Deep seismic reflection line 10GA-CP3

(Narryer Terrane, Glenburgh Terrane)

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Location

Maps: GLENBURGH (SG 50-6) and BYRO (SG 50-10)

Zone: MGA Zone 50

End coordinates: 460676E 7112874N to 466603E 7206006N

Length: 99 km

Scale of interpretation: 1:250 000

This south–north-oriented section is coincident with deep seismic reflection line 10GA-CP3 (Johnson et al., 2011a, 2013) that transects the Glenburgh Terrane of the Capricorn Orogen and the northern part of the Narryer Terrane of the Yilgarn Craton (Fig. 1).

Tectonic units

The Eoarchean to Neoarchean Narryer Terrane of the Yilgarn Craton is predominantly composed of granite and granitic gneiss with subordinate greenstone units (Williams and Myers, 1987; Nutman et al., 1991). It is sutured to the Glenburgh Terrane along the Cardilya Fault, but in the middle to upper crust this fault is truncated by the Errabiddy Shear Zone. This regional-scale shear zone contains imbricate slices of the Narryer Terrane, the 2758–2585 Ma Warrigal Gneiss, and high-grade metasedimentary rocks of the 2001–1955 Ma Camel Hills Metamorphics (Johnson et al., 2010, 2011b), and granitic intrusions of the 1961–1645 Ma Bertibubba Supersuite, which form the first common magmatic component of the two terranes (Sheppard et al., 2004). The Glenburgh Terrane is dominated by granitic rocks of the 2555–2430 Ma Halfway Gneiss and granitic stocks and plutons of the 2005–1975 Ma Dalgaringa Supersuite, which formed in a continental-margin magmatic arc along the southern margin of the terrane (Sheppard, 2004; Sheppard et al., 2004; Johnson et al., 2010, 2011b). High-grade metasedimentary rocks of the 2240–2125 Ma Moogie Metamorphics (Johnson et al., 2010; 2011a) are locally present. The lower crust of the Glenburgh Terrane, the MacAdam Seismic Province, has a distinctly different seismic character and may represent a separate distinct tectonic unit (Korsch et al., 2011). Both the Glenburgh Terrane and MacAdam Seismic Province are interpreted to have been thrust beneath the Narryer Terrane during the 2005–1950 Ma Glenburgh Orogeny (Johnson et al., 2011a, 2013).

Structure

At the surface the Errabiddy Shear Zone separates the Narryer Terrane from the Glenburgh Terrane (Johnson et al., 2011a). However, the deep seismic reflection line indicates that the moderately south dipping Cardilya Fault is actually the suture zone (Johnson et al., 2011b, 2013). Although the Errabiddy Shear Zone appears to merge onto the Cardilya Fault, it is probably a later backthrust formed during the collisional phase of the 2005–1950 Ma Glenburgh Orogeny (Korsch et al., 2011). The Glenburgh Terrane and MacAdam Seismic Province are interpreted to have been thrust beneath the Narryer Terrane (Johnson et al., 2011, 2013), offsetting and duplicating the Moho where it is intersected by the Cardilya Fault. 'Fault 1' is interpreted from magnetic worm data and seismic interpretation as a fault separating different domains of the Narryer Terrane.

Geophysical data

A gravity profile was extracted from the Geological Survey of Western Australia (GSWA) gravity merged grid of Western Australia (GSWA, 2013a), with points sampled every 440 m (Fig. 2b). Additional gravity points have been taken along the seismic line in addition to the statewide 2.5 km coverage. Topographic data were taken from the Shuttle Radar Topography Mission (SRTM) at the same points. Magnetic data were taken from the State 80 m merged map (GSWA, 2013b).

MT data were also collected along this profile at a 5 km spacing for broadband instruments (200 – 0.005 Hz) and a 15 km spacing for long-period instruments (0.1 – 0.0001 Hz).

Forward modelling

The section was modelled down to a depth of 60 km (Fig. 2c). All modelling was performed in Modelvision v.11.0 software. The starting point from the model was the seismic interpretation from 11GA-CP3 (Goodwin, 2011; Johnson et al., 2011a).

Forward modelling results

Values for density and magnetic susceptibility used in the modelling are listed in Table 1.

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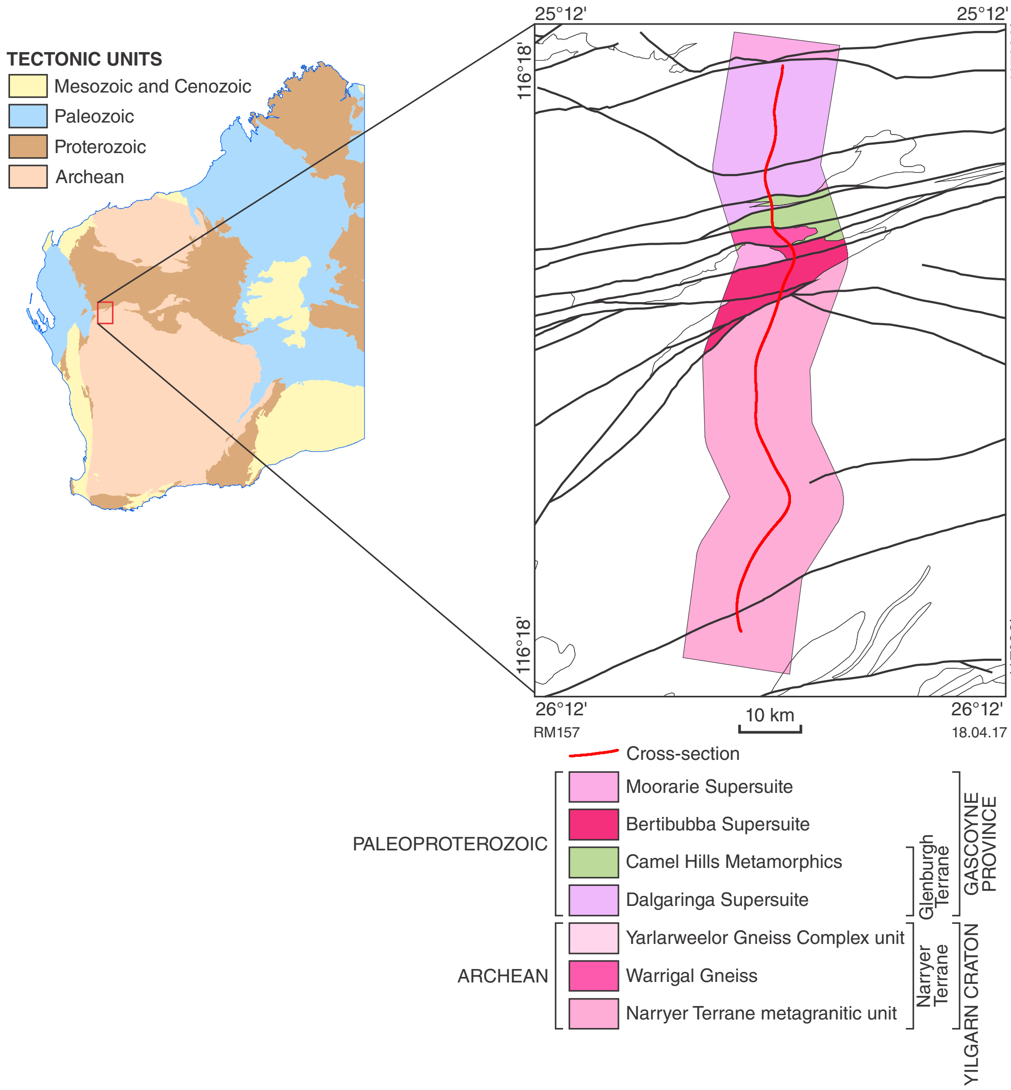

Figure 1. Simplified 1:500 000 interpreted bedrock geology map of the Narryer and Glenburgh Terranes showing location of cross-section A–B

Regional gravity lows (Fig. 2b) in the area (Hackney, 2004) and passive seismic data (Reading et al., 2012) are reinforced by the forward model, which shows that the crust has been significantly thickened, and that there are two Mohos caused by where the Glenburgh Terrane has been thrust beneath the Narryer Terrane (Fig. 2a). The Warrigal Gneiss and Bertibubba Supersuite granites form a gravity low in the centre of the profile (Fig. 2b). The low at the northern end of the profile corresponds to granitic rocks of the Dalgaringa Supersuite. Both have very low magnetic susceptibilities (Goodwin, 2011). However, there are short-wavelength magnetic anomalies in this region (Fig. 2d), which may correspond to the Camel Hills Metamorphics and the Nardoo Granite of the Dalgaringa Supersuite. The Moogie Metamorphics produce a local gravity high towards the northern end of the profile. In the south, the Narryer Terrane has been divided into an upper and lower region on the basis of magnetic signals (Fig. 2e), and has a distinctly higher base at the southern end. The interpretation was assisted by magnetic worms, which support the change in properties along the structure labelled ‘Fault 1’. The short-wavelength features were interpreted to be 500 m thick banded iron-formations (BIF), which were not imaged in the seismic interpretation.

MT inversions

Modelling and inversion of the MT data was done using the WinGLink software which utilizes the 2D inversion code of Rodi and Mackie (2001). More details on the data processing can be found in Heinson et al. (2011).

Inversion results

Phase tensors along this line were relatively uniform indicating a 2D structure. There was a slight change taking place around the location of the Errabiddy Shear Zone.

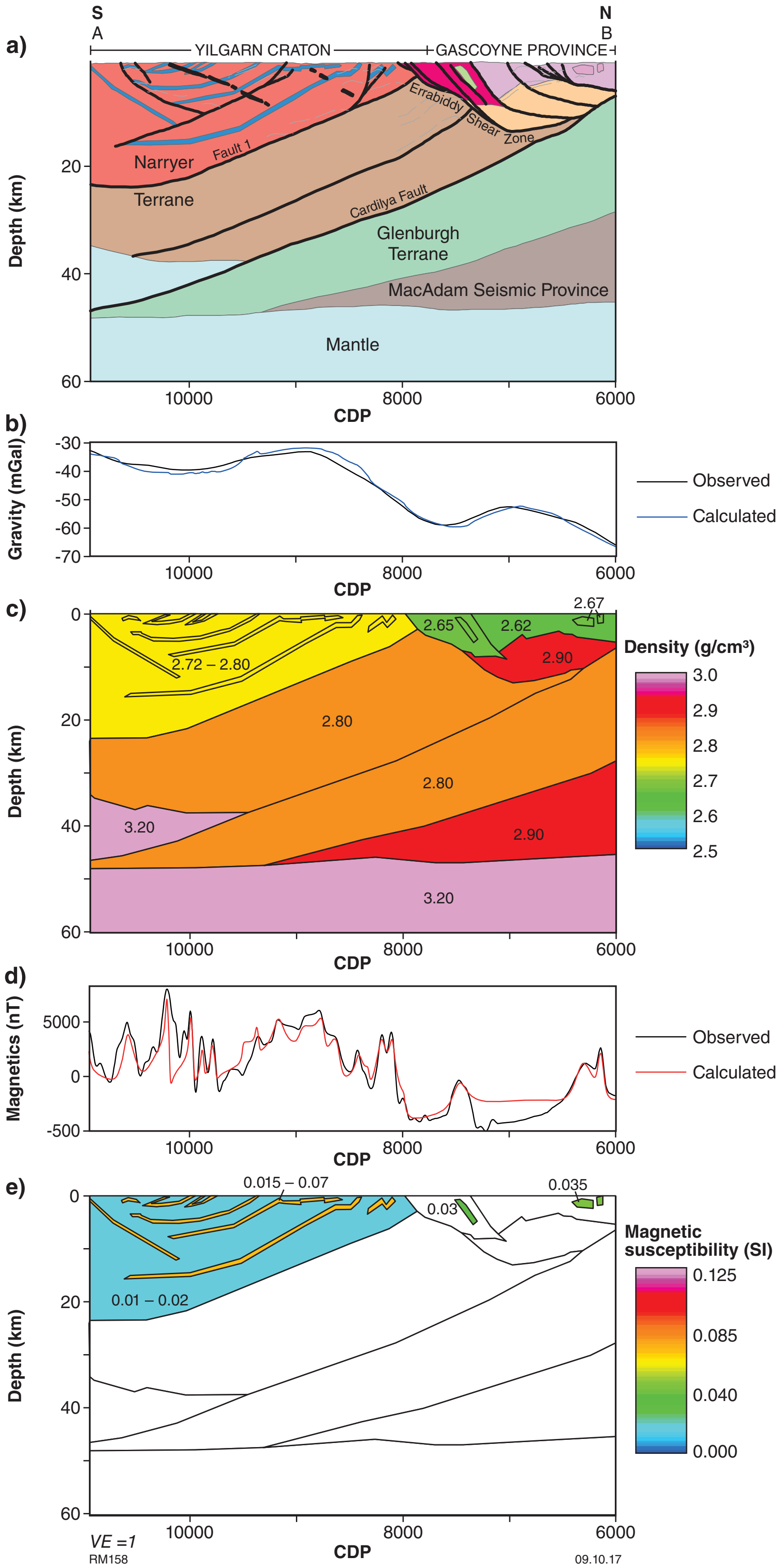

Figure 2. **Profiles of the seismic line 10GA-CP3 showing: a) lithological section from the interpretation of seismic data; b) observed and calculated gravity anomaly profile with error line; c) section of density per lithology; d) observed and calculated gravity anomaly profile with error line; e) section of magnetic susceptibility per lithology**

Table 1. Summary of the physical properties used in the gravity model of the seismic line 10GA-CP3. The colour column refers to colours used in Figure 2a

Colour	*Lithological unit*	*Rock type*	*Density (g/cm^3)*	*Magnetic susceptibility (SI)*
	Nardoo Granite	Granite	2.670	0.035
	Camel Hills Metamorphics	Metasedimentary siliciclastic	2.650	0.030
	Bertibubba Supersuite and Warrigal Gneiss	Granite and metagranite	2.650	
	Dalgaringa Supersuite	Gneissic granites	2.620	
	Moogie Metamorphics	Psammitic schists	2.900	
	Narryer Terrane			
	BIF	BIF	2.720 – 2.800	0.015 – 0.070
	Upper crust	Granitic	2.700 – 2.800	0.010 – 0.020
	Middle crust	Middle crust	2.800	
	Glenburgh Terrane	Granitic gneiss	2.800	
	MacAdam Seismic Province	Lower crust	2.900	
	Upper mantle	Mantle	3.200	

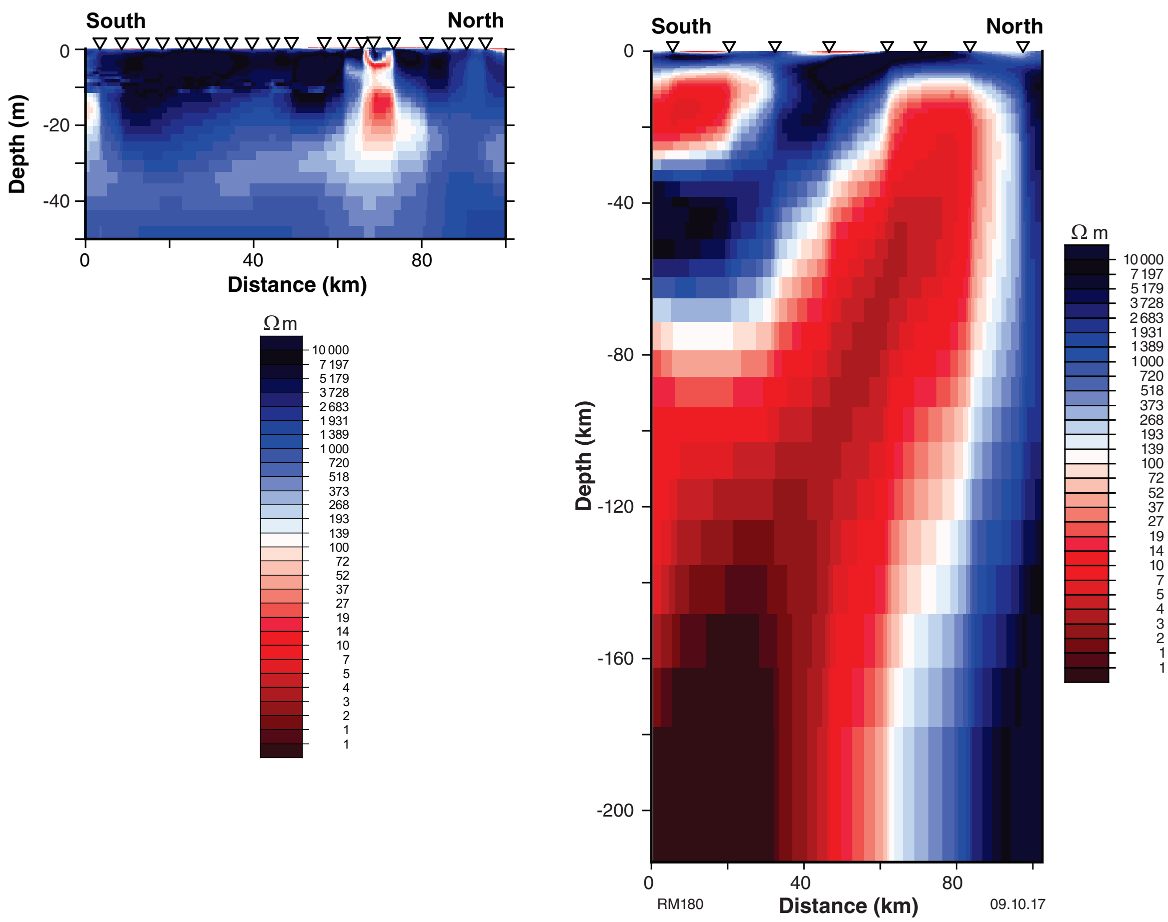

Figure 3. Profiles of the seismic line 10A-CP3 showing: a) broadband 2D resistivity section for line 10GA-CP3; b) long period 2D resistivity section for line 10GA-CP3

The long-period tensors were also uniform with a slight convergence to the north, which may indicate a flow of current aligned with the Errabiddy Shear Zone.

The inversion results of the broadband responses (Fig. 3a) show a simple resistive background with a conductive feature aligned with the Errabiddy Shear Zone. This feature does not intersect the surface, but the surface expression of it coincides with a relatively wide region of low resistivity.

Long-period data were of good enough quality to invert with seven of the eight stations modelled (Fig. 3b) as the response over the Errabiddy Shear Zone was too anisotropic to model. The low-resistivity feature seen in the broadband data is imaged to much greater depths with the low-period data and appears to dip to the south.

From these results the Errabiddy Shear Zone is clearly shown in both sections and shows complex geometry near the surface (Heinson et al., 2011). It appears to be near vertical, but dips to the south at depth.

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