Deep seismic reflection line 10GA-CP2

(Capricorn Orogen)

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Location

Maps: EDMUND (SF 50-14), MOUNT PHILLIPS (SF 50-2), GLENBURGH (SG 50-6)

Zone: MGA Zone 50

End coordinates: 384572E 7202534N to 474094E 7404580N

Length: 180 km

Scale of interpretation: 1:250 000

This section is a southeast–northwest-oriented section that is coincident with deep seismic reflection line 10GA-CP2 (Johnson et al., 2011, 2013) that transects the central part of the Capricorn Orogen (Fig. 1).

Tectonic units

The oldest rocks are present at the southern end of the line. The Glenburgh Terrane comprises granitic and gneissic rocks of the 2555–2430 Ma Halfway Gneiss and the 2005–1970 Ma Dalgaringa Supersuite and medium- to high-grade metasedimentary rocks of the 2240–2125 Ma Moogie Metamorphics. 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). The northern part of the line is underlain by the unexposed Bandee Seismic Province that continues from the southern end of line 10GA-CP1 (Johnson et al., 2011, 2013). The Glenburgh Terrane was intruded by voluminous granitic stocks and batholiths of the 1820–1775 Ma Moorarie Supersuite and 1680–1620 Ma Durlacher Supersuite that appear in the seismic section as distinct, nonreflective bodies (Johnson et al., 2011, 2013). These bodies also contain areas of highly reflective material that are interpreted to be rafts of low-grade metasedimentary rocks of the 1840–1810 Ma Leake Springs Metamorphics (Johnson et al., 2011, 2013). Magmatic intrusions of the Durlacher Supersuite are also interpreted to underlie younger sedimentary rocks of the Edmund Basin along the northern part of the section. These rocks are unconformably overlain by discontinuous, coarse clastic sedimentary rocks of the 1679–1610 Ma Mount Augustus Sandstone. The 1679–1067 Ma Edmund and Collier Basins are the youngest depositional units in the Capricorn Orogen and unconformably overly siliciclastic sedimentary rocks of the Ashburton Basin along the northern part of the line. The Edmund Basin attains a maximum thickness of 7 km on the southern side of the Godfrey Fault (Cutten et al., 2016). Extension on the Talga, Godfrey, and Lyons River Faults formed several half grabens into which the fine-grained siliciclastic and carbonate sedimentary rocks were deposited (Martin and Thorne, 2004; Cutten et al., 2016). Highly reflective packages within the Edmund Basin are interpreted to be dolerite sills of the 1465–1452 Ma Narimbunna and 1084–1067 Ma Kulkatharra Dolerite that were emplaced in the upper parts of the basin (Cutten et al., 2011, 2016). The southern end of the line transects siltstones and sandstones of the Permian Lyons Group of the Southern Carnarvon Basin.

Structure

The major crustal structures in this profile all dip moderately to the south and separate areas of differing structural, magmatic, and metamorphic history (Sheppard et al., 2010; Johnson et al., 2013). The suture between Glenburgh Terrane – MacAdam Seismic Province and the Bandee Seismic Province, identified as the Lyons River Fault (Johnson et al., 2011, 2013), offsets the Moho and in the middle crust splays into the Ti Tree Shear Zone and Edmund Fault (Johnson et al., 2011, 2013). The Talga Fault that soles onto the Godfrey Fault at depth is interpreted to be a major crustal shear zone that forms part of the north-verging fold and thrust system of the Ophthalmia Orogeny.

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 had 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 15 km spacing for long-period instruments (0.1 – 0.0001 Hz).

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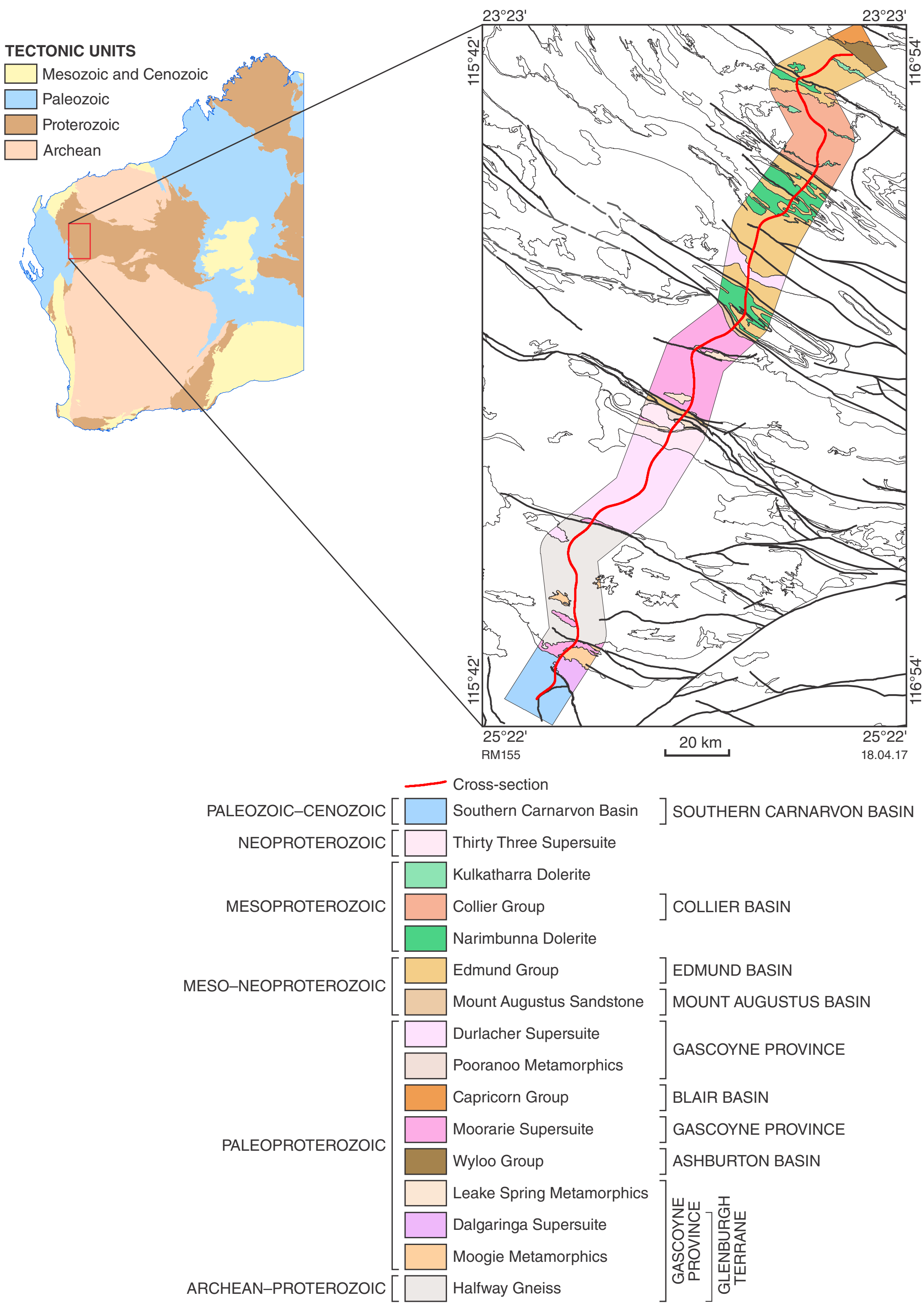

Figure 1. Central Capricorn region; simplified 1:500 000 interpreted bedrock geology map showing location of cross-section A–B

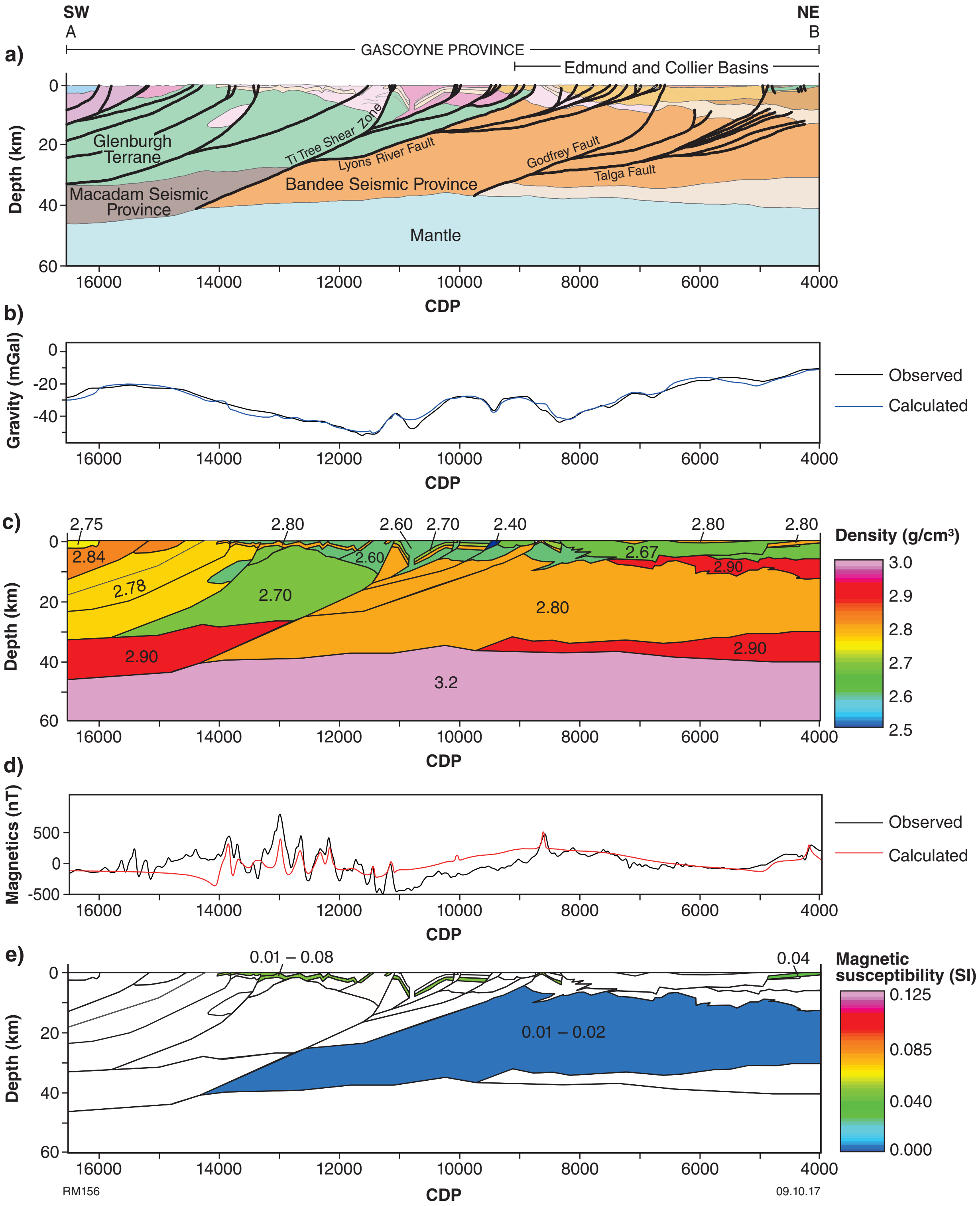

Figure 2. **Profiles of the seismic line 10GA-CP2 showing: a) lithological section from the interpretation of seismic data; b) observed and calculated gravity anomaly profile with error line; c) section of density per lithology; d) observed and calculated gravity anomaly profile with error line; e) section of magnetic susceptibility per lithology**

Table 1. Summary of the physical properties used in the gravity model of the seismic line 10GA-CP2. The colour column refers to colours used in Figure 2a

Colour	*Lithological unit*	*Rock type*	*Density (g/cm³)*	*Magnetic susceptibility (SI)*
	Southern Carnarvon Basin	Sedimentary	2.75	
	Kulkatharra Dolerite	Dolerite	2.80	0.04
	Collier Group	Sedimentry siliciclastic	2.80	
	Edmund Group	Siliciclastic and carbonate sediments	2.67	
	Upper Wyloo Group	Sedimentry siliciclastic	2.67	
	Lower Wyloo Group	Sedimentry siliciclastic	2.90	
	Mount Augustus Sandstone	Sandstone	2.40	
	Durlacher Supersuite	Granitic	2.60	
	Dalgaringa Supersuite	Granitic	2.80	
	Moorarie Supersuite	Granitic	2.80	
	Leake Springs Metamorphics	Metasedimentary siliciclastic	2.80	0.01 – 0.08
	Pooranoo Metamorphics	Metasedimentary siliciclastic	2.70	
	Glenburgh Terrane	Granitic gneiss	2.70 – 2.78	
	Bandee Seismic Province	Middle crust	2.80	0.01 – 0.02
	MacAdam Seismic Province	Lower crust	2.90	
	Lower crust	Lower crust	2.90	
	Upper mantle	Mantle	3.20	

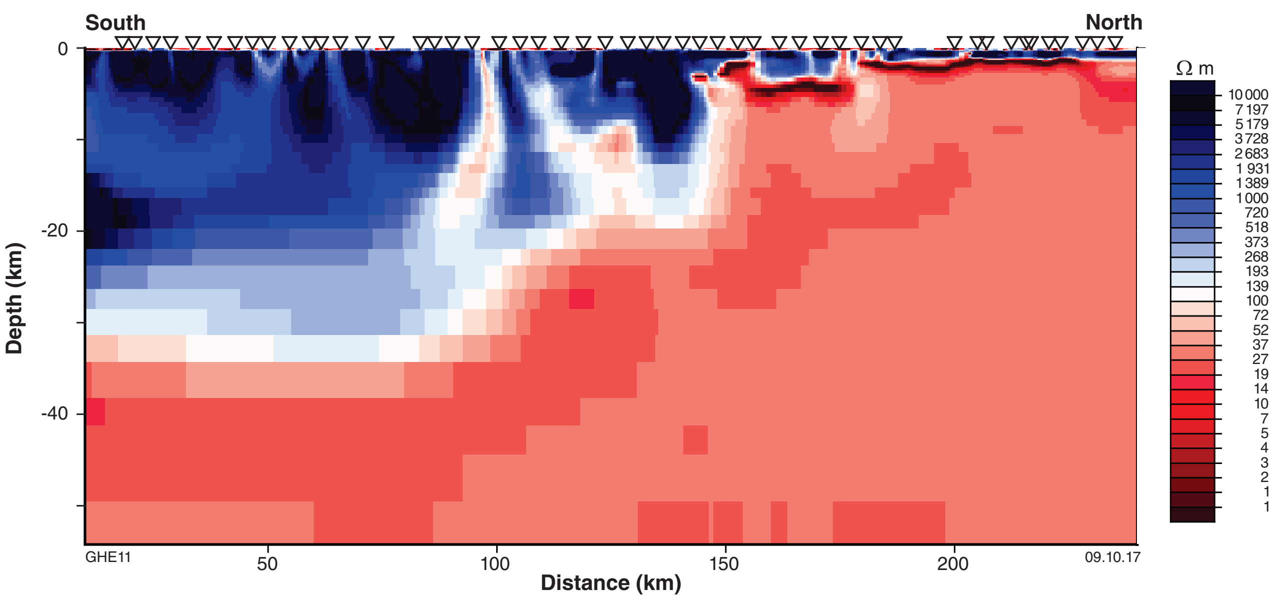

Figure 3. 2D resistivity section for line 10GA–CP2. The bandwidth of the inversion was 200 – 0.1 Hz. The profile orientation was taken to be 30°E of geographic north (with geological strike perpendicular to the profile)

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-CP2 (Goodwin, 2011).

Forward modelling results

Values for density and magnetic susceptibility used in the modelling can be found in Table 1.

The gravity profile features a long wavelength low with lower troughs within it (Fig. 2b). The regional low is provided by a low density section of the Glenburgh Terrane juxtaposed against the relatively high densities of the Moogie Metamorphics (Fig. 2a). One prominent trough is formed by the Mount Augustus Sandstone of very low density. Others are formed by greater or lesser extents of granitic rocks of the Moorarie and Durlacher Supersuites.

The gravity high at the northern end of the profile is modelled as high densities (Fig. 2c) within the Ashburton Basin, which is in contrast to their moderate densities in the model of 10GA-CP1 (Goodwin, 2011).

The dolerite sills in the Edmund Basin and sections of Leake Springs Metamorphics provide the short-wavelength magnetic features (Fig. 2d) across the profile.

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

The broadband responses were inverted for 2D structure. Responses were found to have various amounts of static shift. At frequencies higher than 0.1Hz the electrical structure was found to be only 2D and was aligned with the strike of both the geological and magnetic structures. However, at a few sites some bandwidths showed 3D features.

The final resistivity model (Fig. 3; Heinson et al., 2011) shows a northern section that is very similar to that of profile 10GA-CP1 (Goodwin et al., 2011) with a thin conductive sedimentary layer, followed by a 2–10 km-thick resistive layer, and finally a very conductive layer. Due to the current preferentially staying in the lower conductive layer, no features are resolved below this. Within the Edmund and Collier Basins, little structure is resolved.

In the southern part, the phase tensors become more uniform. There appears to be an electrical contrast between the Bandee Seismic Province and the Glenburgh Terrane. At the surface this is the northern edge of the Moorarie Supersuite. This electrical contrast dips at a similar angle to the Lyons River Fault, which is the suture between the Pilbara Craton and the Glenburgh Terrane. There is possibly a conductive shear zone in the approximate position of the Ti Tree Shear Zone. However, most of the crust to the south is highly resistive, typical of Archean crust. This is the area interpreted from the seismic profile as being the Glenburgh Terrane, indicating an Archean origin.

Long-period data were not modelled due to the low quality and 3D features.

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