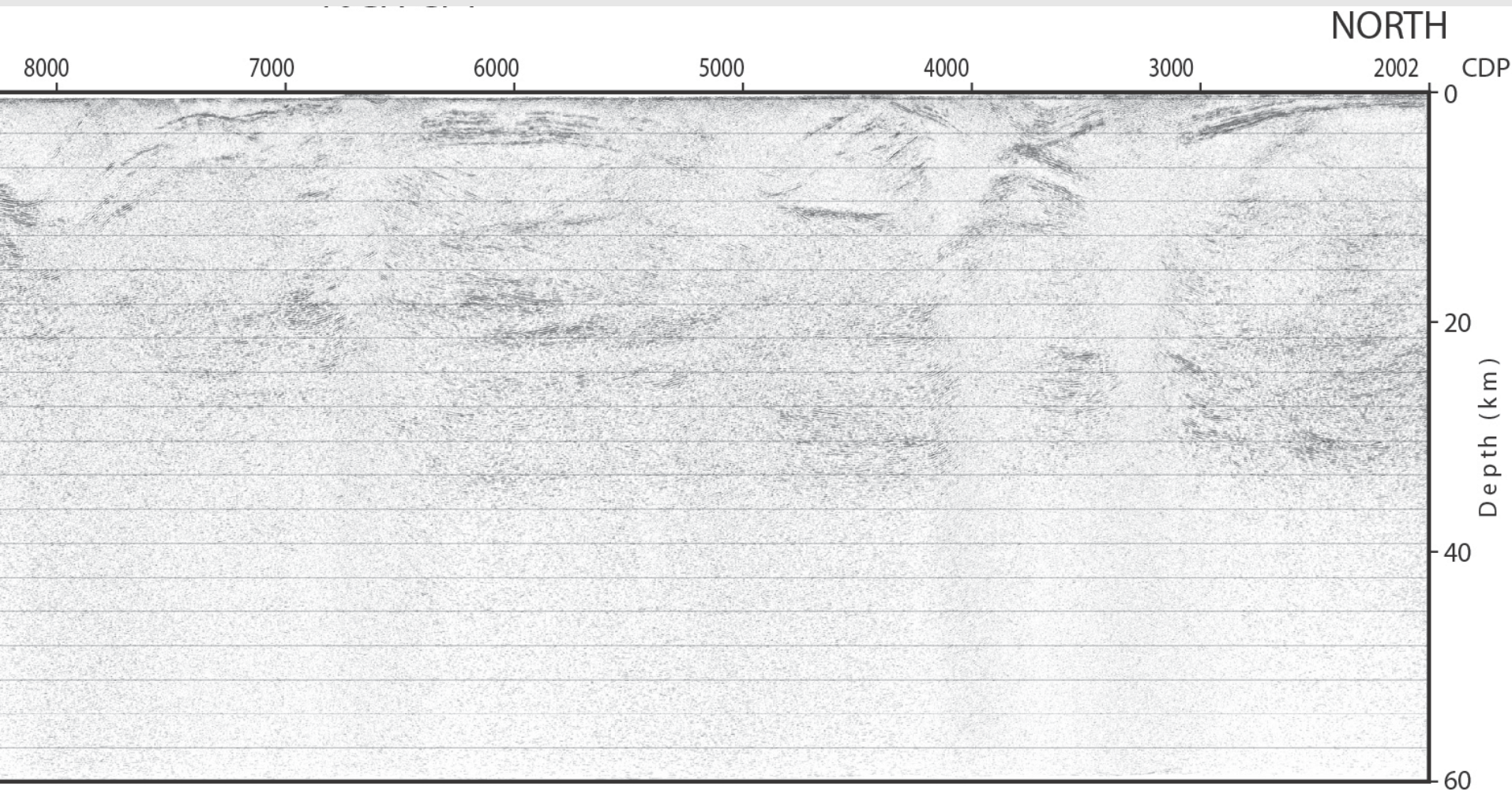


**F = Fortescue Basin (stratigraphic layering)**  
**PC = Pilbara Craton (generally weakly reflective)**

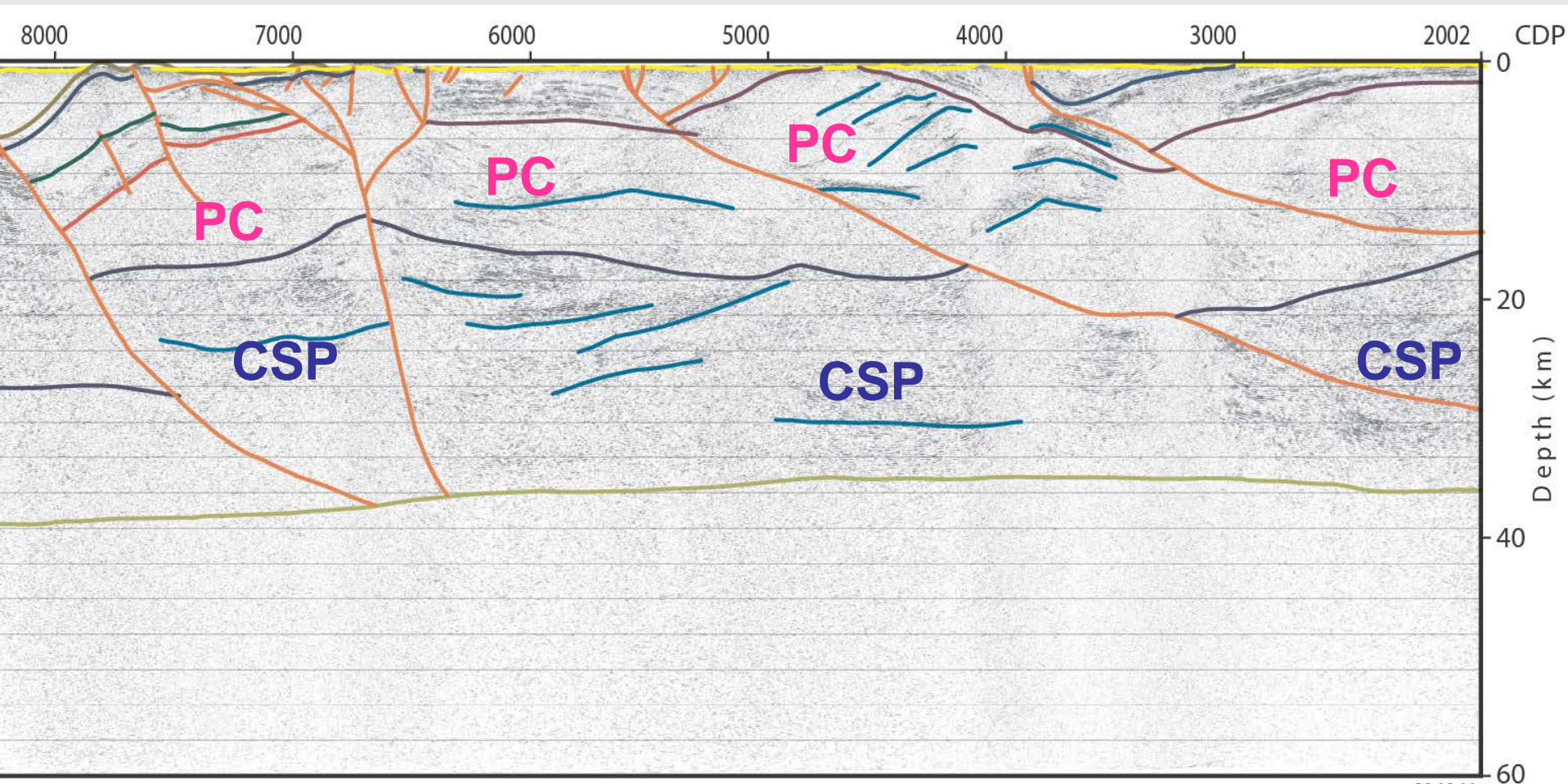


# 10GA-CP1 (northern end) Carlathunda Seismic Province

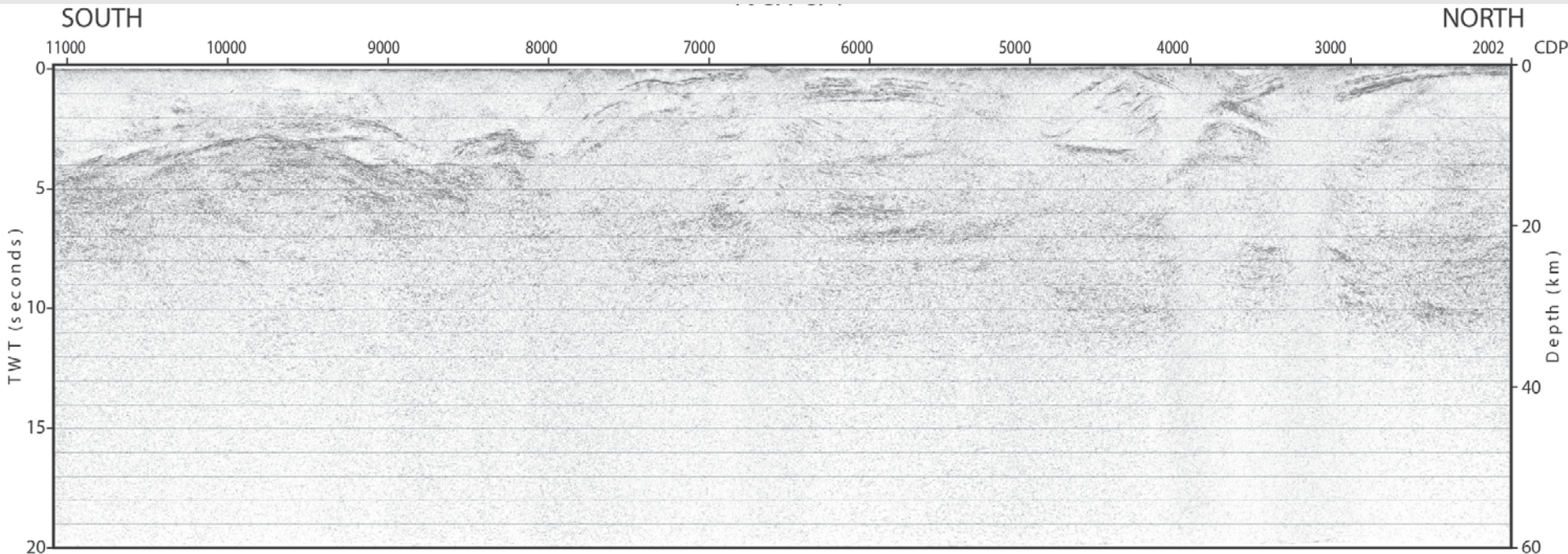
Strongly reflective lower crust (cf. Pilbara Craton)



# 10GA-CP1 (northern end) Carlathunda Seismic Province



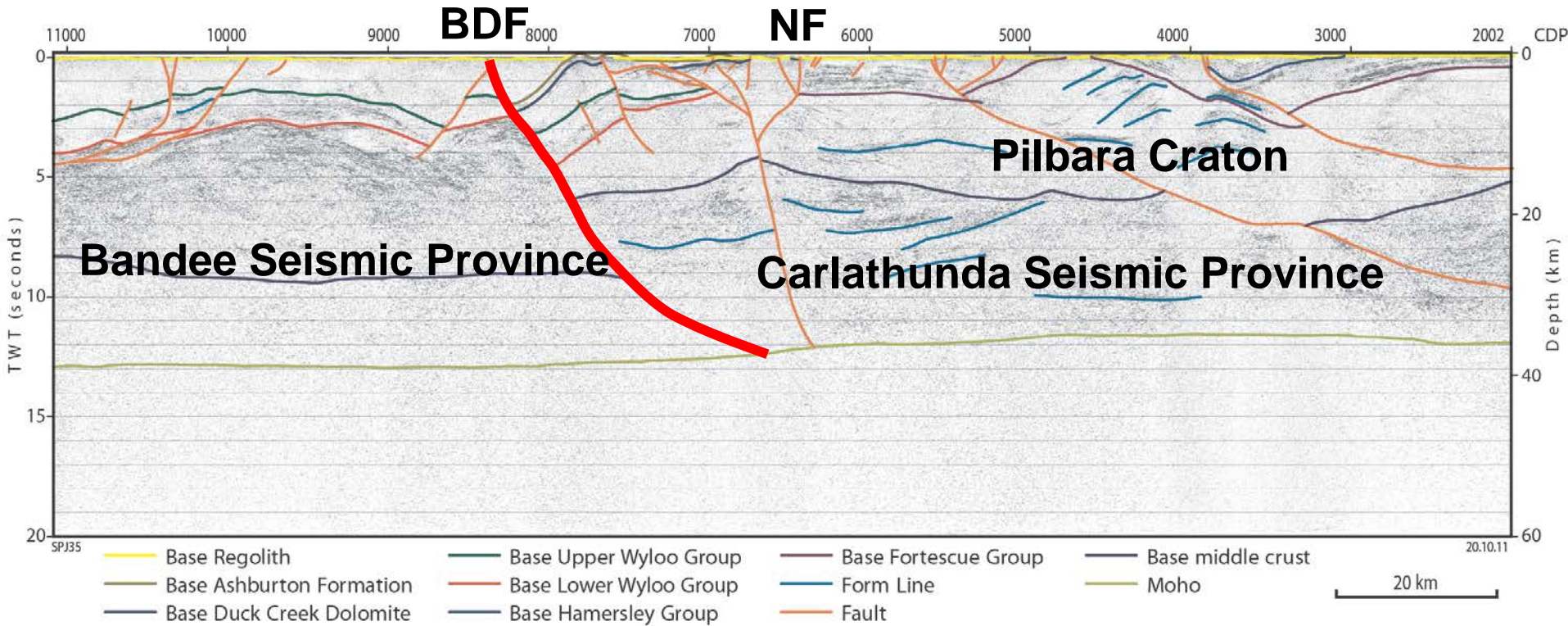
# 10GA-CP1 (entire line) Bandee Seismic Province



- North** – weakly reflective upper-middle crust (Pilbara Craton)
  - strongly reflective lower crust (Carlathunda Seismic Province)
- South** – strongly reflective middle crust beneath Ashburton Basin
  - weakly reflective lower crust

# 10GA-CP1

## Bandee Seismic Province

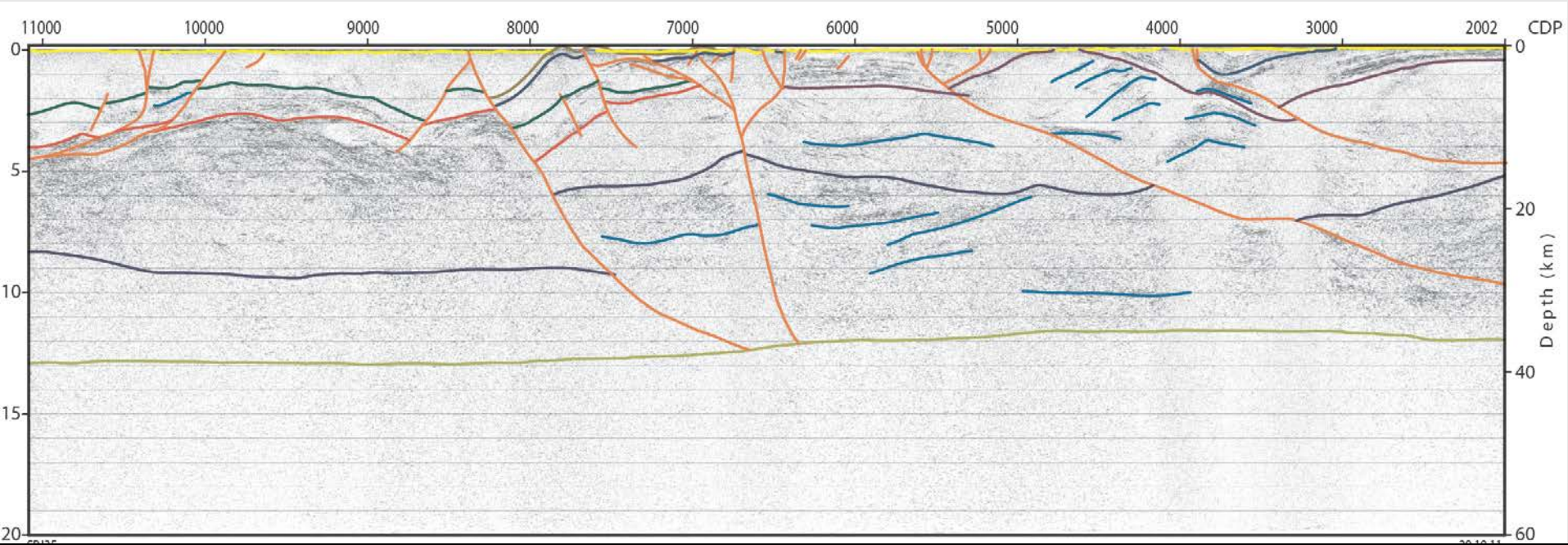


**Different crustal reflectivity on either side of Baring Downs Fault**

**Is it a fossil suture zone?**

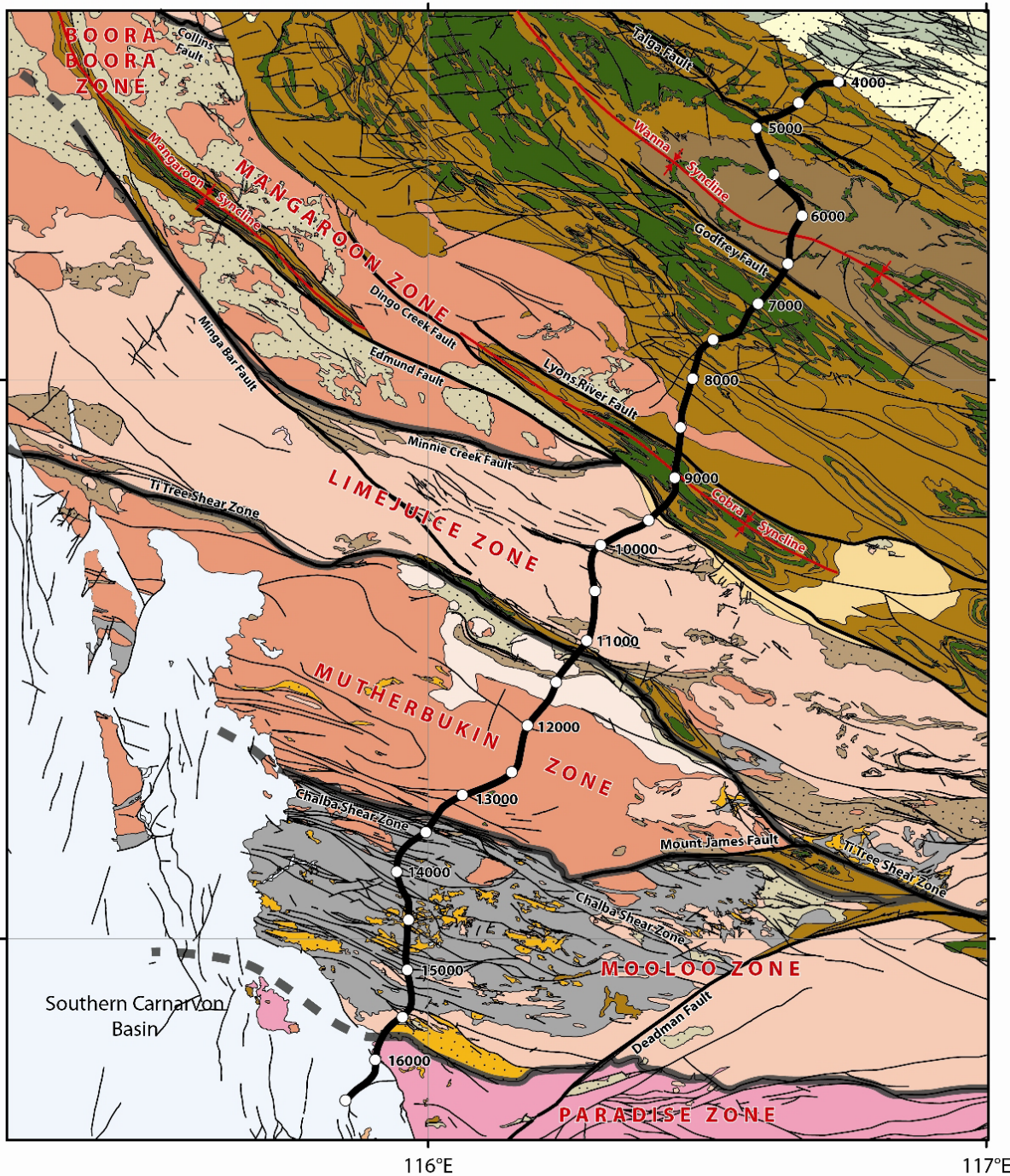
**If so, when did it form?**

**Pre-deposition of lower Wyloo Group (>2210 Ma), and possibly pre-deposition of Hamersley Group (>2630 Ma)**

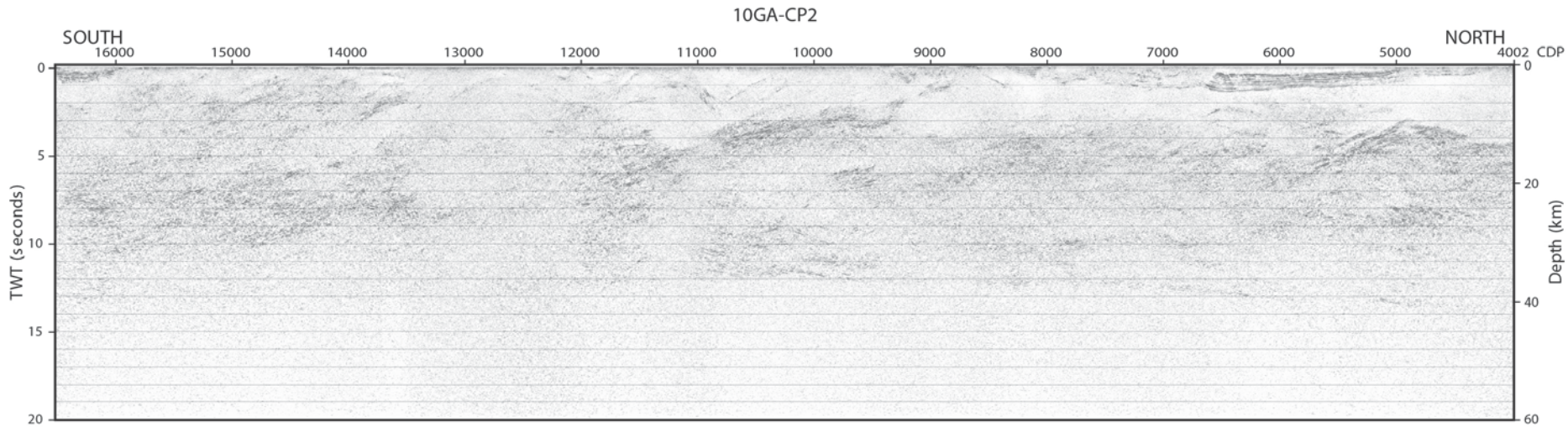


# 10GA-CP2

Crosses  
Edmund &  
Collier  
Basins  
and several  
zones in  
Gascoyne  
Province



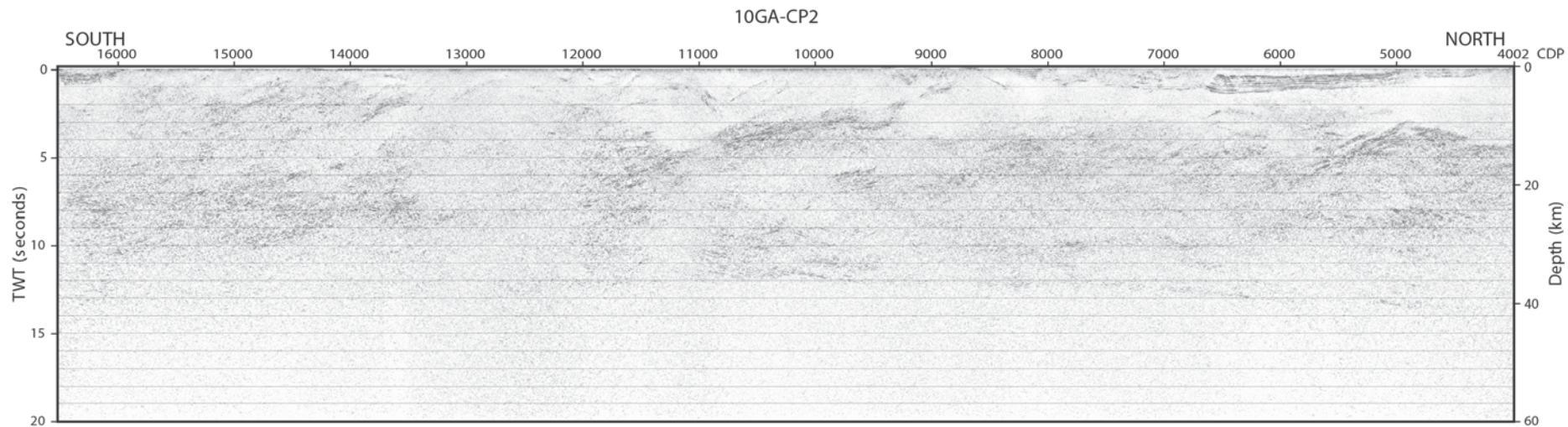
# 10GA-CP2



- Moho** – reasonably well defined in northern half
  - thinnest in centre at ~12 s TWT (~36 km depth)
  - southern end possibly at 15 s TWT (interpreted from north end of 10GA-CP3)

# 10GA-CP2

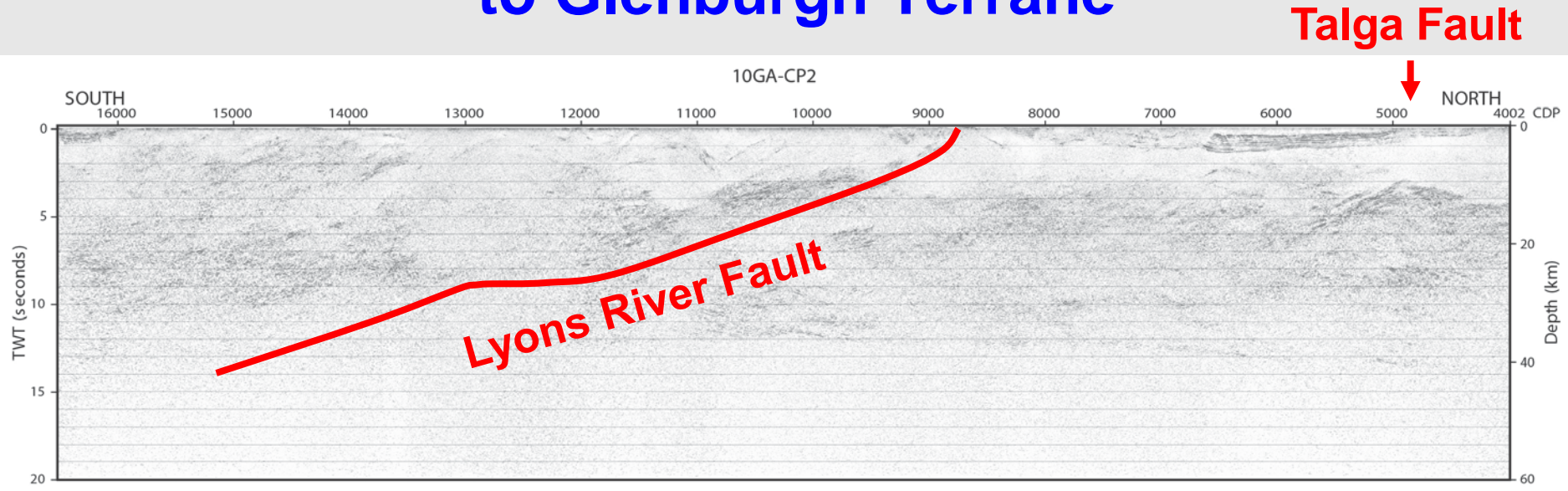
## Bandee Seismic Province – continue from 10GA-CP1 Glenburgh Terrane – surface mapping Are they the same?





# 10GA-CP2

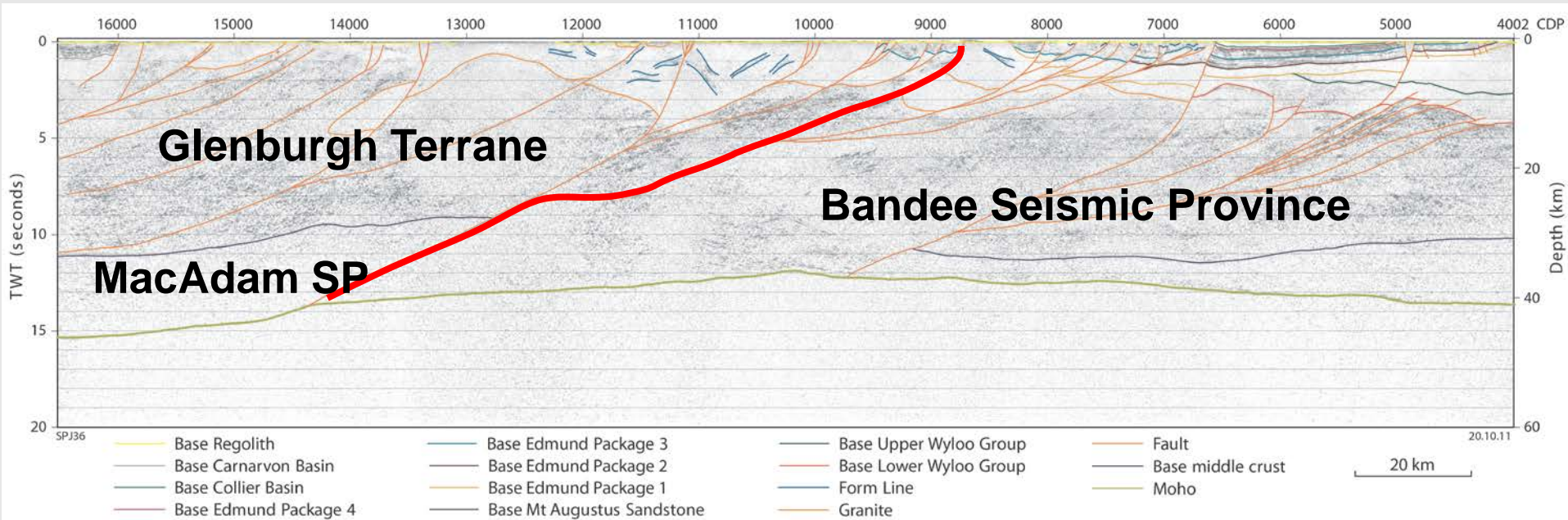
## Bandee Seismic Province to Glenburgh Terrane

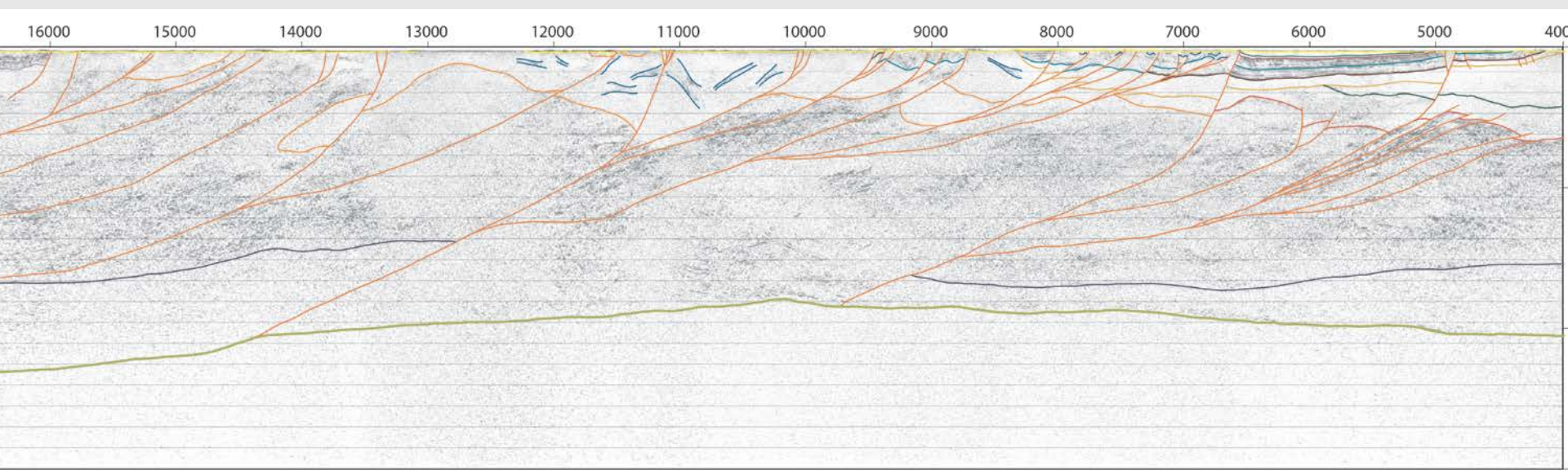


**Lyons River Fault – site of change in nature of crustal reflectivity**  
**Talga Fault – significant fault within Bandee Seismic Province**  
**(consistent basement reflectivity on either side)**

# 10GA-CP2

## Bandee Seismic Province to Glenburgh Terrane





GASCOYNE PROVINCE

PARADISE ZONE      MOOLOO ZONE      MUTHERBUKIN ZONE      LIMEJUICE ZONE      MANGAROON ZONE      BOORA BOORA ZONE

# Relationship between Bandee Seismic Province and Glenburgh Terrane

Is the Lyons River fault a fossil suture zone?

GASCOYNE PROVINCE

PARADISE ZONE

MOOLOO ZONE

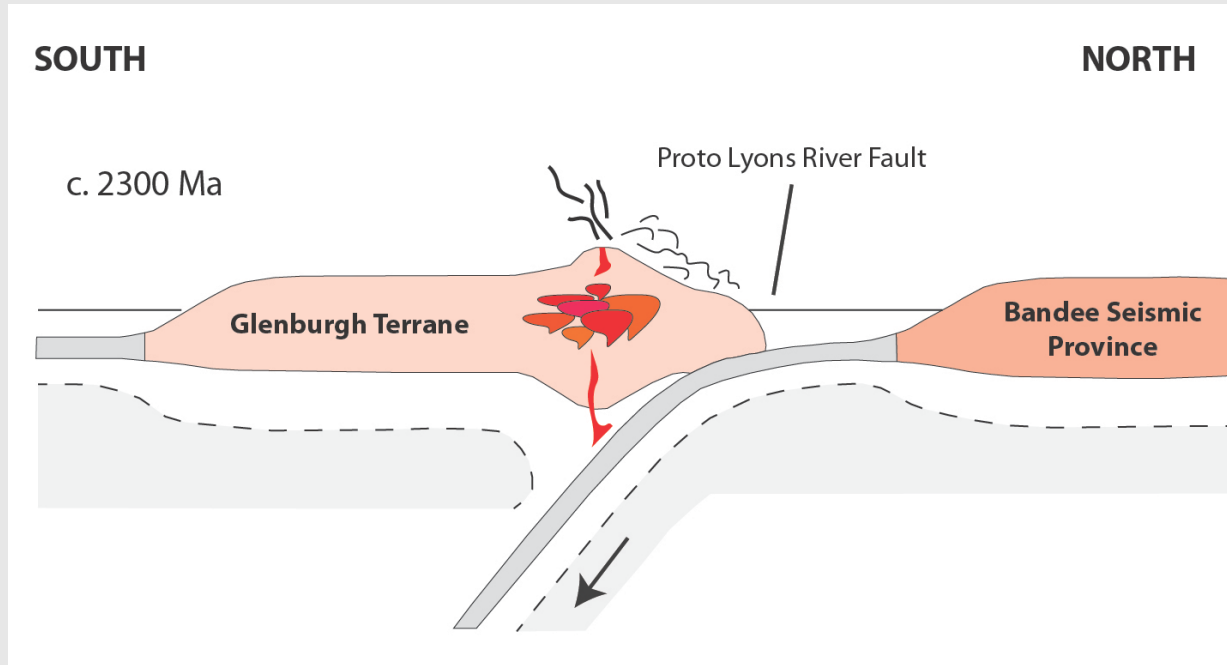
MUTHERBUKIN ZONE

LIMEJUICE ZONE

MANGAROON ZONE

BOORA BOORA ZONE

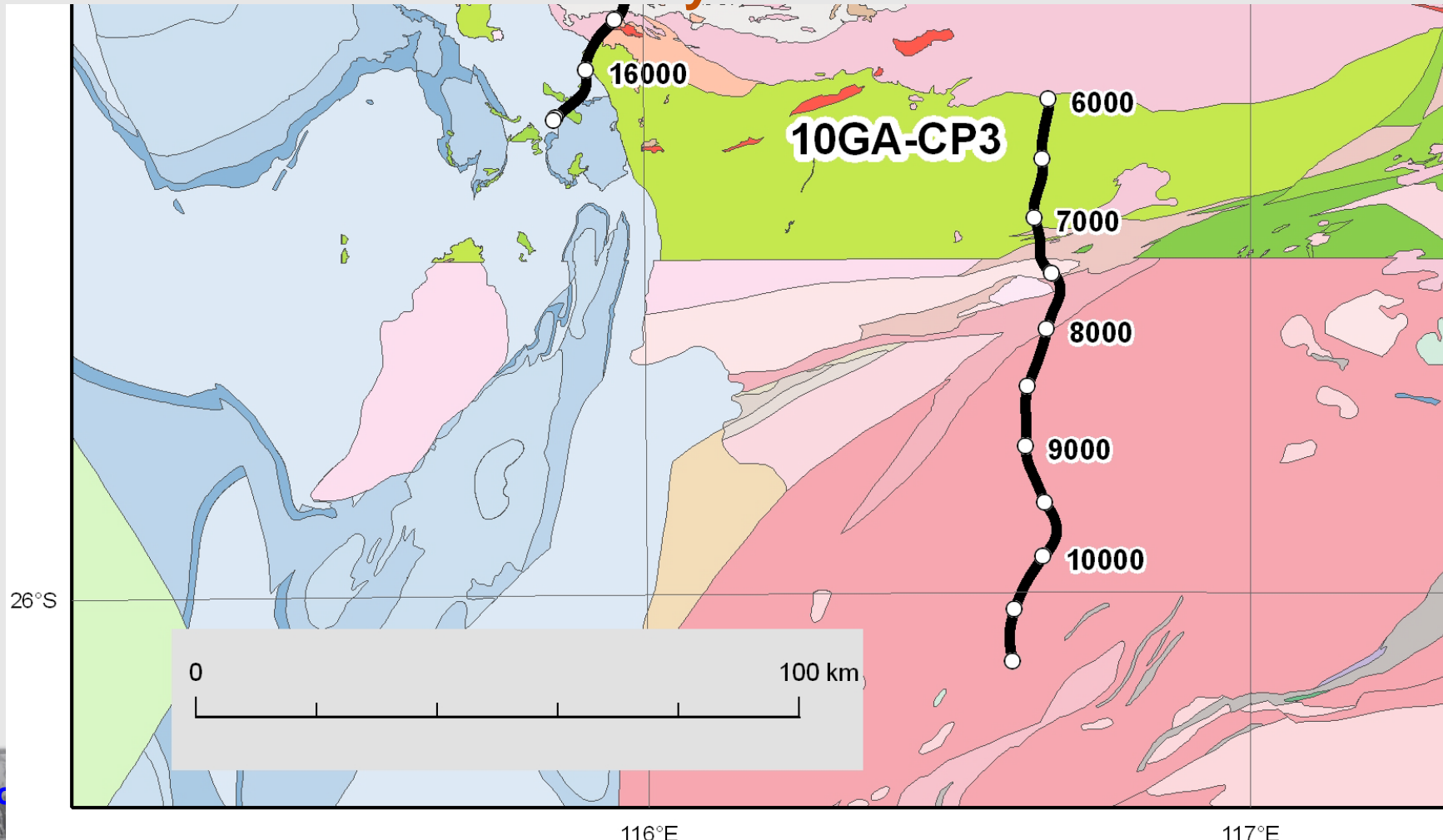
# Collision between Bandee Seismic Province and Glenburgh Terrane?



Timing – after oldest rocks in Glenburgh Terrane (protolith of Halfway Gneiss protolith max 2555 Ma)  
-- most likely at ~2215 Ma, during Ophthalmian Orogeny  
Polarity of subduction is poorly constrained

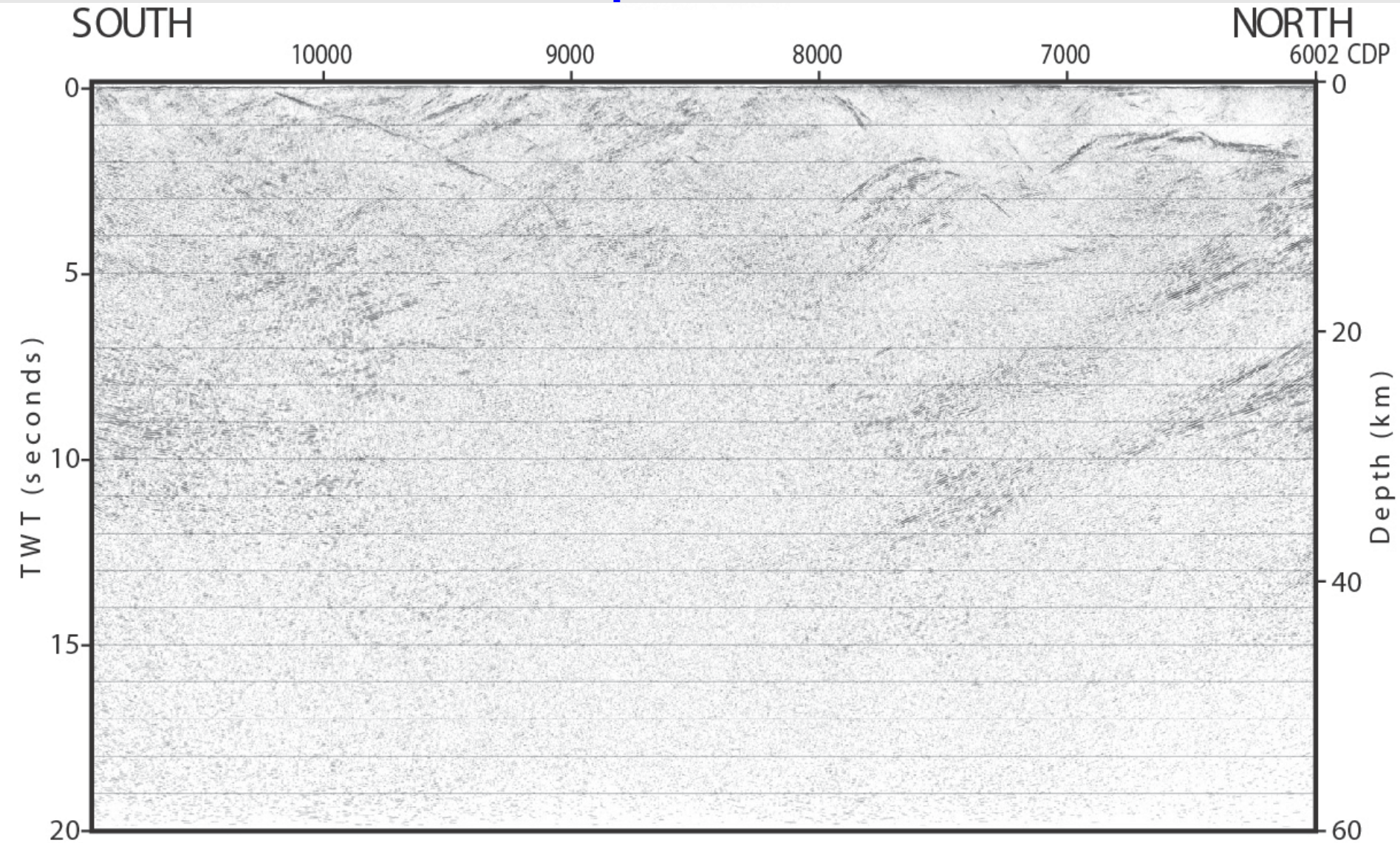
# 10GA-CP3

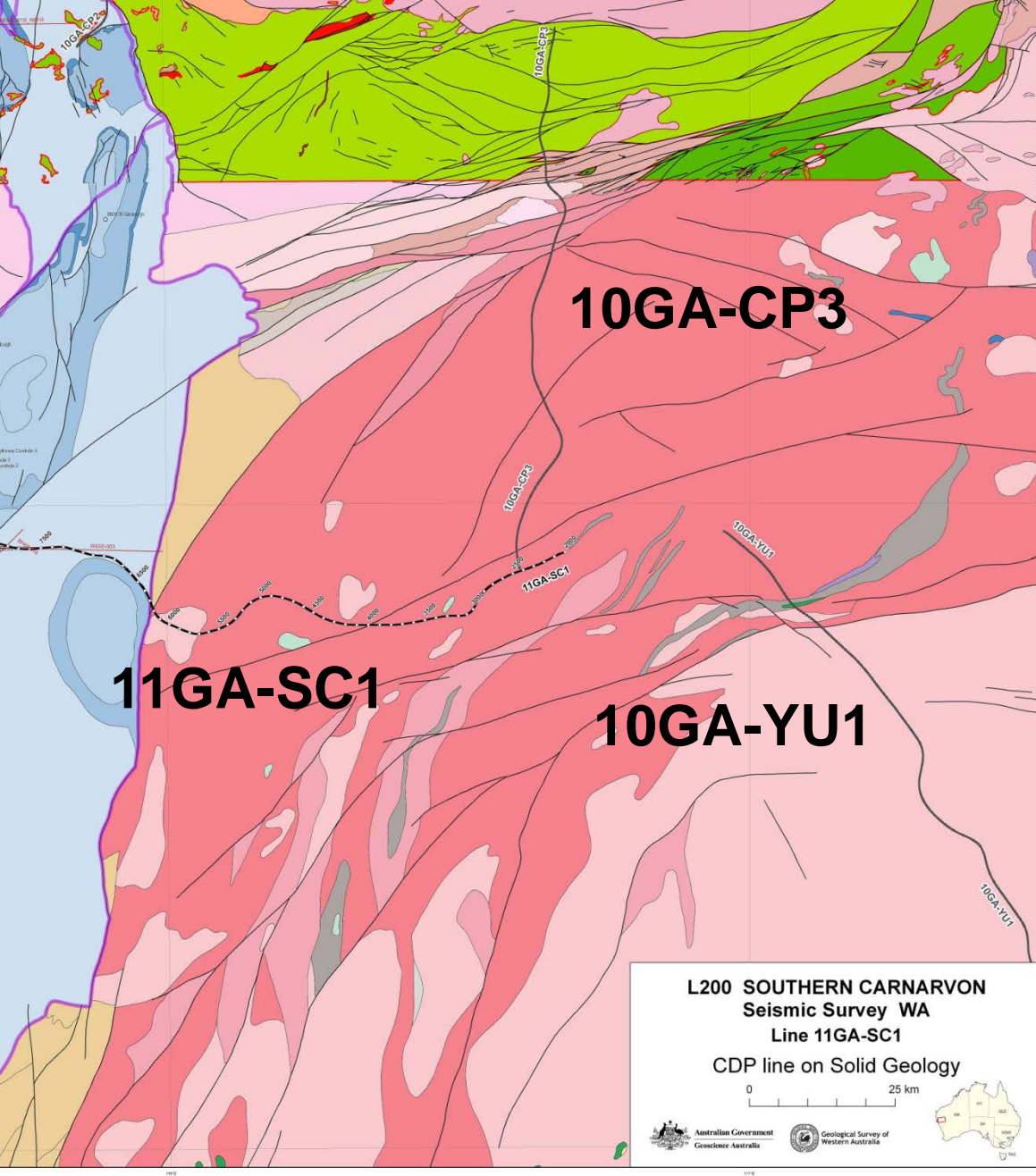
Glenburgh Terrane  
Errabiddy Shear Zone  
Yilgarn Craton  
- Narryer Terrane



# 10GA-CP3

## Moho – difficult to interpret





## Capricorn, Youanmi & southern Carnarvon seismic lines



**Southern end of  
10GA-CP3**



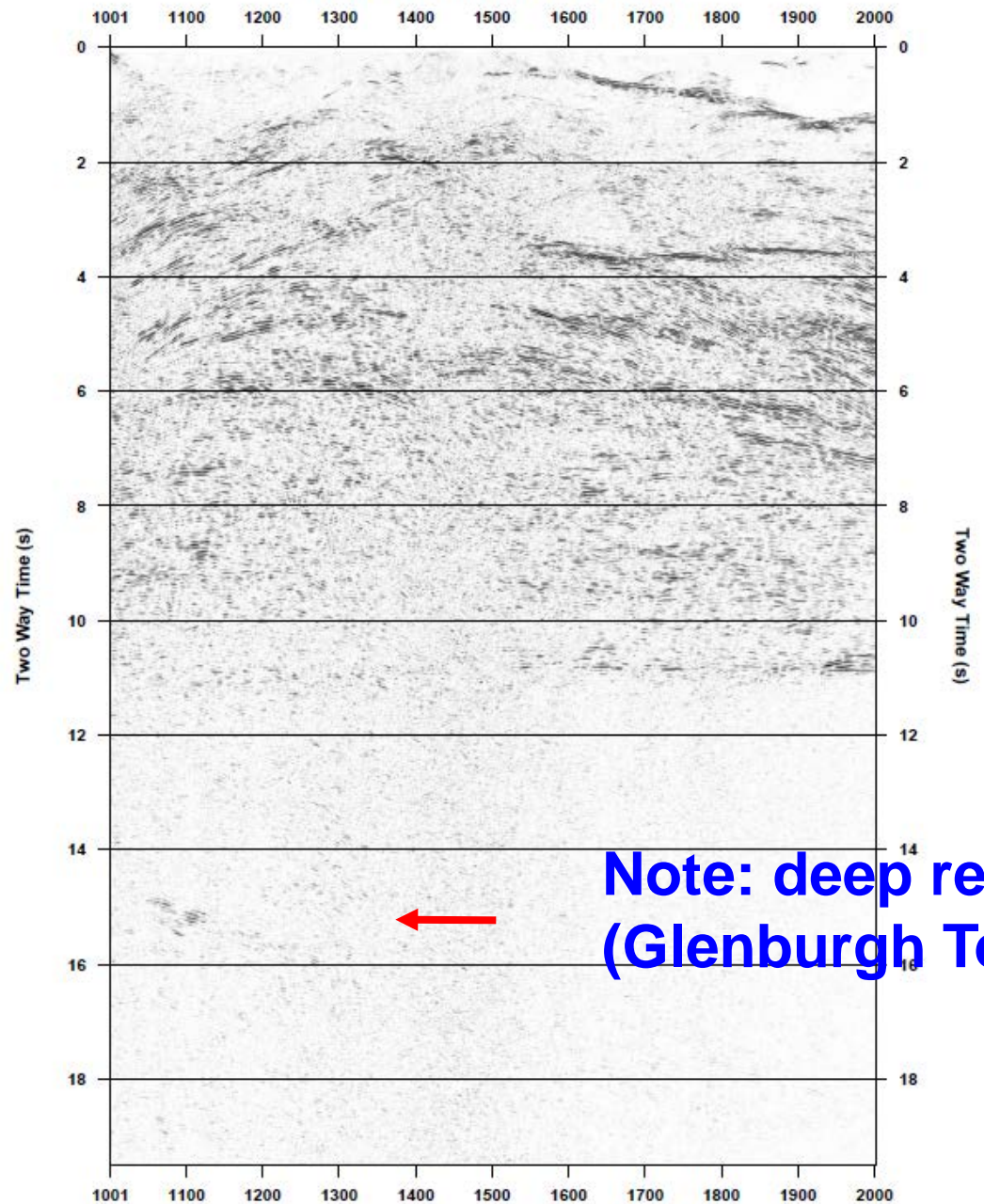
**11GA-SC1  
(eastern end)  
Moho at ~11 s TWT**



**Moho (~11 s TWT)**

|      |      |      |      |         |      |
|------|------|------|------|---------|------|
| 3500 | 3000 | 2500 | 2002 | CDP     | 4000 |
| 1750 | 1500 | 1250 | 1001 | STATION | 2000 |





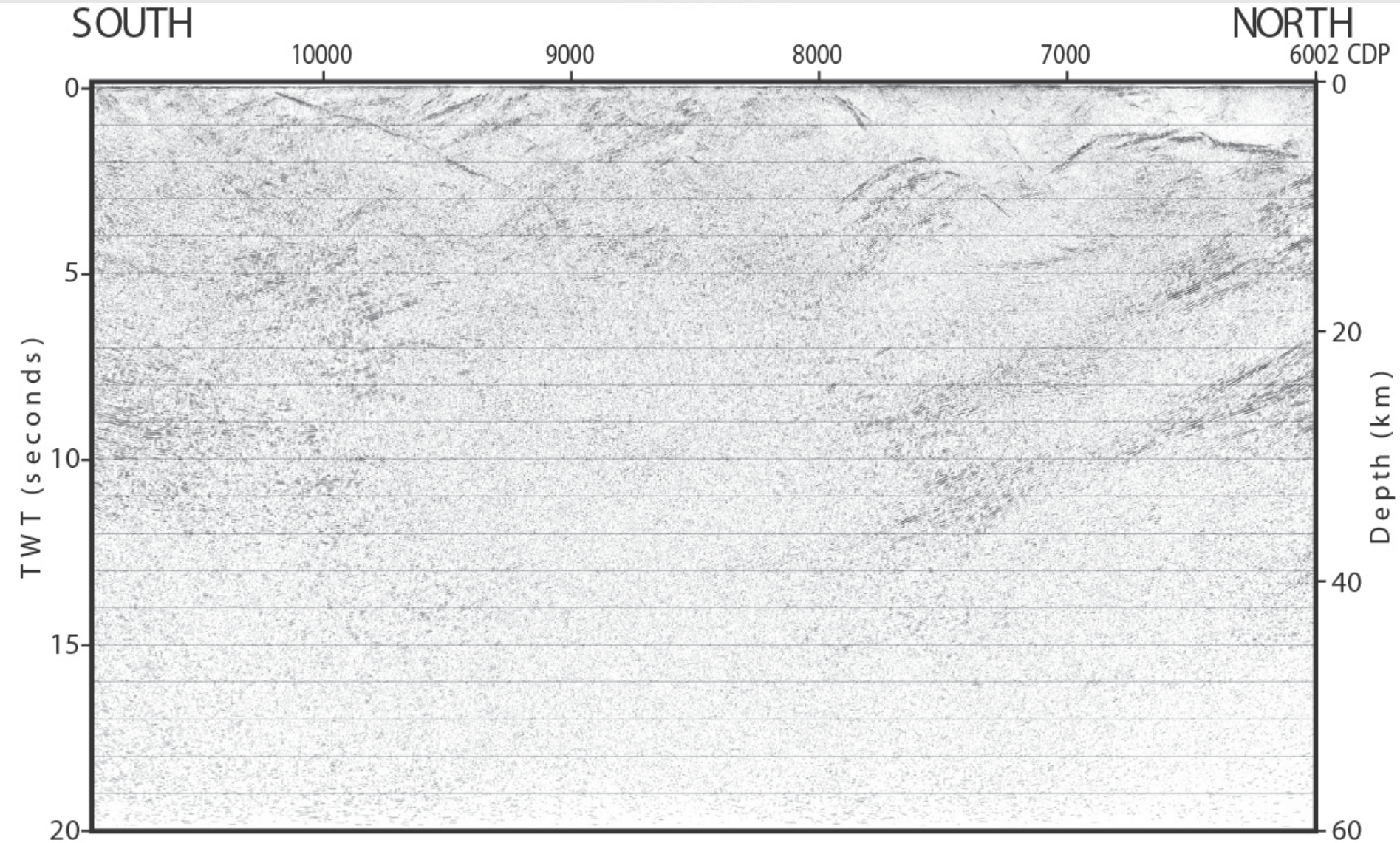
# 10GA-YU1 (western end)

← Moho (~11 s TWT)

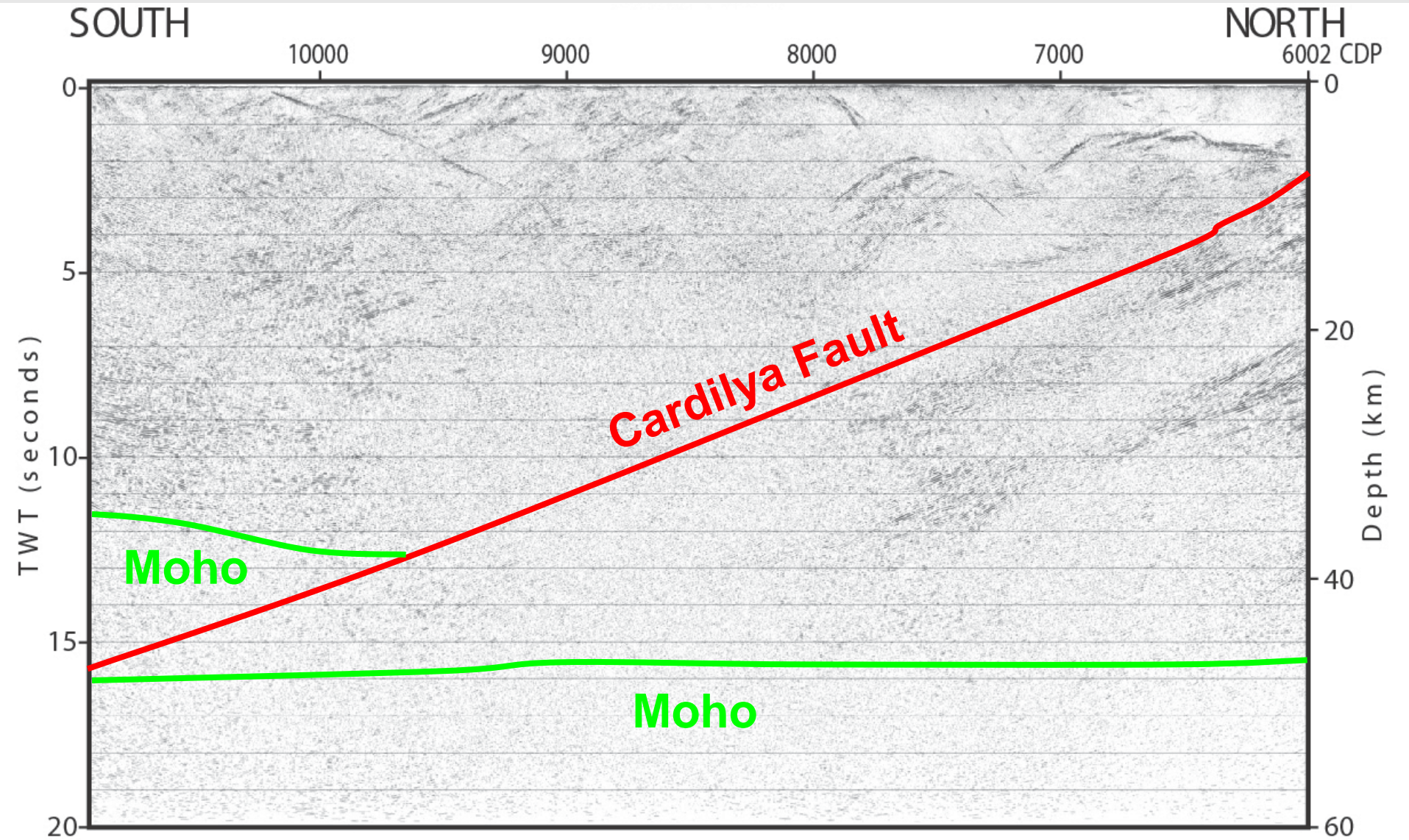
Note: deep reflections  
(Glenburgh Terrane?)

# 10GA-CP3

## Where is the Moho?



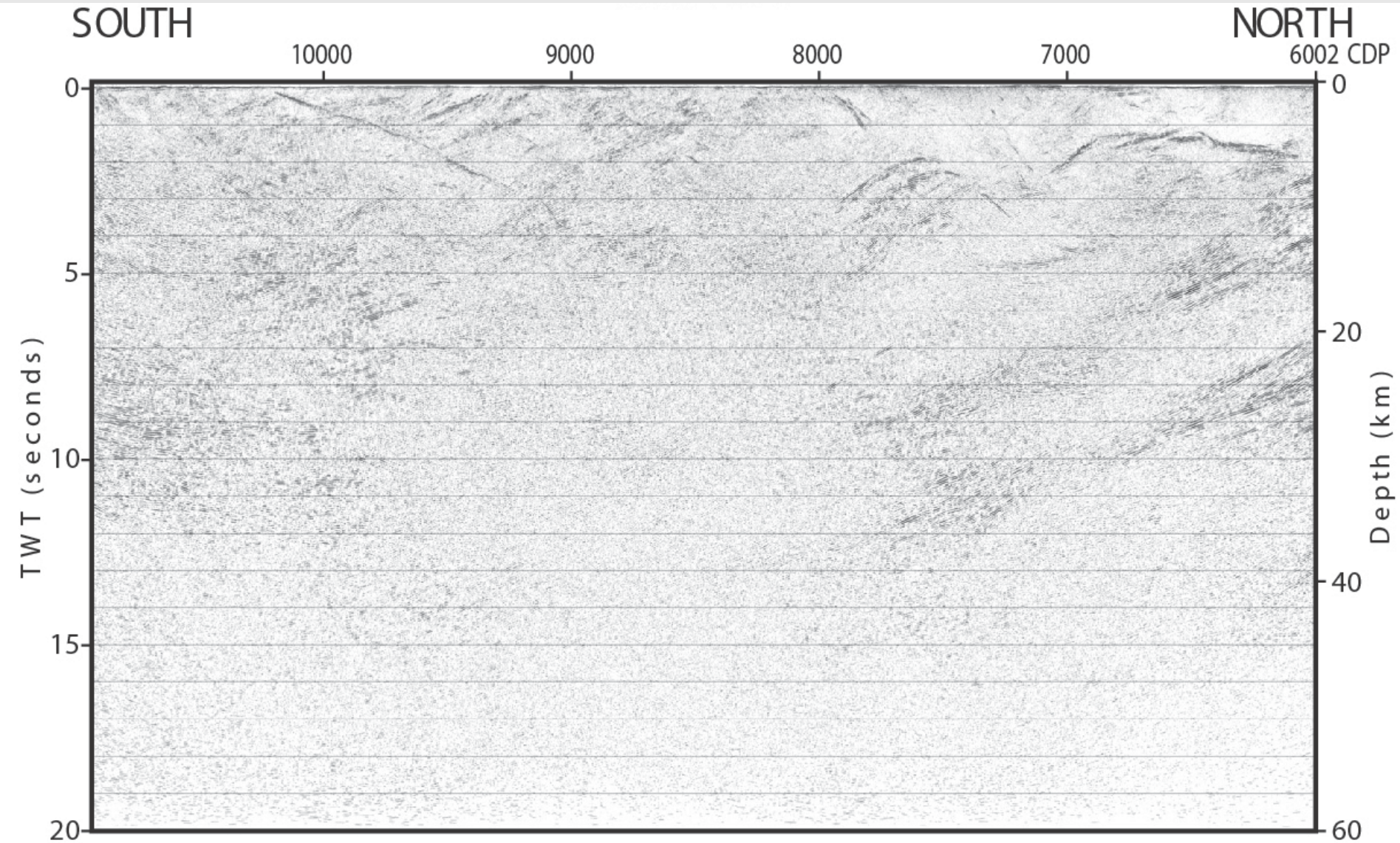
# 10GA-CP3



**Moho – faulted?**

# 10GA-CP3

## Narryer Terrane to Glenburgh Terrane

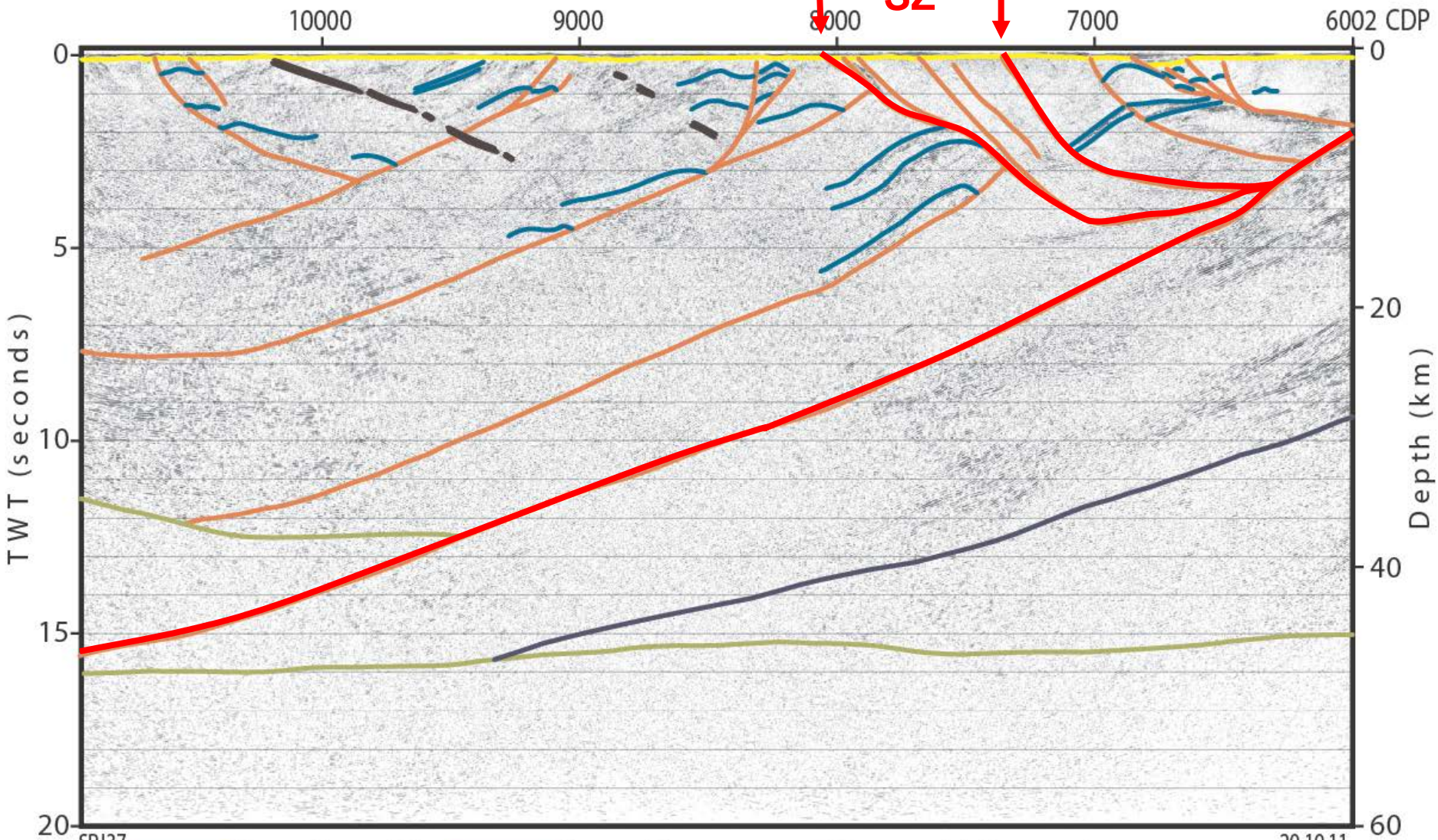


# 10GA-CP3

Narryer Terrane

Errabiddy SZ

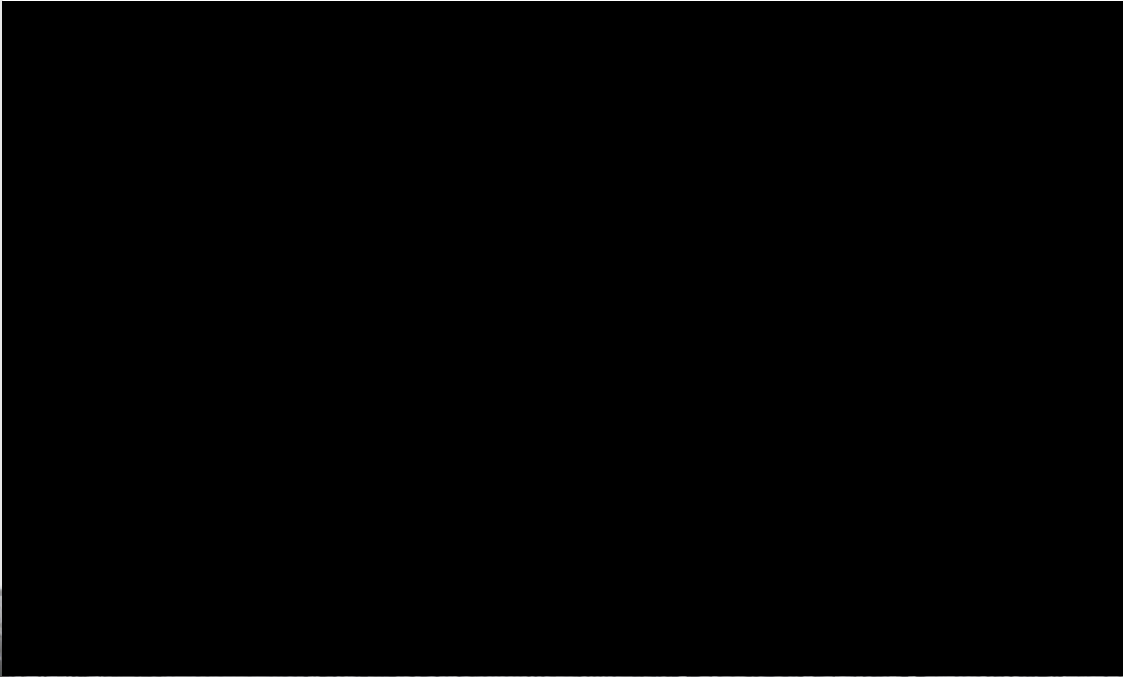
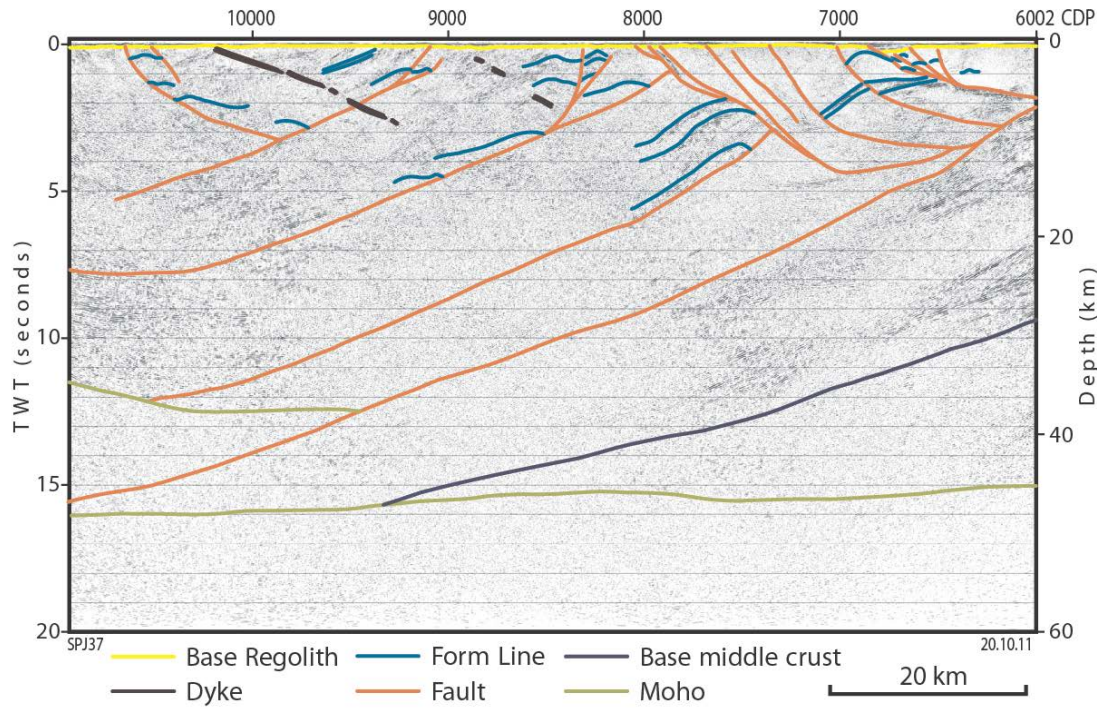
Glenburgh Terrane



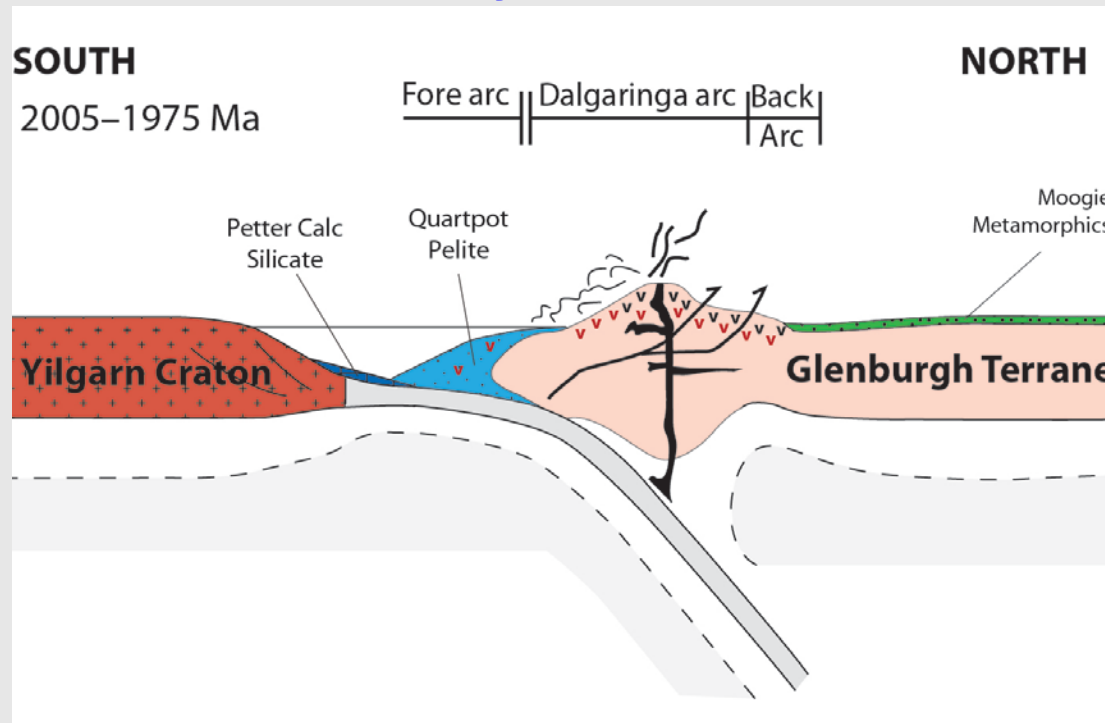
- Base Regolith
- Form Line
- Base middle crust
- Dyke
- Fault
- Moho

20 km

# 10GA-CP3



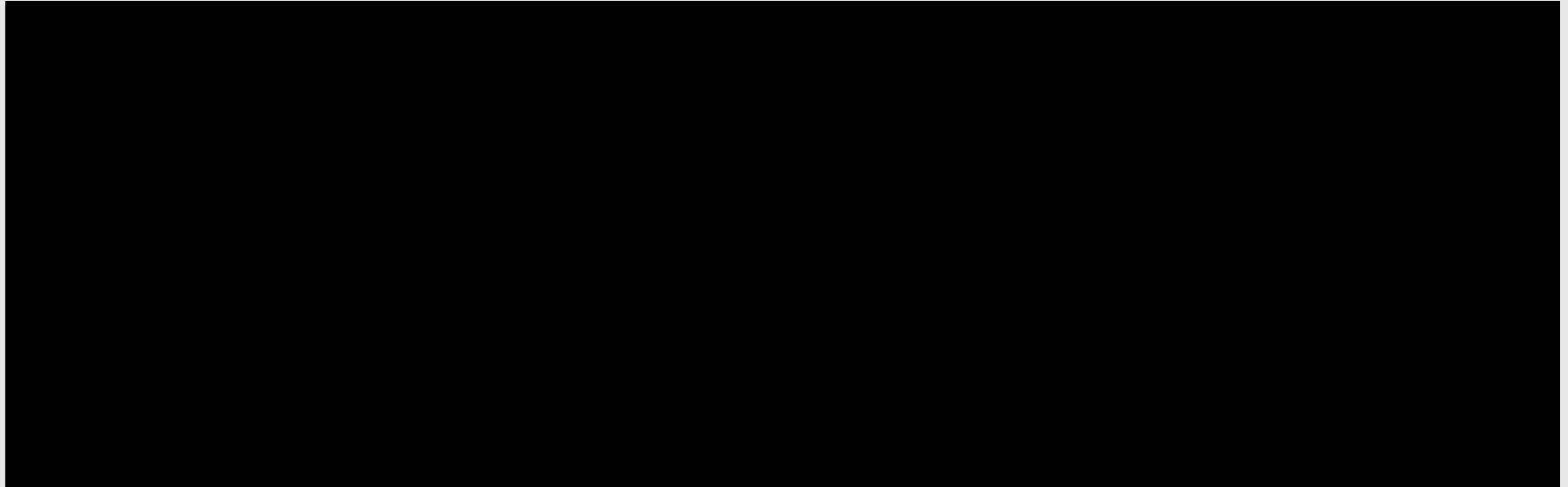
# Collision between Glenburgh Terrane and Narryer Terrane



Dalgaringa magmatic arc (2005-1975 Ma) gives polarity of subduction



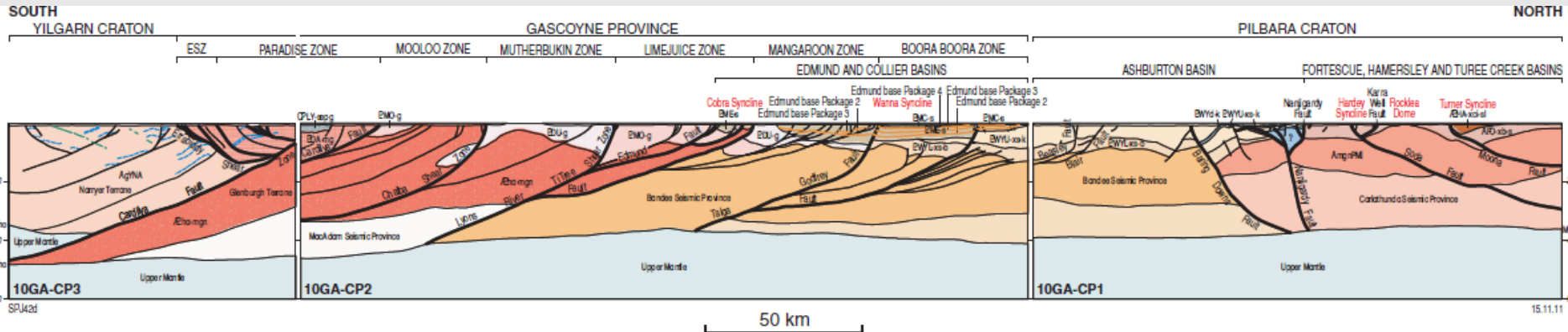
# Role of Errabiddy Shear Zone versus Cardilya Fault



## Alternatives:

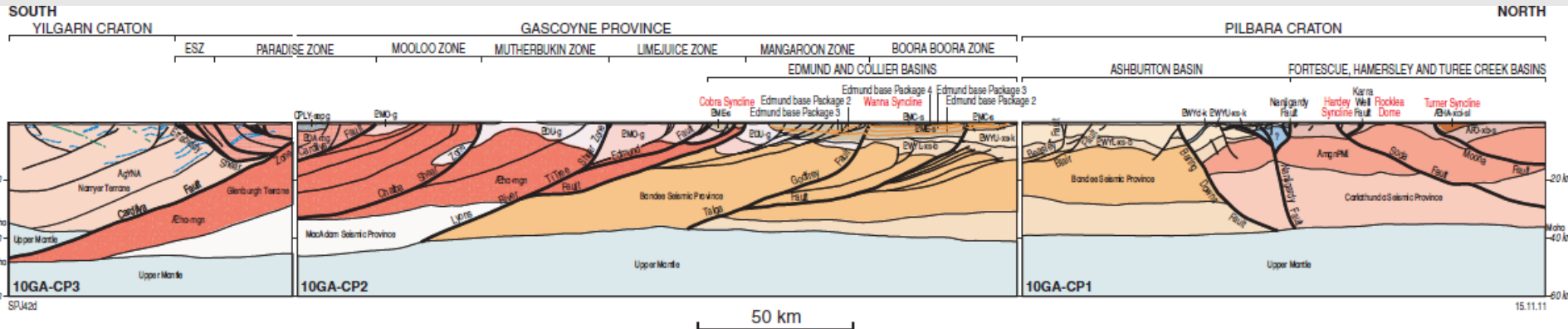
1. Narryer Terrane obducted onto Glenburgh Terrane at Cardilya Fault (= suture), then later backthrusting at Errabiddy SZ
2. Errabiddy SZ is suture, then later development of Cardilya Fault, with underthrusting of Glenburgh Terrane beneath Narryer Terrane

# Overview of the Capricorn Orogen - the whole survey



# Summary 1

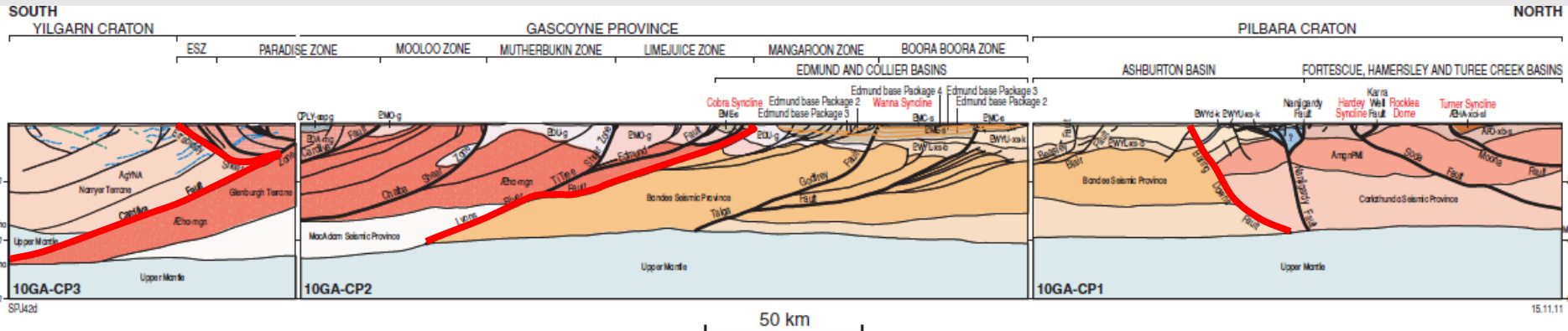
## Crustal architecture of the Capricorn Orogen



- First holistic view of the crustal architecture of the region
- Several crustal scale provinces and terranes
  - Including newly recognised seismic provinces
- Change in polarity of structures across Baring Downs Fault

# Summary 2

## Assembly of West Australian Craton



~2005 Ma

~2215 Ma

>2630 Ma (?)

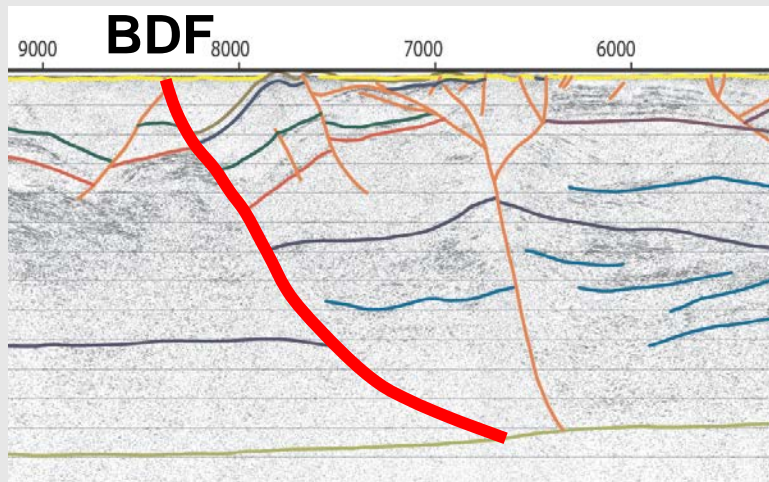
- Three probable sutures recognised
- Progressive accretion of continental slivers onto southern margin of Pilbara Craton to build the WAC

# Summary 3

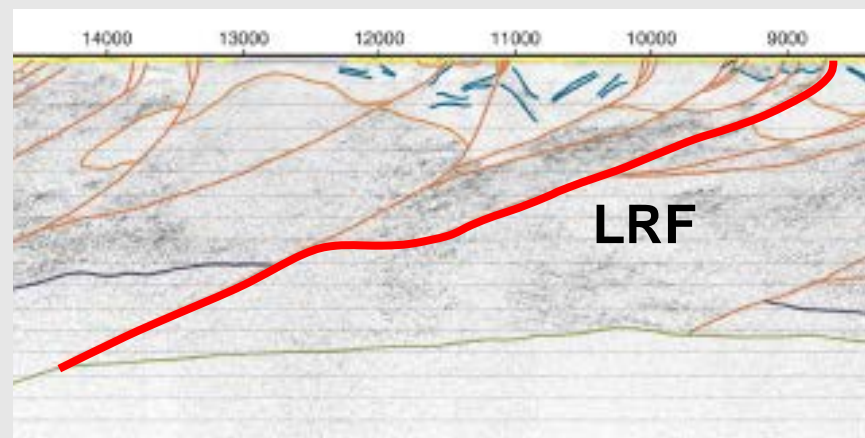
## Intracontinental reactivation

- Several discrete episodes of orogenic reactivation following assembly of WAC
- Most major faults show one or more episodes of reactivation, e.g.

– Baring Downs Fault



Lyons River Fault





**THANK YOU**

**Seismic data available at:**

**<http://www.ga.gov.au/minerals/projects/current-projects/seismic-acquisition-processing.html>**