Seismic line 11GA-SC1

(Southern Carnarvon Basin, Narryer Terrane)

JA Goodwin* and RE Murdie

Location

Maps: Yaringa (SG 50-9) and Byro (SG 50-10)

Zone: MGA Zone 50

End coordinates: 238617E 7100022N to
468429E 7115734N

Length: 259.3 km

Scale of interpretation: 1:250 000

The seismic survey traverses from the Southern Carnarvon Basin in the west to the Narryer Terrane of the Yilgarn Craton in the east, where it almost joins the westernmost end of seismic line 10GA-YU1 (Fig. 1).

Tectonic units

The seismic line 11GA-SC1 passes through Cenozoic and Cretaceous calcareous and carbonate rocks of the Gascoyne Platform and through the Carboniferous–Permian glacigenic sediments and sedimentary rocks of the Byro Sub-basin, which are both part of the Southern Carnarvon Basin (Hocking, 2000; Mory and Backhouse, 1997). The Southern Carnarvon Basin is interpreted to sit on the Pinjarra Orogen basement (Myers, 1990a) in the west and the Narryer Terrane in the east. The Glenburgh Terrane forms a small wedge in the centre of the section (Johnson et al., 2012). There is an intensely faulted section of crust under the eastern Carnarvon Basin, which has been interpreted as the Errabiddy Shear Zone. The Badgeradda Group forms a small basin between the Badgeradda Fault and the Narryer Terrane, which crops out east of the Meerberrie Fault. The Yarraquin Seismic Province is the name given to the lower crust in the eastern part of the profile (Korsch et al., 2014).

Structure

We follow the structural interpretation of Korsch et al. (2014). The Darling Fault is a major trans-crustal structure, which extends to the Moho. The Darling Fault separates the Pinjarra Orogen, which constitutes the basement of the western part of the Southern Carnarvon Basin, from the Narryer Terrane of the Yilgarn Craton to the east. The Glenburgh Terrane is a wedge between the Darling Fault and the Madeline Fault. The Errabiddy Shear Zone is interpreted as a set of imbricate faults in the upper 16 km of the crust, just to the east of the Madeline Fault, and probably contains rocks of both the Glenburgh and Narryer Terranes (Johnson et al., 2011). The Ballythanna Fault is a trans-crustal fault which cuts up through the Byro Sub-basin, dividing them into two small basins. To the north it joins the Meeberrie Fault. Although the Meeberrie Fault is interpreted as an internal fault within the Narryer Terrane, it cuts the depth of the crust to the Moho, and represents the eastern limit of the Byro Sub-basin and the western limit of the surface exposure of the Narryer Terrane. The Narryer Terrane is separated from the rest of the Yilgarn Craton by the northwest dipping Yalgar Fault (Myers, 1990b).

Geophysical data

The gravity data used in the forward modelling were extracted from Bacchin et al. (2008). The seismic interpretation used in this modelling was derived from Korsch et al. (2014, figure 2).

Physical property values were taken from tabled data from Emerson (1990), Telford et al. (1990), and Rudnick and Fountain (1995).

Forward modelling

Geoscience Australia, in collaboration with the Geological Survey of Western Australia, conducted the Southern Carnarvon Deep Crustal Seismic Reflection Survey (11GA-SC1) in 2011 (Korsch et al., 2013). The purpose of this survey was to image deep crustal structures and the crust–mantle boundary. Data were recorded to 20 seconds of two-way travel time (~60 km deep, assuming an average crustal velocity of 6000 m/s) (Costelloe and Jones, 2014).

A crucial part of the seismic interpretation process is to test the interpretation against other data. In this case, the seismic interpretation was tested against gravity data through 2D forward modelling using ModelVision v.11.0 software.

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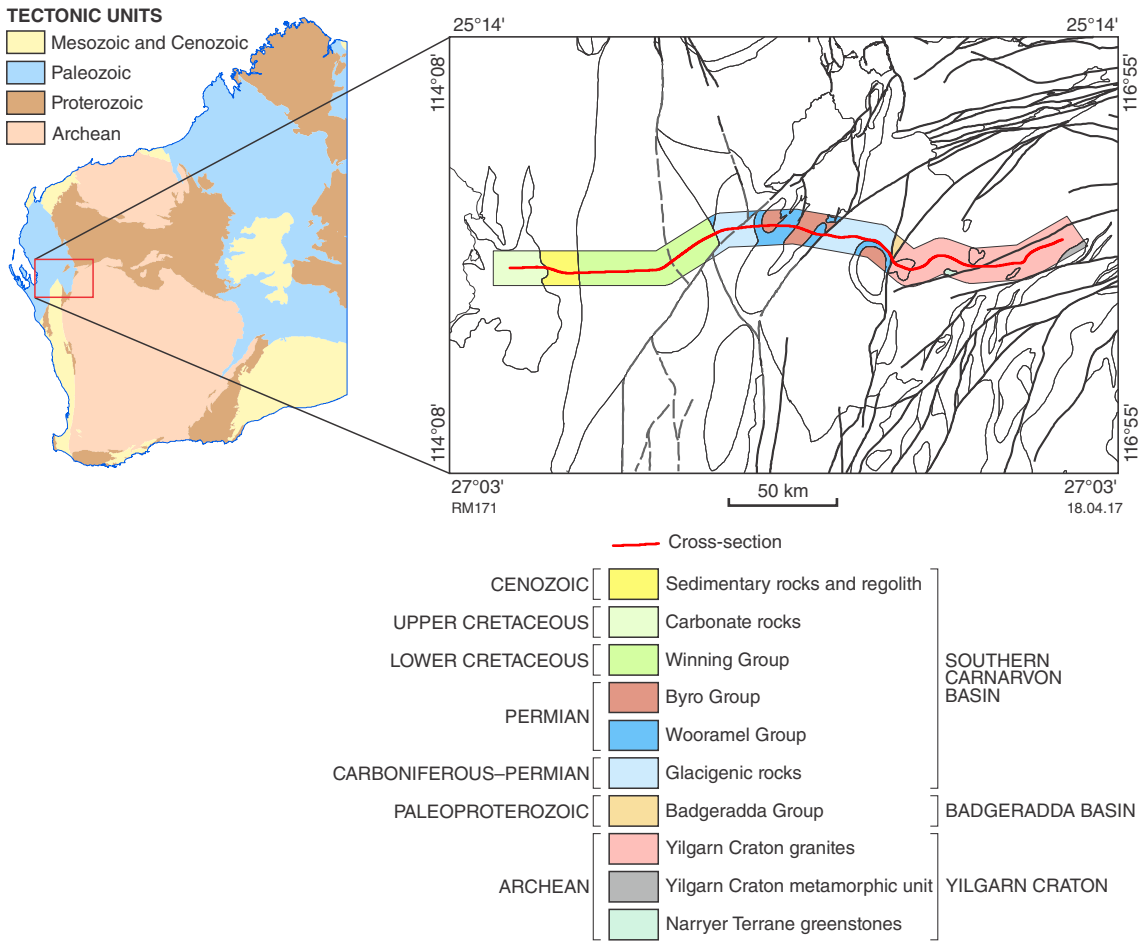

Figure 1. Southern Carnarvon Basin 1:500 000 interpreted bedrock geology map showing the location of seismic line 11GA-SC1

Forward modelling results

A density of 3.30 g/cm^3 is used to reflect the density of the upper mantle (Poudjom Djomani et al., 2001). This creates a regional trend which matches the topography seen on the Moho (Fig. 2b).

Mid (10–20 km) to lower (20–40 km) crustal layers (Fig. 2a) match the observed gravity profile when using densities of 2.70 – 2.85 g/cm^3. These densities correlate with amphibolite to granulite facies and felsic to intermediate rocks (Rudnick and Fountain, 1995).

The upper crustal portion of the Narryer Terrane, between 100 and 260 km, consists of amphibolite to granulite facies and felsic rocks and was modelled with densities in the range of 2.60 – 2.82 g/cm^3 (Rudnick and Fountain, 1995).

The Southern Carnarvon Basin is modelled with a density of 2.40 g/cm^3 (Fig. 2c) typical of sedimentary rocks (Emerson, 1990; Telford et al., 1990) and overlies the Pinjarra Orogen Terrane and the western part of the Narryer Terrane.

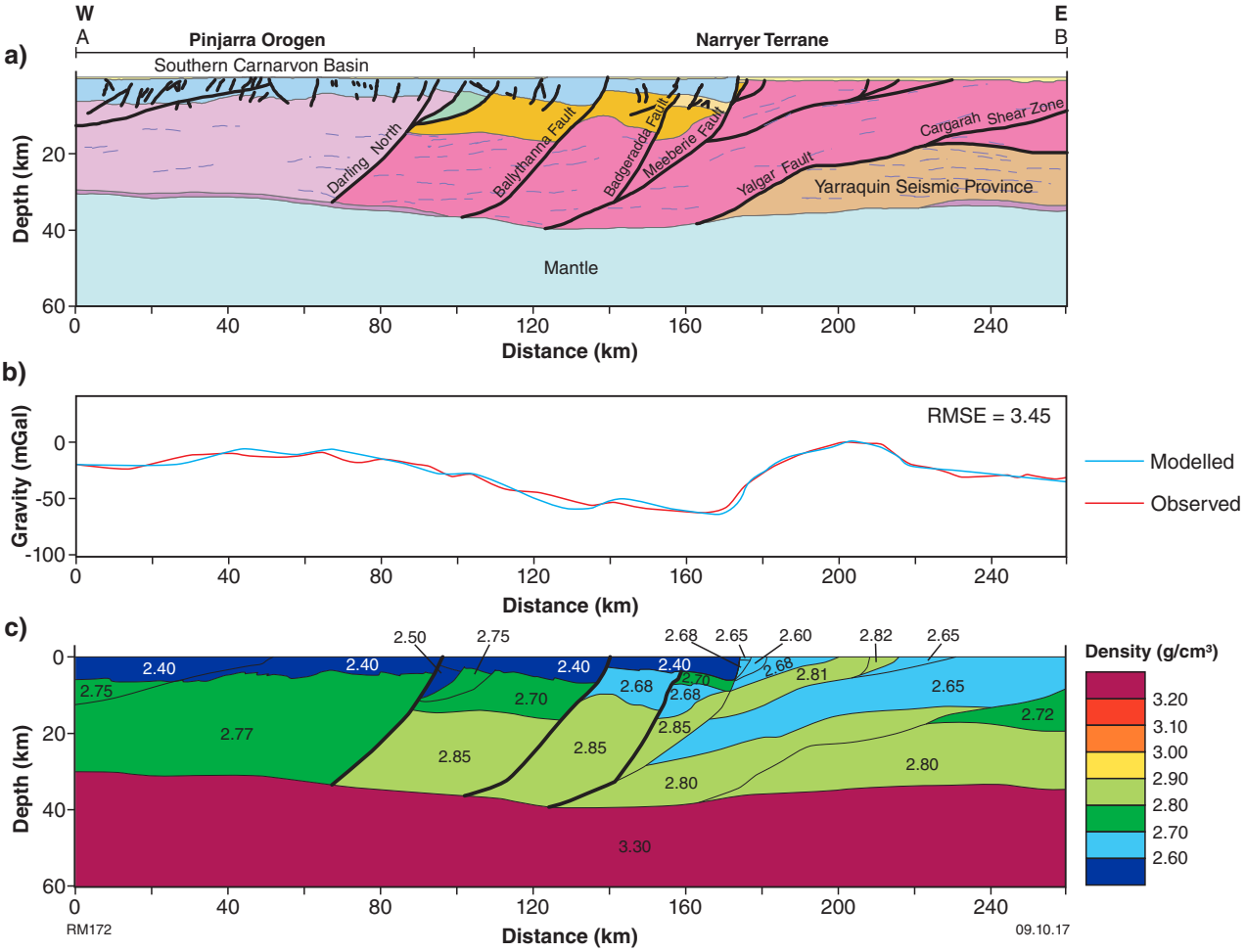

Figure 2. Profiles of 11GA-SC1 seismic line showing: a) lithological interpretation from Korsch et al. (2014); b) observed and calculated gravity anomaly profile from Gessner et al. (2014); c) profile of density in g/cm³ per lithology

Table 1. Summary of the physical properties used in the gravity model of the seismic line 11GA-SC1. The colour column refers to colours used in Fig. 2a

Colour	*Lithological unit*	*Rock type*	*Density (g/cm³)*
	Southern Carnarvon Basin	Sediments	2.40
	Pinjarra Orogen	Metasediments and meta-igneous rocks	2.75 – 2.77
	Glenburgh Terrane	Granitic gneiss	2.75
	Badgeradda Group	Sediments	2.68 – 2.70
	Errabiddy Shear Zone	Sheared metagranites	2.70 – 2.75
	Narryer Terrane		
	Lower crust	Lower crust	2.80 – 2.85
	Upper crust	Granitic crust	2.60 – 2.82
	Yarraquin Seismic Province	Lower crust	2.80
	Upper mantle	Mantle	3.30

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