Government of **Western Australia**
Department of **Mines, Industry Regulation and Safety**

RECORD 2019/4

COMPILATION OF GEOPHYSICAL MODELLING RECORDS, 2019

compiled by
LI Brisbout and RE Murdie

Geological Survey of Western Australia

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PERTH 2019

Geological Survey of
Western Australia

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Cover image: Sunset over the Yalgoo Mineral Field. Photograph by T Ivanic, DMIRS

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Introduction

This Geological Survey of Western Australia (GSWA) Record documents the geophysical forward modelling of gravity and aeromagnetic anomaly data along various 2D geological cross-sections within Western Australia (Fig. 1). These forward modelled cross-sections have been generated to support the production of 1:100 000 and 1:250 000 Geological Series maps by increasing constraints on interpretations at depth.

In most cases, the 2D models are attributed with densities representative of the rock type interpreted at that location. In models related to Geological Series maps, the geometries of bodies were adjusted where necessary to improve the fit to the potential field data. Very few sections have local, measured petrophysical data as an input.

As with all potential field modelling, solutions are non-unique. These models, therefore, provide examples of geometries and physical properties that are consistent with the observed potential field data but are not unique solutions.

For simplicity, the following abbreviations are used throughout this volume

1VD	1st vertical derivative
RTP	reduced-to-pole
SRTM3	Shuttle Radar Topography Mission version 3
TMI	total magnetic intensity

Reference

GSWA 2016, 1:500 000 interpreted bedrock geology of Western Australia: Geological Survey of Western Australia, digital data layer, <www.dmp.wa.gov.au/geoview>.

Figure 1. **1:500 000 interpreted bedrock geology map of Western Australia (GSWA, 2016) showing locations of cross-sections along which gravity and magnetic anomaly data have been forward modelled**

Drysdale–Londonderry SD 52-09 1:250 000 geological map, section A–B

(Kimberley Basin)

LI Brisbout and C Phillips

Location

Map: Drysdale–Londonderry (52-09)

Zone: MGA Zone 52

End coordinates: 176697E 8388171N to 338228E 8415696N

Length: 160 km

Interpretation scale: 1:250 000

Section A–B is an east-northeasterly trending cross-section traversing the centre of the Drysdale–Londonderry map sheet (Phillips and de Souza Kovacs, 2016; Fig. 1a).

Tectonostratigraphy

The Drysdale–Londonderry 1:250 000 Geological Series map sheet (Phillips and de Souza Kovacs, 2016) exclusively covers sedimentary and volcanic rocks deposited within the >1795 to 1740 Ma Kimberley Basin (Fig. 1a). The Kimberley Basin contains the 1.5 km thick Speewah Group overlain by the >4 km thick Kimberley Group. Only the Kimberley Group is exposed on the map sheet, where it dips gently to the east exposing a near complete stratigraphy. In ascending stratigraphic order, and from west to east, the Kimberley Group consists of the King Leopold Sandstone, Carson Volcanics, Warton Sandstone, Elgee Siltstone and Pentecost Sandstone. The Kimberley Group represents fluvio-deltaic, fluvio-marine and shallow-marine sedimentation on a continually subsiding continental margin on the western edge of the North Australian Craton. The 1799–1791 Ma Hart Dolerite intrudes rocks of the Kimberley Group. On Drysdale–Londonderry, sills of the Hart Dolerite extensively intrude the King Leopold Sandstone. Sills of Hart Dolerite and mafic volcanic rocks in the Carson Volcanics are contiguous in the Halls Creek and King Leopold Orogens and constitute the Hart–Carson Large Igneous Province (Sheppard et al., 2012).

The Kimberley Group conformably to locally unconformably overlies the Speewah Group on the margins of the Halls Creek and King Leopold Orogens (Griffin et al., 1994; Thorne et al., 1999). The Speewah Group has not been confidently identified under the Kimberley Group in geophysical data away from the King Leopold and Halls Creek Orogens (Spratt et al., 2014; Lindsay et al., 2015, 2016). Current tectonic models suggest that the Kimberley Basin is underlain by granitic continental crust of the inferred Archean to Paleoproterozoic Kimberley Craton (Gunn and Meixner, 1998; Tyler et al., 1999; Griffin et al., 2000; Hollis et al., 2014).

Structure

Rocks within the Kimberley Basin on the Drysdale–Londonderry 1:250 000 map sheet are largely undeformed, flat lying or very gently dipping. Two sets of large, open folds trend northwest and northeast, respectively, resulting in a gentle warping of the sedimentary and volcanic rocks. Overall, rocks on Drysdale–Londonderry dip gently (and young) to the east, typically with dips <10°. Faulting is uncommon with only two structures, the Barton Range Fault and Seppelt Range Fault, producing any appreciable displacement.

Cross-section A–B trends roughly east-northeast and presents the typically flat-lying stratigraphy (Fig. 1b) interrupted by the normal Seppelt Range Fault at the eastern end of the section, with a displacement of up to 180 m.

Geophysical data

Topographic, Bouguer gravity and aeromagnetic data were sampled every 500 m along profile A–B. The topography, defining the surface of the model, was sampled from SRTM3 (Jarvis et al., 2006). Gravity data were sampled from the GSWA 2015 merged 400 m Bouguer gravity grid of Western Australia (GSWA, 2015). On Drysdale–Londonderry, gravity stations are spaced in a ~10 km grid, with a higher resolution survey along the Gibb River – Kalumburu Road. Aeromagnetic data were sampled from the GSWA 2014 merged 80 m magnetic grid of Western Australia (GSWA, 2014). On Drysdale–Londonderry, aeromagnetic data are available at 400 m line spacing (180° line direction) with higher resolution surveys in the northeast.

Specific gravity data from Lindsay et al. (2015) were used to attribute densities to the forward model. Model densities are listed in Table 1.

Forward modelling

The initial geology interpreted along section A–B has been tested and where necessary modified using 2D gravity

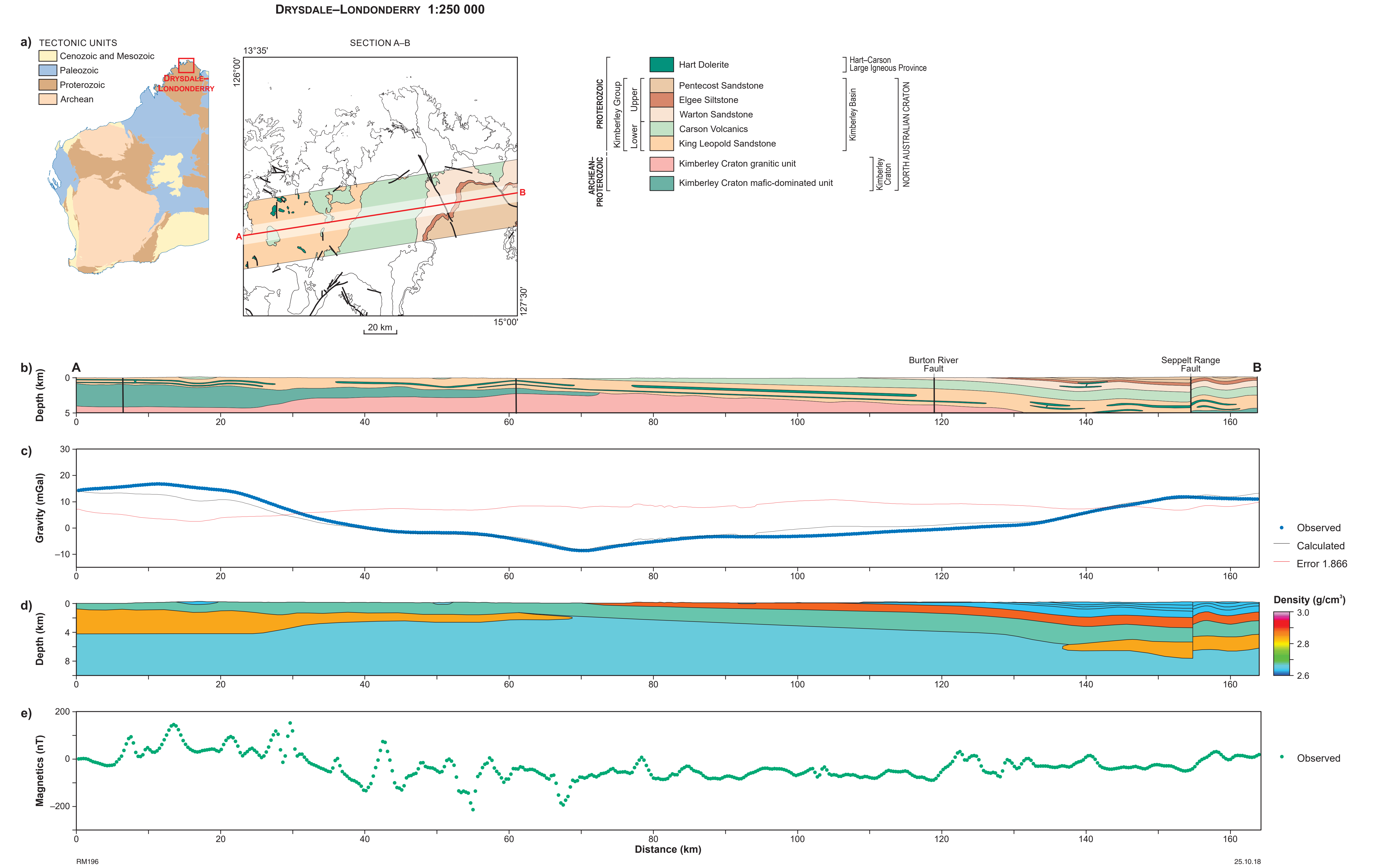

Figure 1. a) Location of cross-section A–B on the DRYSDALE–LONDONDERRY 1:250 000 map sheet (Phillips and de Souza Kovacs, 2016) showing simplified interpreted bedrock geology at 1:500 000 scale within 20 km of the line of section. Sections: b) lithology from DRYSDALE–LONDONDERRY (Phillips and de Souza Kovacs, 2016), see a) for legend; c) observed and calculated Bouguer gravity data showing model error; d) density model; e) observed RTP TMI data

Table 1. Petrophysical properties of modelled units and the corresponding map codes and lithologies

Modelled unit	*Map code*	*Rock type*	*Model density (g/cm³)*
upper Kimberley Group			
Pentecost Sandstone middle unit	P_-KMp-ss	pink and white quartz sandstone, purple to grey fine-grained sandstone, purple siltstone and mudstone	2.65
Pentecost Sandstone lower unit	P_-KMp-stq	quartz sandstone, feldspathic sandstone and micaceous siltstone	2.65
Elgee Siltstone	P_-KMe-xsl-kd	siltstone, mudstone and sandstone	2.65
Warton Sandstone	P_-KMw-st	quartz sandstone and feldspathic sandstone	2.65
lower Kimberley Group			
Carson Volcanics	P_-KMc-bb	basalt and basaltic volcaniclastic rock	2.90
King Leopold Sandstone and Hart Dolerite	P_-KMl-st, P_-_ha-od	quartz sandstone, pebbly quartz sandstone and dolerite	2.68
Kimberley Craton			
Kimberley Craton granitic unit	AP_-g-K	unexposed granitic rocks	2.67
Kimberley Craton mafic unit	AP_-xo-md-K	unexposed dominantly mafic intrusive and metasedimentary rocks	2.85

forward modelling to produce the final section (Fig. 1b). 2D gravity forward modelling along A–B was performed in Oasis montaj GM-SYS (version 8.2). Gravity stations were placed 1 m above the topography and the air was modelled with a density of 2.67 g/cm^3. A linear regional trend was removed from the Bouguer gravity data and the DC shift was automatically applied to the Bouguer gravity data. The section was modelled to a depth of 10 km and units were extended horizontally beyond the ends of the section to avoid edge effects.

Results

The gravity profile along section A–B contains two broad, high-amplitude anomalies (~20 mGal) at each end of the section (Fig. 1c). The sources of these gravity highs are interpreted to be dense, mafic-dominated units within the Kimberley Craton basement. In section A–B, this unit is modelled with a density of 2.85 g/cm^3 and placed at the top of the Kimberley Craton (Fig. 1d). However, the depth, density and geometry of this dense unit are unconstrained and it is possible that it occurs at greater depth within the Kimberley Craton. An attempt was made to model the two broad gravity highs as sills and dykes of Hart Dolerite in the Kimberley Group. However, at the western end of the section, it was not possible to produce a gravity anomaly of ~24 mGal by adding 3.00 g/cm^3 dolerite sills and dykes to ~1 km of sediments.

Excluding the unexposed dense units at the western and eastern ends of the section, the Kimberley Craton is interpreted to be intruded by granitic rocks of the Paperbark Supersuite which have been modelled with a density of 2.67 g/cm^3. The Kimberley Group sedimentary rocks overlying the Kimberley Craton have been modelled with densities of 2.65 – 2.68 g/cm^3. The higher density of 2.68 g/cm^3 was attributed to the King Leopold Sandstone to account for the presence of the Hart Dolerite sills. The Carson Volcanics, which overlie the King Leopold Sandstone, have been modelled with a density of 2.90 g/cm^3.

Magnetic data along A–B are dominated by high-frequency (~100 nT) anomalies produced by Hart Dolerite sills and dykes and subvertical northeast-trending dykes of the Kimberley Dyke Suite. Superimposed on these high-frequency anomalies are long-wavelength magnetic highs that, along profile A–B, are broadly coincident with the gravity highs. At the western end of section A–B, the gravity high coincides with a broad magnetic high (Fig. 1e) and at the eastern end, the gravity high is on the margin of a long-wavelength magnetic high.

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LANSDOWNE SE 52-05 1:250 000 geological map, section A–B

(Canning Basin – Lamboo Province – Kimberley Basin)

RE Murdie and C Phillips

Location

Map: LANSDOWNE (SE 52-5)

Zone: MGA Zone 52

End coordinates: 189625E 8007360N to
255126E 8119007N

Length: 129 km

Interpretation scale: 1:250 000

Section A–B traversing the LANSDOWNE 1:250 000 Geological Series map (Phillips et al., 2018) is drawn perpendicular to the northwest-trending King Leopold Orogen (Fig. 1a). The cross-section is dominated by flat-lying sedimentary rocks in the Kimberley Basin, which are in thrust-contact with the underlying Western Zone of the Lamboo Province.

Tectonostratigraphy

The Lamboo Province is divided into Western, Central and Eastern Zones (Tyler et al., 1995), of which only the Western Zone is exposed in LANSDOWNE section A–B. The Western Zone of the Lamboo Province consists of metasedimentary rocks intruded and overlain by granitic and volcanic rocks, all metamorphosed to upper greenschist or lower amphibolite facies during the 1870–1850 Ma Hopper Orogeny (Bodorkos et al., 1999; Tyler et al., 1999) and 1832–1808 Ma Halls Creek Orogeny (Tyler et al., 1998a; Page et al., 2001).

The Kimberley Basin unconformably overlies the Western Zone. The Kimberley Basin consists of the siliciclastic sedimentary Speewah Group and the volcano-sedimentary Kimberley Group deposited between about 1814 and 1740 Ma (Wingate et al., 2011; Ramsay et al., 2017). The Kimberley Basin preserves fluvial to shallow-marine sedimentation in a broad, typically flat-lying intracratonic basin, where continual subsidence largely controlled sedimentation, lithofacies distribution and the relatively stable depositional setting. Large volumes of the Hart–Carson Large Igneous Province dolerite and gabbro were emplaced within the Speewah Group and lower Kimberley Group of the Kimberley Basin at c. 1795 Ma (Sheppard et al., 2012). These were coeval with large volumes of basalt and basaltic andesite in the Carson Volcanics of the Kimberley Group.

Neoproterozoic glacial sedimentary units of the Mount House Group of the Louisa Basin unconformably overlie the Kimberley Basin. Devonian sedimentary units of the Canning Basin are exposed in the extreme southwest on LANSDOWNE, where they are in fault contact with granitic rocks of the Western Zone of the Lamboo Province.

Structure

The major structure crossed by LANSDOWNE A–B is the Inglis Fault that can be traced for more than 300 km in the King Leopold Orogen. The structure is a northwest-trending, northeast-dipping, low-angle thrust fault that juxtaposes the Kimberley Basin against the underlying Western Zone of the Lamboo Province. The Inglis Fault was produced during the intracratonic King Leopold Orogeny at c. 560 Ma (Shaw et al., 1992; Griffin et al., 1993; Tyler and Griffin, 1993). This event also produced a series of northwest-trending, northeast-dipping reverse faults interpreted to attach to the Inglis Fault at depth. Northeast from the King Leopold Orogen, the Kimberley Basin is largely undeformed with folding largely restricted to very broad, gentle anticlines and synclines, commonly doubly plunging, producing dome-and-basin patterns.

Older structures in the Western Zone include very steep or near vertical shear zones and faults. The Sandy Creek Shear Zone and Sandy Creek Fault on LANSDOWNE, is a near vertical strike-slip fault with a sinistral sense of movement; displacements of 5–10 km have been noted (Gellatly and Derrick, 1967). The Barramundi Fault has a normal sense of movement that places the Canning Basin in contact with the Western Zone.

Geophysical data

A gravity profile was extracted from the GSWA gravity compilation grid of Western Australia (GSWA, 2017a) with points sampled every 430 m (Fig. 1b). It should be noted that although the gravity grid is gridded at 400 m spacing, the original data points are spaced on the old 11 km grid so that there are only 13 points within a 5 km distance from the section. Topographic data were taken from SRTM3 at the same points.

A magnetic profile was taken across the same section from the State magnetic 80 m merged grid (GSWA, 2017b). Physical property data were compiled using generic values from Dentith and Mudge (2014). These values were interpolated to corresponding lithologies along this section (Table 1).

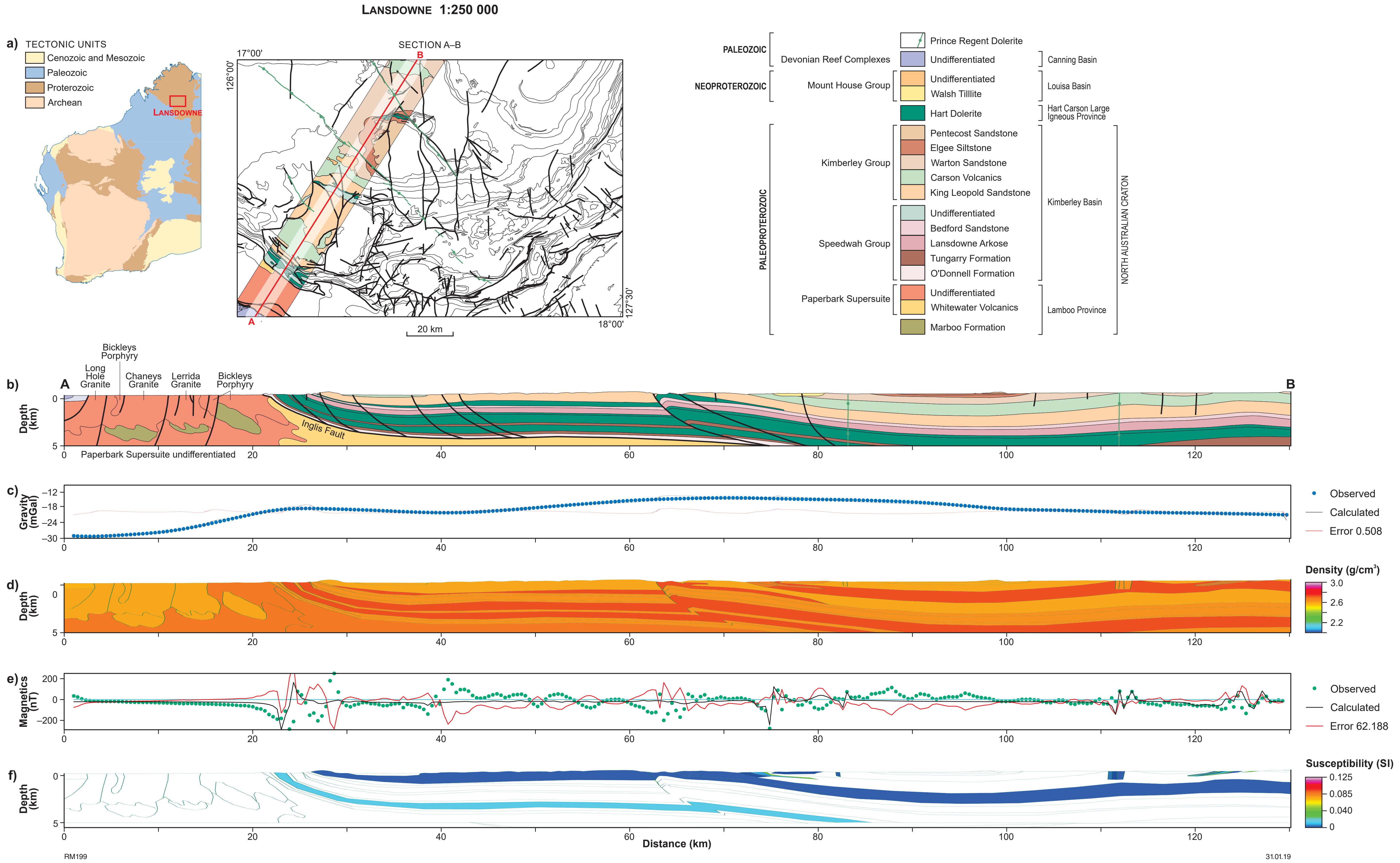

Figure 1. a) Location of cross-section A–B on the LANSDOWNE 1:250 000 map sheet (Phillips et al., 2018) showing simplified interpreted bedrock geology map at 1:500 000 scale within 20 km of the line of section. Sections: b) lithology from LANSDOWNE (Phillips et al., 2018), see a) for legend; c) observed and calculated gravity anomaly profile with error line; d) density; e) observed and calculated magnetic anomaly profile with error line; f) susceptibility

Table 1. Petrophysical properties of modelled units and the corresponding map codes and lithologies

Modelled unit	*Map code*	*Rock type*	*Density (g/cm³)*	*Magnetic susceptibility (SI)*
Prince Regent Dolerite	DC-_pe-od	dolerite	2.67	0 – 0.0004
Devonian reef complexes				
Barramundi Conglomerate	D-_ba-sbp	conglomerate	2.60	
Mount House Group				
Walsh Tillite	P_-HUw-sepg	conglomerate, sandstone and siltstone	2.63	
Hart Dolerite	P_-_ha-od P_-_ha-gv	dolerite granophyre	2.75 2.67	0.001 – 0.006
Kimberley Group				
Pentecost Sandstone	P_-KMp-stq	sandstone	2.65	
Elgee Siltstone	P_-KMe-xsl-kd	siltstone		
Teronis Member	P_-KMet-kd	dolomitic sandstone and siltstone	2.65	
Warton Sandstone	P_-KMw-st	sandstone	2.63	
Carson Volcanics	P_-KMc-bb	basalt and sandstone	2.71	0.000 – 0.004
King Leopold Sandstone	P_-KMl-st	sandstone	2.65	0.0002
Speewah Group				
Bedford Sandstone	P_-SPb-stq	sandstone	2.67	
Lansdowne Arkose	P_-SPo-sta	sandstone	2.67	
Tunganary Formation	P_-SPt-st	sandstone	2.67	
O'Donnell Formation	P_-SPn-stq	sandstone	2.65	
Paperbark Supersuite	P_-PB-xg-o	undifferentiated igneous and volcanic rock	2.64 – 2.65	
Long Hole Granite	P_-PBlh-mgm	metagranite	2.62	
Bickleys Porphyry	P_-PBbi-mgm	metagranite	2.64 – 2.71	
Chaneys Granite	P_-PBcy-mgm	metagranite	2.63	
Lerida Granite	P_-PBle-mgg	metagranite	2.64	

Forward modelling

All modelling was performed in GM-SYS run within the Oasis montaj software. 2.5D modelling was performed where the polygons were extended by 100 m perpendicular to the strike of the profile.

Results

The section (Fig. 1a) was modelled to a depth of 5 km (Fig. 1c,e). The low dip of the rocks, similar lithologies and lack of measured densities meant that the modelled section was built to fit the hypothesized geology of the section and had no real constraints. The few magnetic susceptibility measurements made (M Lindsay, 2018, written comm.) were used as guidelines for the magnetic modelling.

The gravity profile (Fig. 1c) is dominated by a low amplitude (5 mGal) long wavelength (about 59 km wide) peak across the centre of the profile and large-amplitude (–10 mGal) gravity low in the southern end of the profile.

The southern end of the profile is modelled with low-density granitic rocks (2.62 – 2.65 g/cm³) of the Paperbark Supersuite. The exception is the Bickleys Porphyry, which has a higher density of 2.64 – 2.72 g/cm³. This is implied due to the point of curvature of the gravity profile into the low anomaly at a distance of about 30–70 km along the profile.

The broad gravity high modelled between 50 and 90 km is interpreted to be due to two components. The first is a thick and extensive intrusion of the Hart Dolerite into sandstone and siltstone units of the Speedwah Group. The Hart Dolerite is given a relatively high density of 2.75 g/cm³ for the dolerite units and a moderate density of 2.67 g/cm³ for the granophyre unit, although this is so small in the section that it is hard to resolve. Sandstone units were given moderate densities of 2.63 – 2.67 g/cm³. However, this did not give a large enough anomaly. Hence, the full amplitude was achieved by implying variations in basement geology beneath the Kimberley Basin, which is thickest in this part of the section (>5 km thick). It is possible that this anomaly is responding to a large volume of mafic material in the basement. Voluminous mafic material is present in the Paperbark Supersuite and is exposed in the Western Zone on adjoining map sheets to the east (e.g. DIXON RANGE 1:250 000; Tyler et al., 1998b). Alternatively, the anomaly could be a previously unrecognized unit not exposed in the Lamboo Province.

Numerous magnetic anomalies in the Kimberley Basin between 40 and 80 km along the section (Fig. 1e) are interpreted to result from faults within volcanic and subvolcanic units. These small-amplitude magnetic anomalies are modelled as shallow thrusting in the Kimberley Basin such that the thrusts sole onto the Inglis Fault at depth. Other short-wavelength magnetic anomalies are produced by northwest-trending dolerite dykes of the Prince Regent Dolerite that crosscut the Kimberley Basin.

These highly magnetic anomalies are measured where the Hart Dolerite is exposed at 22–25 km (Fig. 1d,e). Hand specimen magnetic susceptibility measurements (M Lindsay, 2018, written comm.) on two of the sandstone units (O'Donnell Formation and King Leopold Sandstone) showed low susceptibilities. The Carson Volcanics at the northern end of the profile is modelled as having layering of different magnetic susceptibilities. These are only modelled at the surface, but it implies that this type of layering or lensing continues through the whole body.

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MACDONALD SF 52-14
1:250 000 geological map, section A–B
(Amadeus Basin – west Arunta Orogen)

RE Murdie, DW Maidment, PW Haines and CV Spaggiari

Location

Map: MACDONALD (SF 52-14)

Zone: MGA Zone 52

End coordinates: 420331E 7346619N to 479212E 7455473N

Length: 124 km

Interpretation scale: 1:250 000

Section A–B traversing the MACDONALD 1:250 000 Geological Series map (Haines et al., 2018) is a south-southwest section that crosses the central to northern part of the western Amadeus Basin, and the Warumpi and Aileron Provinces of the Arunta Orogen (Fig. 1a).

Tectonostratigraphy

The northern end of the modelled section crosses the southwestern part of the dominantly Paleoproterozoic Arunta Orogen. The Arunta Orogen consists of two main elements: the Aileron Province to the north (Scrimgeour, 2013a) and the Warumpi Province to the south (Scrimgeour, 2013b). The oldest known unit in the Aileron Province consists of metasedimentary rocks of the 1840–1830 Ma Lander Rock Formation. In the area of the modelled section, this package has been deformed and intruded by granitic rocks emplaced between 1840 and 1630 Ma. The Warumpi Province consists of metasedimentary and meta-igneous rocks that are mostly younger than those of the Aileron Province, ranging between 1690 and 1600 Ma. Geochronology and Lu–Hf isotope analysis of zircons from the Warumpi Province in Western Australia suggests that although the exposed units are younger than most of those exposed in the Aileron Province, the Warumpi Province might reflect a crustal block that was rifted from the Aileron Province at or before c. 1690 Ma (Hollis et al., 2013). During the Liebig Orogeny, between 1640 and 1630 Ma, synchronous compression and extension indicate sinistral, oblique accretion of the Warumpi Province onto the Aileron Province along the Central Australian Suture (Scrimgeour et al., 2005).

The Amadeus Basin (Wells et al., 1970; Korsch and Kennard, 1991; Edgoose, 2013) is an extensive, Neoproterozoic to Paleozoic sedimentary basin situated between the Arunta Orogen to the north, and the Musgrave region to the south. It forms the structural remnant of a formerly larger depositional system, the Centralian Superbasin (Walter et al., 1995), which was modified by deformation and basement uplift during the 580–520 Ma Petermann Orogeny, and during the 450–295 Ma Alice Springs Orogeny.

Structure

The Aileron and Warumpi Provinces are separated by a major east–west trending shear zone network, collectively named the Central Australian Suture, which the modelled section intersected near its northern end. This shear zone network has been reactivated several times since its formation and although its exposure in the west Arunta is limited, magnetic data and exposures to the east indicate it is steeply dipping, and has experienced at least one episode of dextral transpression. The Aileron and Warumpi Provinces have each experienced complex, multiphase tectono-thermal histories, and much of this complexity cannot be modelled in this section. Some linear to arcuate structures within these provinces are evident in aeromagnetic images and have been incorporated in the modelled section. They may reflect movement during the Petermann and Alice Springs Orogenies.

Within the Amadeus Basin, aeromagnetic images outline complex dome-and-basin patterns that appear to be influenced, at least in part, by salt movement during deformation of the Petermann and Alice Springs Orogenies (Foss et al., 2015). The main salt-bearing unit in the Amadeus Basin is the Gillen Formation of the Bitter Springs Group, towards the base of the succession. Detachment faulting during deformation is possible at this level, though salt may not be present within this unit in all parts of the basin, due to either non-deposition or later dissolution. Along the trace of the section faults are limited, and much of the regional-scale folding in the central part of the basin is relatively open in style, though tighter folds are locally evident in some outcrops, particularly where carbonate is present (e.g. the Bitter Springs Group). The northern part of the basin approaching the Warumpi Province appears to be more deformed, though faulting in this area may be largely blind and not expressed at the surface.

Geophysical data

A gravity profile was extracted from the GSWA gravity compilation grid of Western Australia (GSWA, 2017a) with points sampled every 124 m (Fig. 1c). Gravity data in this region are of high density due to the inclusion of an airborne gravity survey, flown by Airborne Petroleum

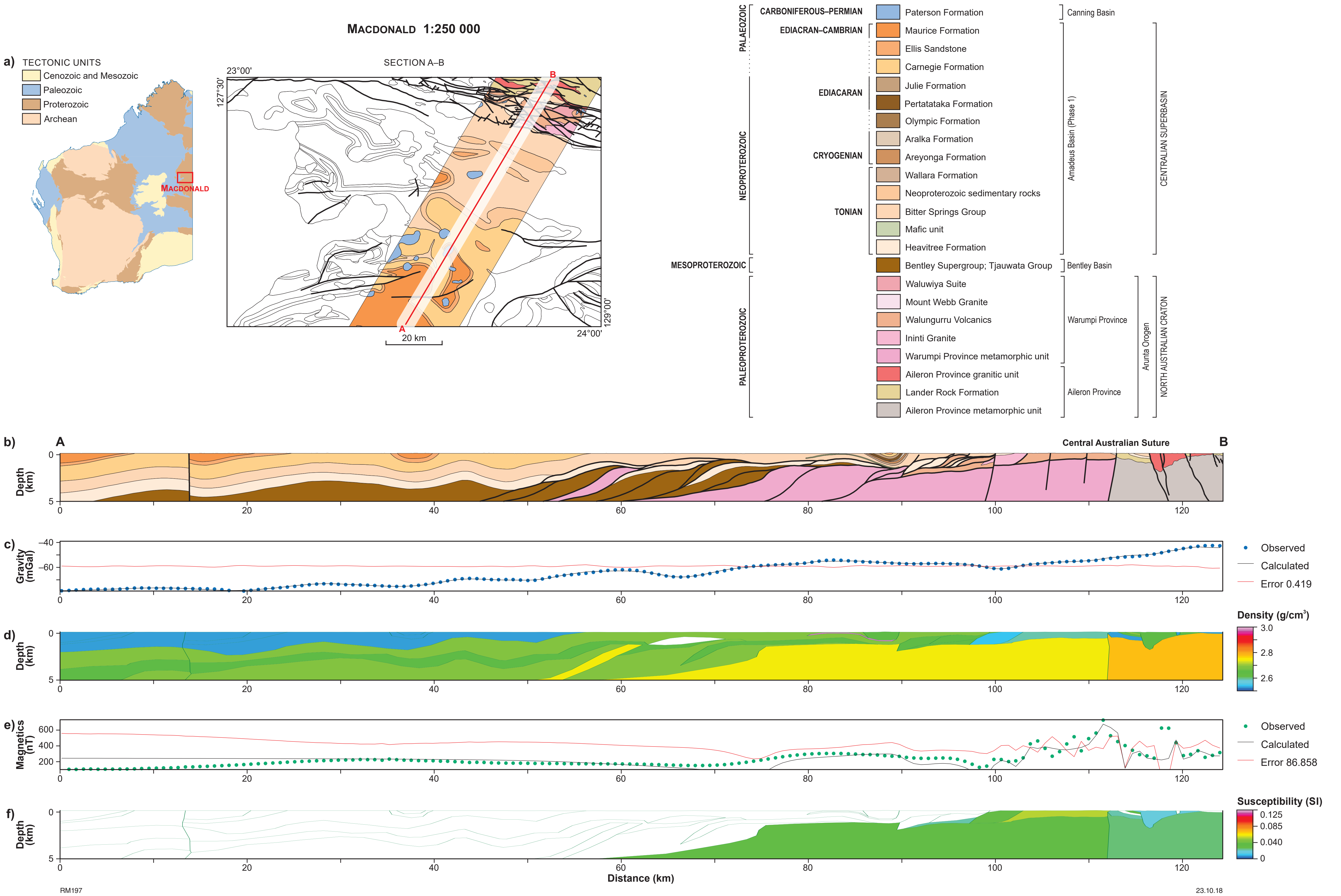

Figure 1. a) Location of cross-section A–B on the MACDONALD 1:250 000 map sheet (Haines et al., 2018) showing simplified interpreted bedrock geology map at 1:500 000 scale within 20 km of the line of section. Sections: b) lithology from MACDONALD (Haines et al., 2018), see a) for legend; c) observed and calculated gravity anomaly profile with error line; d) density; e) observed and calculated magnetic anomaly profile with error line; f) susceptibility

Geophysics in 2008, within the State compilation. This has the effect of enhancing shallow structure (Foss et al., 2015). Topographic data were taken from SRTM at the same points.

The magnetic profile was taken across the same section from the State magnetic 80 m merged grid (GSWA, 2017b).

Physical property data included informed estimates as used in previous modelling done in association with the interpretation of seismic line 09GA-GA1 (Joly et al., 2013). Otherwise generic values from Dentith and Mudge (2014) and Emmerson (1990) were interpolated to corresponding lithologies in the vicinity of this section (Table 1).

Forward modelling

All modelling was performed in GM-SYS run within the Oasis montaj software. 2.5D modelling was performed where the polygons extend 100 m perpendicular to the strike of the profile. It should be noted that the following model is one hypothetical representation where the assumed densities and geometries fit the observed gravity anomaly, but equally a different choice of densities and geometries could also fit the anomaly. Where possible, we have attempted to retain thicknesses of units at depth as observed at the surface and we infer structures consistent with those mapped at the surface and the interpreted bedrock geology map (Haines et al., 2018).

Results

The section was modelled down to 5 km as displayed in the cross-section for the 1:250 000 map (Fig. 1b; Haines et al., 2018).

The gravity signal shows an increasing gradient from southwest to northeast (Fig. 1c). At depth, this reflects the inferred changes in rocks in the lower part of the modelled section, from relatively low-density Tjauwata Group sedimentary rocks in the southwest, across undivided and unexposed Warumpi Province in the centre, and metasedimentary and meta-igneous rocks of the Aileron basement in the north (Fig. 1b,d). To honour the general trend of the gravity data, it was necessary to infer the presence of basement rocks of the Warumpi Province in the centre of the profile, though the nature of the basement in this area is largely unconstrained. Foss et al. (2015) found it necessary to add a low to moderate density 'Pre-Amadeus' unit to their models. We also incorporate a unit in this position, and interpret this to be (meta) sedimentary rocks of the Tjauwata Group, which outcrops stratigraphically beneath the Amadeus Basin farther to the south of the modelled section. We modelled this unit with a slightly higher bulk density — 2.75 g/cm^3 compared to 2.70 g/cm^3 used by Foss et al. (2015) — and do not interpret this unit to be present in the northern part of the Amadeus Basin, suggesting that basement rocks of the Warumpi Province are at significantly shallower depths in that area.

Table 1. Petrophysical properties of modelled units and the corresponding map codes and lithologies

Modelled unit	*Map code*	*Rock type*	*Density (g/cm^3)*	*Susceptibility (model) (SI)*	*Susceptibility (measured) (SI)*
Amadeus Basin					
Maurice Formation	P_E-_ma-ss	sandstone	2.55		
Ellis Sandstone	P_E-_el-st	quartz sandstone	2.67		
Carnegie Formation	P_E-_cn-ss	siliciclastic rock	2.60		
Julie Formation	P_-_ju-xk-s	carbonate	2.67		
Pertatataka Formation	P_-_pk-sl	siltstone	2.67		
Olympic Formation	P_-_oy-se	diamictite	2.67		
Aralka Formation	P_-_ak-sk	siliciclastic rocks	2.67		
Areyonga Formation	P_-_ay-se	diamictite	2.67		
Wallara Formation	P_-_wr-kt	carbonate rocks	2.67		
mafic unit	P_-b-NA	mafic rock	2.87		
Bitter Springs Group	P_-BS-xk-s	dolomite	2.70		
Heavitree Formation	P_-_ht-stq	quartzite	2.67		
Bentley Basin					
Tjauwata Group	P_-TJ-xs-fr	silicicastic sedimentary and volcanic rocks	2.70	0.0011	
Warumpi Province					
Walungurru Volcanics	P_-_wu-mfc	metadacite	2.60	0.0042	0.00003 – 0.0016
Ininti Granite	P_-_it-mgn	granitic gneiss	2.56		0.0008 – 0.0010
metamorphic unit	P_-xmr-mw-WR	metafelsic rock	2.75	0.0023	
Aileron Province					
Lander Rock Formation	P_-_lr-mhs	psammitic schist	2.55	0.0004	0.005
granitic unit	P_-g-AI	granite	2.67		
metamorphic unit	P_-xmd-mr-AI	metasedimentary and meta-igneous rocks	2.80	0.0023	

The mid-wavelength (15–18 km) features in the southwestern part of the section can be modelled by differences in depth to the basement. These are modelled as anticlines and synclines, reflecting the mapped surface geology and the features observed in the gravity and magnetic imagery (Haines et al., 2018) of the area. All units above the Carnegie Formation in the Amadeus Basin have been modelled with the same average density.

Based on mapped south-dipping thrusts farther north at the surface, the northern part of the Amadeus Basin is interpreted be interleaved with thrust slices of the Warumpi Province and Tjauwata Group, which can explain blocks of higher density material in this area.

In the centre of the profile is a prominent gravity low. This has been modelled as a salt body with low density causing a large negative density difference. The wavelength of the gravity low suggests that the source of this relative gravity difference is within the Amadeus Basin, rather than the basement, and the only lithology within this setting that is of sufficiently low density is likely to be salt rich. Elsewhere in the basin, salt within the Gillen Formation of the Bitter Springs Group is known to have been mobile during deformation (Lindsay, 1987). In anticlines where the Bitter Springs Group reaches the surface, it is suspected that the salt has been dissolved, concentrating the denser dolomite component of the Gillen Formation, whereas the salt is still preserved intact beneath the synclines where it has been less mobilized. This fact, coupled with irregular dome-and-basin patterns in aeromagnetic images, supports the interpretation of salt in this area. However, the general coincidence between gravity highs and anticlinal axes, and gravity lows with synclinal axes, suggests that although salt might have influenced folding patterns, it is unlikely to have formed diapirs in anticlinal culminations. Therefore, salt has not been modelled as a discrete unit elsewhere in the section. It is highly likely that salt migrated through rocks that were already folded above complex basement, thus complicating the resultant geophysical architecture.

The next feature to the northeast is a small gravity high. While there are no high-density units mapped in the area, a discrete magnetic high in this area might represent an unexposed mafic body. Although no mafic rocks have been observed in outcrop in this area of the Amadeus Basin, minor basaltic rocks have been noted from the eastern and south-central part of the basin within the Bitter Springs Group, raising the possibility that similar basaltic rocks are present in the western part of the basin. In the modelled section, this coincident gravity and magnetic high has thus been modelled as a concordant mafic unit, either an extrusive basalt or a mafic sill. This mafic unit is modelled to extend below a syncline cored by carbonate and siliciclastic sedimentary rocks of the Amadeus Basin. The gravity data require these rocks to be modelled with a density only slightly lower than the Bitter Springs Group. This is denser than equivalent sedimentary rocks of the Amadeus Basin to the southwest, although this might be explained by the fact that these rocks contain more of the Amadeus Basin stratigraphy that includes a higher proportion of relatively dense dolomite of the Bitter Springs Group.

The Ininti Granite (density = 2.56 g/cm^3) in the Warumpi Province forms a gravity low towards the northern end of the section, and is indicated to dip to the southwest. The Walungurru Volcanics represent the most widely exposed unit of the Warumpi Province in this area. They are dominated by felsic compositions and have been given a relatively low density of 2.60 g/cm^3. Apart from the Waluwiya Suite, which comprises foliated hornblende metagranodiorite to quartz metadiorite, two-pyroxene metagranite and migmatitic felsic rocks, the nature of the bulk of the Warumpi Province rocks underlying the Walungurru Volcanics is unknown, and has been assigned a bulk density of 2.60 g/cm^3, assuming a complex mix of metasedimentary and meta-igneous rocks.

On the northeast side of the Central Australian Suture, relatively low-density rocks of the Lander Rock Formation in the Aileron Province are interpreted to overlie rocks of higher density. The Lander Rock Formation has been assigned a bulk density of 2.55 g/cm^3 and unnamed granitic rocks in this part of the Aileron Province are given an average crustal density. A deeper extension of the southwestern end of these granitic rocks is required to fit the form of the gravity profile, which shallows to the northeast. The occurrence of Lander Rock Formation at the far northeast end of the profile causes a low in the calculated gravity, which does not match the observed data, but this mismatch cannot be addressed without extending the model to the northeast, and is essentially an edge effect. The Central Australian Suture is interpreted as a steeply south-dipping structure based on limited outcrop information in the region and interpretations of magnetic data. Modelling of the gravity data is consistent with this interpretation, although locally steep northerly dips are also possible. This would fit with a steeply dipping, anastomosing shear zone network as previously interpreted.

The magnetic data have only been very coarsely modelled (Fig. 1e,f). Sedimentary rocks of the Amadeus Basin are generally non-magnetic (Foss et al., 2015). The basement rocks of the Warumpi and Aileron Provinces have a low susceptibility which provides a muted long-wavelength signal. Most of the outcropping units of these provinces have moderate magnetic susceptibilities. Hand specimen readings from the Walungurru Volcanics, Ininti Granite and Lander Rock Formation show small to larger susceptibility readings (Table 1). The exact shape of the magnetic anomalies have not been matched as this would require splitting the mapped units into smaller units, as done by Foss et al. (2015), which is not achievable at the scale of this section.

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Webb SF 52-10
1:250 000 geological map, section A–B
(Amadeus Basin)

RE Murdie, DW Maidment and CV Spaggiari

Location

Map: Webb (SF 52-10)

Zone: MGA Zone 52

End coordinates: 406756E 7456690N to
470124E 7566657N

Length: 129 km

Interpretation scale: 1:250 000

This section is a southwest–northeast section that crosses the central eastern region of the Webb 1:250 000 Geological Series map (Spaggiari et al., 2016), traversing the Warumpi and Aileron Provinces of the Arunta Orogen, which are largely covered by sedimentary rocks of the Birrindudu and Amadeus Basins (Fig. 1a).

Tectonostratigraphy

The northern part of the section is underlain by metamorphosed sedimentary and igneous rocks of the 2500–1700 Ma Aileron Province of the Arunta Orogen (Hollis et al., 2013; Scrimgeour, 2013a,b). The oldest rocks identified in the orogen are metasedimentary and volcanic rocks of the 1840–1830 Ma Lander Rock Formation, but rare outcrops of c. 2500 Ma granitic gneiss in the adjacent Tanami Orogen suggest that Neoarchean rocks might occur at depth. The Lander Rock Formation is intruded by 1779–1767 Ma granitic rocks of the Carrington Suite, which includes the Dwarf Well and Rapide Granites, and which might also include a mafic component at depth. A later phase of sedimentation is recorded by the <1750 Ma Lake Mackay Quartzite, which occurs in restricted areas unconformably overlying the older units.

The southern part of the section is underlain by metamorphosed volcanic, sedimentary and igneous rocks of the 1690–1600 Ma Warumpi Province, which comprise the southern margin of the Arunta Orogen. The Warumpi Province is separated from the Aileron Province by a generally poorly exposed, approximately west-northwesterly trending structure, termed the Central Australian Suture. On the Webb sheet, the Warumpi Province comprises felsic volcanic and volcaniclastic rocks of the c. 1677 Ma Pollock Hills Formation and the 1647–1633 Ma Mount Webb Granite.

In the area of the section, units of the Arunta Orogen are overlain by Neoproterozoic to Cambrian sedimentary rocks of the Amadeus Basin, which are dominantly siliciclastic, but also contain lesser carbonate and evaporite units. These include, from older to younger, the Heavitree Formation, Bitter Springs Group and Angas Hills Formation. Phanerozoic sedimentary rocks of the Canning Basin overlie the Amadeus Basin in the western part of the Webb sheet, but not along the modelled line. Unconsolidated sediment and regolith form a relatively thin veneer that covers much of the section line.

Structure

The major regional structure in the Webb area is the Central Australian Suture, which marks the boundary between the Aileron and Warumpi Provinces. The structure is poorly exposed, but appears to be steeply dipping with a possible strike-slip component. A subparallel fault south of the suture defines the southern margin of outcropping Warumpi Province rocks, and appears to be a steeply north-dipping thrust fault or back-thrust that exhumed basement rocks from beneath the Amadeus Basin. A series of west-northwesterly to westerly trending and northeasterly trending faults that affect the Amadeus Basin succession have been defined in aeromagnetic data. The kinematics of the west-northwesterly trending faults are uncertain due to the extensive cover, but at least in some cases appear to represent thrust faults that have uplifted basement. Some northeasterly trending faults in the northern part of the section have an apparent sinistral strike-slip offset in aeromagnetic imagery.

Basement rocks of the Arunta Orogen are variably deformed and metamorphosed and structurally complex, having been affected by multiple tectono-thermal events. Sedimentary rocks of the Amadeus Basin are generally less deformed, with more open folding and discrete faulting. An apparent west-northwesterly trending fold, defined in aeromagnetic imagery near the central part of the section, might reflect the effects of salt movement of an evaporite-rich unit within the Bitter Springs Group in the lower part of the Amadeus Basin succession (Joly et al., 2013).

Geophysical data

A gravity profile was extracted from the GSWA gravity compilation grid of Western Australia (GSWA, 2015), with points sampled every 150 m (Fig. 1c). Topographic data were taken from the SRTM3 at the same points.

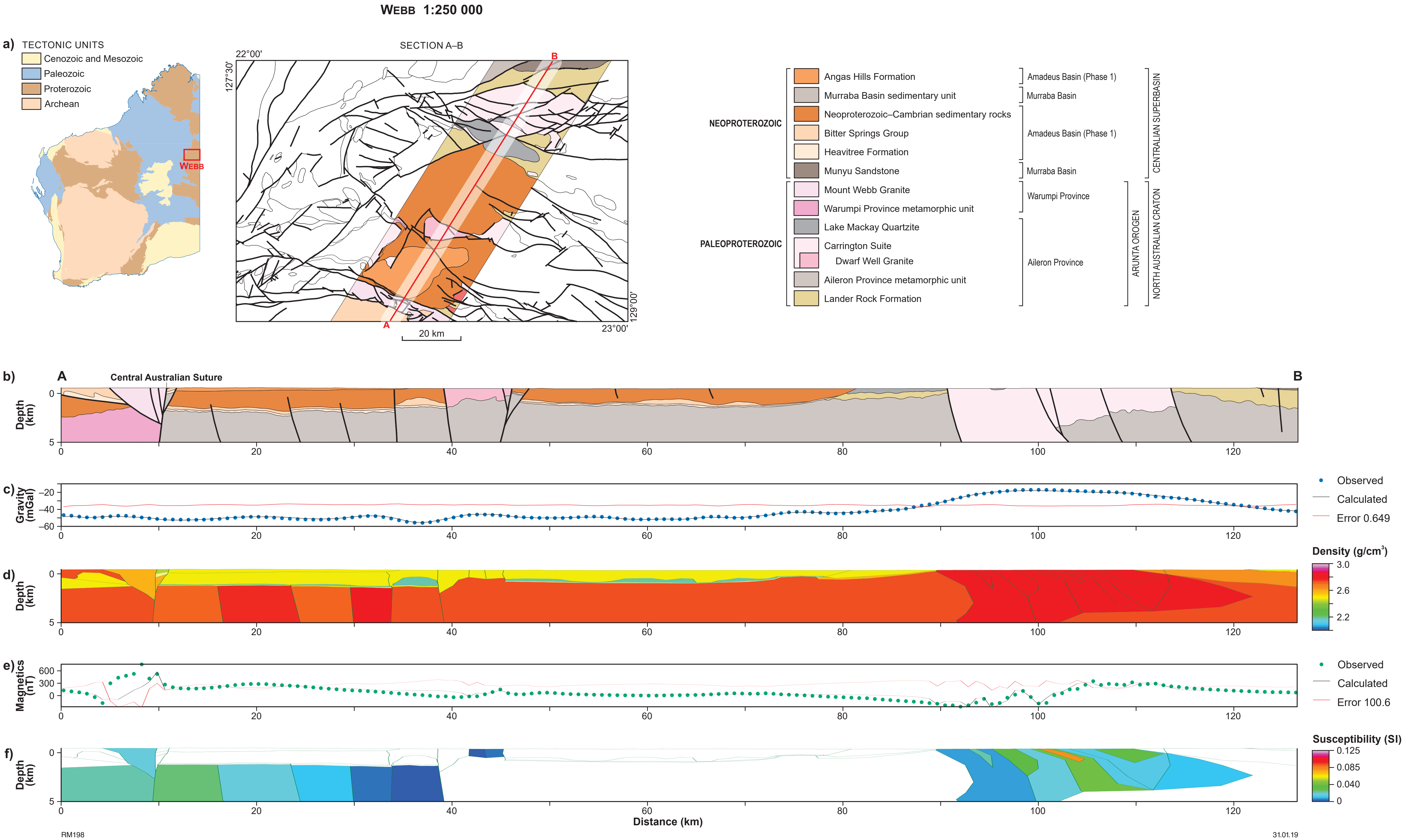

Figure 1. a) Location of cross-section A–B on the WEBB 1:250 000 map sheet (Spaggiari et al., 2016) showing simplified interpreted bedrock geology map at 1:500 000 scale within 20 km of the line of section. Sections: b) lithology from WEBB (Spaggiari et al., 2016), see a) for legend; c) observed and calculated gravity anomaly profile with error line; d) density; e) observed and calculated magnetic anomaly profile with error line; f) susceptibility

The magnetic profile was taken across the same section from the State magnetic 80 m merged grid (GSWA, 2014).

Physical property data were compiled from Joly et al. (2013) and generic values from Emmerson (1990). These values were interpolated to corresponding lithologies in the vicinity of this section (Table 1).

Forward modelling

All modelling was performed in GM-SYS run within the Oasis montaj software. 2.5D modelling was performed were the polygons were extended by 100 m perpendicular to the strike of the profile.

Results

The section was modelled down to 8 km (Fig. 1d) although only the top 5 km was displayed in the cross-section for the 1:250 000 map (Fig. 1b) (Spaggiari et al., 2016).

The gravity profile is dominated by a large-amplitude (30 mGal), long-wavelength (about 37 km wide) peak at the northern end and small amplitude (<10 mGal) shorter wavelength undulations in the southern half of the profile.

The large peak was modelled as a dense (2.87 g/cm^3) body of mixed felsic and mafic rocks of the Carrington Suite, which requires a steep dip to the northeast on its southern margin and a shallow dip to the northeast on its northern margin to fit the gravity profile.

The sedimentary rocks of the undivided Amadeus Basin were modelled as a homogeneous low-density body of 2.5 g/cm^3. Where divided, sandstone of the Heavitree Formation at the base of the basin was assigned an average density of 2.55 g/cm^3, similar to a measured specimen value of 2.55 g/cm^3 (Schroder and Gorter, 1984). The overlying Bitter Springs Group contains a formation with a very high percentage of salt and was hence attributed with a low density of 2.2 g/cm^3. This is not in conflict with the data from (Schroder and Gorter, 1984), who although they reported an average density of 2.85 g/cm^3, they also stated that the formation was made up of low-density evaporates and high-density mafic rocks. In the far south of the profile, the Bitter Springs Group is assigned a higher density (2.75 g/cm^3) due to a lack of evaporite in this area. In the central part of the section, thickening of the salt layer into potential domes is used to model the gravity lows in the profile.

The Dwarf Well Granite is modelled with a similar density to the Amadeus Basin sedimentary rocks, but the slight peak in the gravity requires that there is an upthrust block of denser basement beneath it.

The Mount Webb Granite is modelled as slightly denser than the basin sediments at 2.6 g/cm^3, which gives the small rise in the gravity profile at this location.

Undivided Aileron Province basement, comprising mixed metasedimentary and meta-igneous rocks, was modelled with an average value of 2.75 g/cm^3. However, the topography of the basement was hypothesized to be generally flat. This required variations in density from

Table 1. Petrophysical properties of modelled units and the corresponding map codes and lithologies

Modelled unit	*Map code*	*Rock type*	*Density (g/cm^3)*	*Magentic susceptibility (SI)*
Amadeus Basin				
Angas Hills Formation	P_E-_ag-sg	conglomerate and sandstone, minor siltstone	2.50	0
undivided Neoproterozoic–Cambrian Amadeus Basin sedimentary rocks	P_E-s-NA, P_-sk-NA	sandstone, siltstone, carbonate minor dolomite and evaporite	2.50	0
Bitter Springs Group	P_-BS-kds	dolomite, siltstone, sandstone, evaporite	2.20	0
Heavitree Formation	P_-_ht-stq	sandstone and quartzite, minor siltstone and conglomerate	2.67	0
Munaba Basin				
Munyu Sandstone	P_-_my-st	sandstone and conglomerate	2.50	0
Waumpi Province				
Mount Webb Granite	P_-_we-mgm	granite	2.60	0 – 0.024
Warumpi Province metamorphic unit	P_-xmr-mw-WR	metamorphosed felsic, mafic and metasedimentary rocks	2.75	0.027
Aileron Province				
Lake Mackay Quartzite	P_-_lm-mtq	quartzite and quartz–mica schist	2.50	0
Carrington Suite	P_-CN-xmgn-mog	felsic and mafic intrusive rocks	2.87	0.012 – 0.084
Dwarf Well Granite	P_-CNdw-mgm	granite	2.50	0.005 – 0.007
Aileron Province metamorphic unit	P_-xmd-mr-AI	metamorphosed felsic, mafic and metasedimentary rocks	2.73 – 2.78	0 – 0.003
Lander Rock Formation	P_-_lr-mh	metamorphosed psammite and pelite, minor BIF and metavolcanic rocks	2.60 – 2.67	0

2.73 to 2.83 g/cm^3 to fit the undulations observed in the gravity profile.

The magnetic profile (Fig. 1e,f) is fairly subdued due to the lack of magnetization within the sedimentary rocks of the Amadeus Basin. Peaks at the northern end of the profile can be correlated with the mixed felsic and mafic rocks of the Carrington Suite, which is modelled as folds of higher susceptibility material interlayered with lower susceptibility material.

The magnetic peak in the southern end is poorly fitted but is probably related to the Mount Webb Granite. A small peak in the centre of the profile is coincident with the Dwarf Well Granite.

The long wavelength rise in the magnetic profile in the south is modelled as an increase in the susceptibility of the different blocks of basement.

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Gabanintha 2644
1:100 000 geological map, section A–B
(Meekatharra greenstone belt, Youanmi Terrane, Yilgarn Craton)

RE Murdie, SS Romano and J Lowrey

Location

Map: Gabanintha (2644)

Zone: MGA Zone 50

End coordinates: 650490E 7052746N to
662992E 7048658N

Length: 13.4 km

Interpretation scale: 1:100 000

This section is a west-northwest section on the northern part of the 1:100 000 Gabanintha map sheet (Romano, 2018), crossing the Meekatharra greenstone belt which sits within granitic rocks of the northern Youanmi Terrane (Fig. 1a).

Tectonostratigraphy

The cross-section comprises Archean granitic rocks of the Yilgarn Craton and the greenstone succession of the Meekatharra greenstone belt. The latter comprises rocks of the Murchison Supergroup, in particular the mafic, volcanic-dominated Singleton Formation and felsic volcanic succession of the Yaloginda Formation, both part of the Norie Group. These are overlain by mafic rocks of the Meekatharra Formation (Polelle Group). The greenstones were intruded by monzogranitic rocks of the Tuckanarra Suite.

Structure

The Meekatharra greenstone belt forms a large refolded fold. The centre of the syncline is towards the western half of the section. The youngest unit at the core of the syncline is the Stockyard Basalt Member of the Meekatharra Formation of the Polelle Group, and the oldest unit of the syncline is the Singleton Formation of the Norie Group. Generally, the north-northeasterly trending deep crustal shear zones dip east.

Geophysical data

A gravity profile was extracted from the GSWA gravity merged grid of Western Australia (GSWA, 2017a), with points sampled every 130 m (Fig. 1c). It should be noted that the gravity point spacing is 2.5 km in this area so there are not many observation points along the profile. Therefore, although gravity is modelled in detail, the Bouguer anomaly data only show the longer wavelength features.

Total magnetic intensity data were extracted from the TMI map of Western Australia (GSWA, 2017b) and topography data were taken from SRTM3 at the same points.

Physical property data were measured by hand where samples were available (Table 1) or otherwise estimated from tabled values of representative lithologies published by Emerson (1990) or Dentith and Mudge (2014; Table 1).

Forward modelling

All modelling was performed in GM-SYS run within the Oasis montaj software. 2.5D modelling was performed where the polygons were extended by 100 m perpendicular to the strike of the profile.

Results

The Bouguer profile (Fig. 1c) shows the gravity high associated with the dense rocks of the Meekatharra greenstone belt in the west, which is replaced by low-density granitic rocks in the east (Fig. 1b–d). This gives a Bouguer anomaly profile of a large high in the west and a low in the east with a smooth slope between them (Fig. 1c).

Mafic rocks of the Polelle Group are very dense. Some hand samples exceeded 2.95 g/cm^3, so a blanket value of 2.96 g/cm^3 was used in the modelling as an average for the whole group.

Rocks of the Norie Group, which form the lower stratigraphic part of the syncline, vary from very dense banded iron-formation to local felsic layers with a relatively low density of 2.72 g/cm^3. The basal member of the Norie Group, the Singleton Formation, is a metabasalt unit with a density exceeding 3.00 g/cm^3. A large root of this or some other dense material, such as the Lady Alma Igneous Complex, is required to fit the gravity high in the west of the profile. Even denser material could be accommodated by the modelling. The wavelength of the anomaly suggests that this dense body is very thick (i.e. greater than the 4 km of this section) and close to the surface. Two smaller synclines of Norie Group rocks lie farther to the east, but neither is as deep as the western syncline.

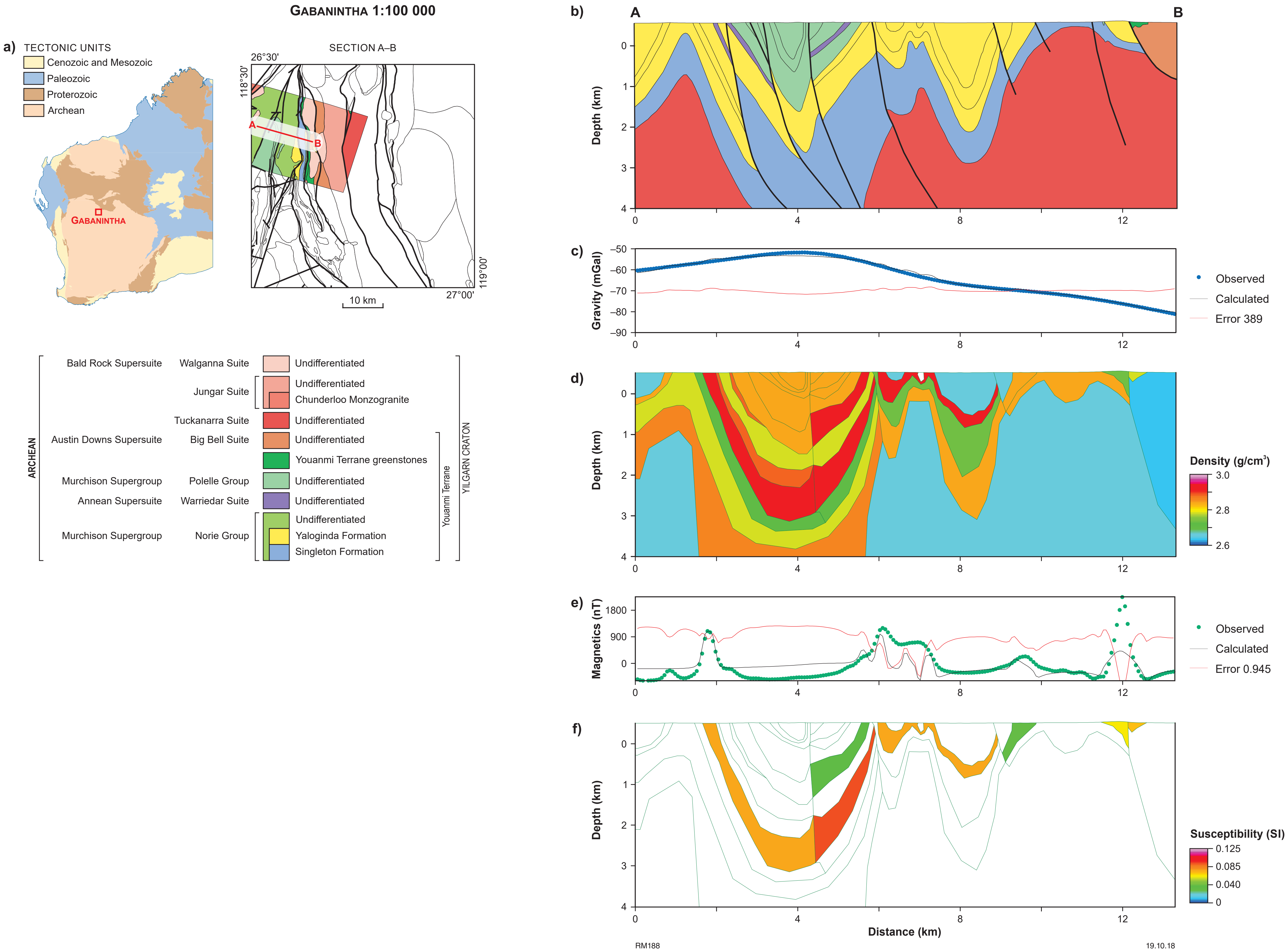

Figure 1. a) Location of cross-section A–B on the GABANINTHA 1:100 000 map sheet (Romano, 2018) showing simplified interpreted bedrock geology map at 1:500 000 scale within 8 km of the line of section. Sections: b) lithology from GABANINTHA (Romano, 2018), see a) for legend; c) observed and calculated gravity anomaly profile with error line; d) density; e) observed and calculated magnetic anomaly profile with error line; f) susceptibility

Table 1. Petrophysical properties of modelled units and the corresponding map codes and lithologies

Modelled unit	*Map code*	*Rock type*	*Model density (g/cm³)*	*Measured density (g/cm³)*	*Magnetic susceptibility (SI)*
Tuckanarra Suite	A-TU-mgmu	monzogranite	2.70		
Big Bell Suite	A-SDB-mgms	metamonzogranite	2.72		
Youanmi Terrane greenstones	A-mbb-YYO	greenstone	2.80		0.006
Polelle Group					
Meekatharra Formation	A-POm-b, A-POm-bko	basalt	2.96	2.89	
Stockyard Basalt Member	A-POms-b	basalt	2.96	2.88	
Bassetts Volcanic Member	A-POmb-bs	basalt	2.96	2.96	
Lordy Basalt Member	A-POml-b	basalt	2.96	2.88 – 2.96[(a)]	
Annean Supersuite					
Warriedar Suite	A-ANW-od	dolerite	3.02		0.002
	A-ANW-xax-og	pyroxenite	3.03		
Norie Group					
Yaloginda Formation	A-NOy-cx	banded iron-formation	3.03		0.003 – 0.008
	A-NOy-fn	felsic volcanic rocks	2.72	2.65 – 2.80[(b)]	
	A-NOy-xf-cib	felsic volcanic rocks with banded iron-fomation	2.85		0.005
Singleton Formation	A-NOs-bs	basalt	3.03	2.85 – 3.04[(c)]	

(a) Includes basalt horizon and olivine orthocumulate at the heavier end of the range
(b) Includes rhyolite and andesite members of the Yaloginda Suite
(c) Includes both low-Mg (less dense) and high-Mg (more dense) dolerites

Granitic rocks which surround the greenstone units are given an average crustal density of 2.70 – 2.72 g/cm³. A better fit of the model would be obtained if the granitic rocks were denser; however, the petrophysical properties of these rocks have not been measured and so generic values have been assigned.

The only units given a magnetic susceptibility in this profile are the banded iron-formations (Fig. 1e,f).

References

Dentith, MC and Mudge, ST 2014, Geophysics for the mineral exploration geoscientist: Cambridge University Press, Cambridge, UK, 438p.

Emerson, DW 1990, Notes on mass properties of rock-density, porosity, permeability: Exploration Geophysics, v. 21, p. 209–216.

Geological Survey of Western Australia 2017a, Gravity anomaly grid (400 m) of Western Australia (2017 — version 1): Geological Survey of Western Australia, <www.dmp.wa.gov.au/geophysics>.

Geological Survey of Western Australia 2017b, Magnetic anomaly grids (80 m) of Western Australia (2017 – version 1): Geological Survey of Western Australia, <www.dmp.wa.gov.au/geophysics>.

Romano, SS 2018, Gabanintha, WA Sheet 2644: Geological Survey of Western Australia, 1:100 000 Geological Series.

GABANINTHA 2644
1:100 000 geological map, section C–D
(Meekatharra greenstone belt, Youanmi Terrane, Yilgarn Craton)

RE Murdie, SS Romano and J Lowrey

Location

Map: GABANINTHA (2644)

Zone: MGA Zone 50

End coordinates: 649300E 7026274N to
676136E 7027310N

Length: 26.8 km

Interpretation scale: 1:100 000

This section is a west–east section on the southern part of the 1:100 000 GABANINTHA map sheet (Romano, 2018), crossing the Meekatharra greenstone belt and adjacent granitic rocks of the Youanmi Terrane (Fig. 1a).

Tectonostratigraphy

The cross-section includes Archean granitic rocks of the Yilgarn Craton and the greenstone succession of the Meekatharra greenstone belt. The latter comprises rocks of the Murchison Supergroup, in particular the mafic volcanic-dominated Singelton Formation and felsic volcanic succession of the Yaloginda Formation, both part of the Norie Group. These are overlain by mafic rocks of the Meekatharra Formation, Polelle Group. The lower part of the greenstone belt has been intruded by the Lady Alma Igneous Complex.

Structure

The Meekatharra greenstone belt is bounded by the Chunderloo Shear Zone to the west and undeformed to foliated granitic rocks to the east. The greenstone belt forms a regional-scale refolded fold with sheared north-northeasterly trending F_2 fold axes that are rotated subparallel to the north-northeasterly trending shear zones. The centre of the syncline is towards the western half of the section. The youngest unit at the core of the syncline is the Greensleeves Formation of the Polelle Group, and the oldest unit of the syncline is the Meekatharra Formation also of the Polelle Group. Generally, the north-northeasterly trending deep crustal shear zones dip east.

Geophysical data

A gravity profile was extracted from the GSWA gravity merged grid of Western Australia (GSWA, 2017a), with points sampled every 130 m (Fig. 1c). It should be noted that the gravity point spacing is 2.5 km in this area so there are not many observation points along the profile. Hence we can only model the larger structure.

Total magnetic intensity (TMI) data were extracted from the TMI map of Western Australia (GSWA, 2017b) and topography data were taken from SRTM3 at the same points.

Physical property data were measured by hand where samples were available (Table 1) or otherwise estimated from tabled values of representative lithologies published by Emerson (1990) or Dentith and Mudge (2014; Table 1).

Forward modelling

All modelling was performed in GM-SYS run within the Oasis montaj software. 2.5D modelling was performed where the polygons were extended by 100 m perpendicular to the strike of the profile.

Results

The Bouguer profile (Fig. 1c) shows the gravity high associated with the dense rocks of the Meekatharra greenstone belt in the west, which is replaced by low-density granitic rocks in the east (Fig. 1b–d). This gives a Bouguer anomaly profile of a large high in the west and a low in the east, with another high in the centre of the profile (Fig. 1c).

The mafic rocks of the Polelle Group are very dense. Some hand samples exceeded 2.95 g/cm^3 so a blanket value of 2.96 g/cm^3 was used in the modelling as an average for the whole group. An exception to this is the Greensleeves Formation, the topmost formation of the Polelle Group, which is composed of intermediate volcanic and volcaniclastic rocks and was given a density of 2.80 g/cm^3.

Rocks of the Norie Group, which form the lower stratigraphic part of the syncline, comprise felsic volcanic rocks with a relatively low density of 2.72 g/cm^3. The basal formation of the Norie Group, the Singleton Formation, is a metabasalt unit with a density exceeding 3.00 g/cm^3. There are two outcropping areas of Norie Group rocks separated by granitic rocks of the Annean and Tuckanarra Suites. These low-density rocks produce a trough in the gravity high of the western half of the profile. However, the high-density rocks of the Norie Group are not enough to account for the large amplitude of the anomaly and a significant thickness of high-density rock is required to make up the elevated anomaly.

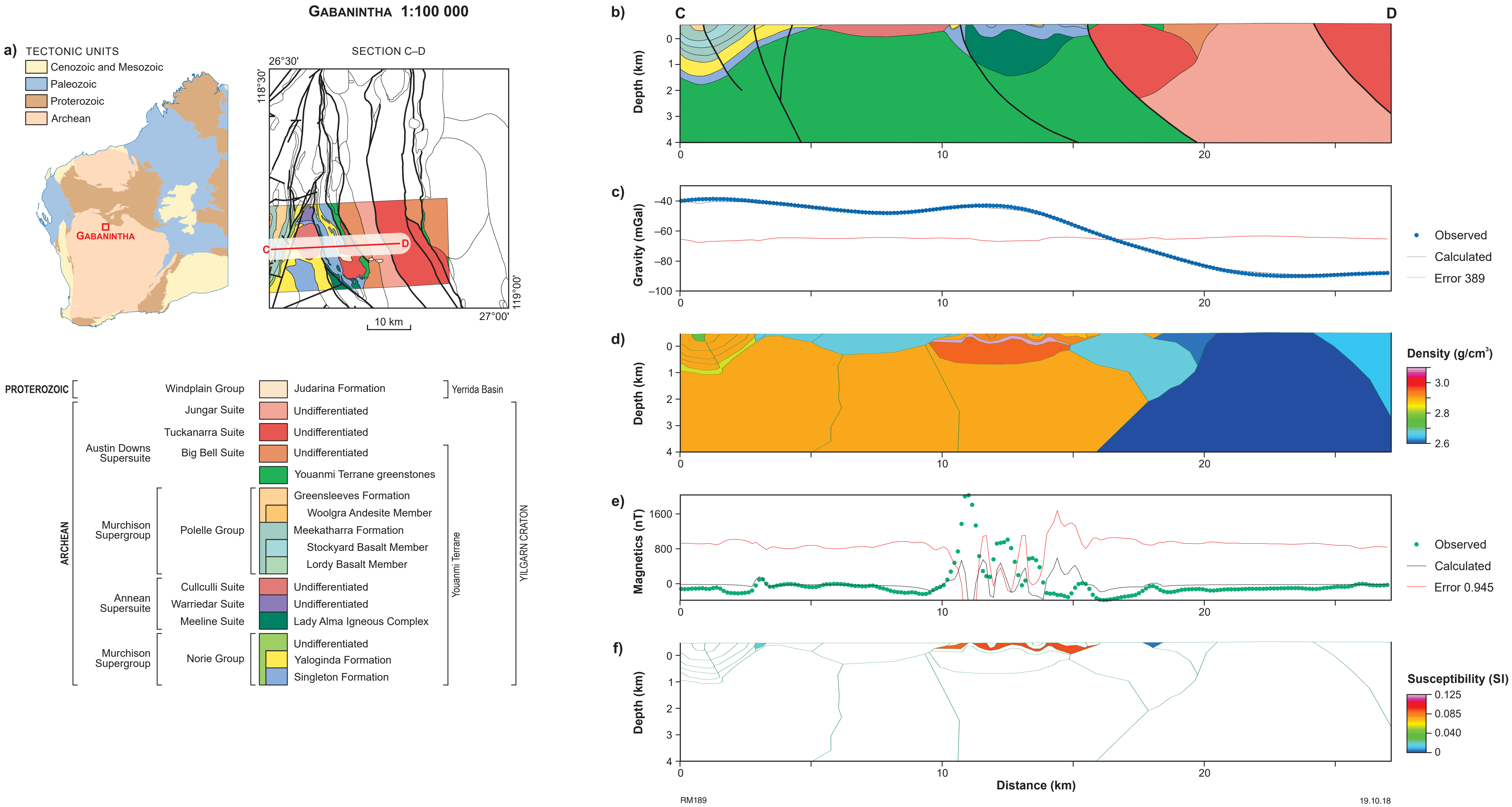

Figure 1. a) Location of cross-section C–D on the GABANINTHA 1:100 000 map sheet (Romano, 2018) showing simplified interpreted bedrock geology map at 1:500 000 scale within 8 km of the line of section. Sections: b) lithology from GABANINTHA (Romano, 2018), see a) for legend; c) observed and calculated gravity anomaly profile with error line; d) density; e) observed and calculated magnetic anomaly profile with error line; f) susceptibility

Table 1. Petrophysical properties of modelled units and the corresponding map codes and lithologies

Modelled unit	*Map code*	*Rock type*	*Model density (g/cm³)*	*Measured density (g/cm³)*	*Magnetic susceptibility (SI)*
Jungar Suite	A-JU-gm	monzogranite	2.67		
Tuckanarra Suite	A-TU-mg, A-TU-mgms	monzogranite	2.70		
Big Bell Suite	A-SDB-mgms	metamonzogranite	2.72		
Youanmi Terrane greenstones	A-mwa-YYO	greenstone	2.85		0.0007
Polelle Group					
Greensleeves Formation	A-POg-xf-s	felsic volcanic rocks	2.80	2.80	
Meekatharra Formation	A-POm-bs	basalt	2.96	2.89 – 2.90(a)	
Stockyard Basalt Member	A-POms-b	basalt	2.96	2.88	
Lordy Basalt Member	A-POml-b	basalt	2.96	2.92 – 2.96(b)	
Bassetts Volcanic Member	A-POmb-bs	basalt	2.96	2.96	0.008
Annean Supersuite					
Lady Alma Igneous Complex	A-ANla-am	magnetite	3.03		0.0007 – 0.006
Cullculli Suite	A-ANC-mg	metatonalite	2.70	2.66	
Norie Group					
Yaloginda Formation	A-NOy-xf-cib, A-NOy-cx	felsic volcanic rocks with banded iron-fomation	2.85		
	A-NOy-fn	felsic volcanic rocks	2.67	2.65 – 2.80(c)	
Singleton Formation	A-NOs-mb, A-NOs-bs, A-NOs-bbo, A-NOs-mbms,	basalt	3.03		0 – 0.004
Quinns Basalt Member	A-NOsq-b	mafic volcanic rock			

(a) Includes both low-Mg (less dense) and high Mg (more dense) dolerites
(b) Includes basalt horizon and olivine orthocumulate at the heavier end of the range
(c) Includes rhyolite and andesite members of the Yaloginda Formations

This is modelled as a thickness of at least 4 km postulated to be part of the Lady Alma Igneous Complex, which is present as small outcrops in the centre of the profile. The anomaly produced is a product of the thickness of the igneous complex and the density used, for which there are no controls on either. However, this is not unfeasible as the Windimurra and Narndee Igneous Complexes are examples of similar rock successions of similar age and thicknesses, and the Windimurra Igneous Complex has been estimated to be 11 km thick (Ivanic et al., 2010, 2017).

Archean granitic rocks that surround the greenstone succession were given average crustal densities of 2.70 – 2.72 g/cm³. A better fit of the model would be obtained if the granitic rocks were denser; however, the petrophysical properties of these have not been measured and only generic values have been assigned.

The basaltic rocks of the Singleton Formation of the Norie Group are modelled as a folded layer with a high magnetic susceptibility (Fig. 1e,f). The magnetic profile is poorly fitted and requires more detailed mapping or representation of individual units and also some petrophysical data to justify further modelling.

The outcropping layer of the Lady Alma Igneous Complex is modelled with a low susceptibility, which is probably due to the magnetite layer within it. However, the hypothesized main body of the complex was not assigned a susceptibility.

A small segment of banded iron-formation within the Norie Group was given a moderate susceptibility to create the small magnetic anomaly towards the western end of the profile. No remanence has been considered in the modelling.

References

Dentith, MC and Mudge, ST 2014, Geophysics for the mineral exploration geoscientist: Cambridge University Press, Cambridge, UK, 438p.

Emerson, DW 1990, Notes on mass properties of rock-density, porosity, permeability: Exploration Geophysics, v. 21, p. 209–216.

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Romano, SS 2018, Gabanintha, WA Sheet 2644: Geological Survey of Western Australia, 1:100 000 Geological Series.

MEEKATHARRA 2544
1:100 000 geological map, section A–B
(Youanmi Terrane, Yilgarn Craton)

LI Brisbout and SS Romano

Location

Map: MEEKATHARRA (2544)

Zone: MGA Zone 50

End coordinates: 626830E 7062161N to 645417E 7062161N

Length: 18.5 km

Interpretation scale: 1:100 000

Cross-section A–B is an east-trending section that traverses the central northern part of the MEEKATHARRA Geological Series map (Romano et al., 2017; Fig. 1a).

Tectonostratigraphy

Cross-section A–B traverses mafic rocks of the Meekatharra Formation and the felsic volcanic and volcaniclastic dominated Greensleeves Formation, of the Polelle Group, Murchison Supergroup, in the Yilgarn Craton. The Meekatharra Formation comprises basaltic rocks with variable Mg content, some of which are pyroxene spinifex-textured. The Greensleeves Formation comprises coherent dacitic to andesitic lava flows, and felsic volcaniclastic horizons ranging from fragmental conglomerate and breccia to fine-grained quartzofeldspathic volcaniclastic siltstones.

The succession is intruded by dolerite and fractionated gabbro sills of the Yalgowra Suite, including the Opal Gabbro, and by monzogranitic rocks of the Big Bell Suite. To the west and east, the greenstone succession is in structural contact with monzongranitic rocks of the Jungar Suite.

Structure

Cross-section A–B traverses the Abbotts greenstone belt in the northern Youanmi Terrane. The Abbotts greenstone belt is folded into an isoclinal syncline and transposed by several major and minor thrusts. One of these is the regionally important, steeply dipping Chunderloo Shear Zone, which transposes granitic rocks of the Jungar Suite, including the Chunderloo Monzogranite, against the older rocks of the folded Abbotts greenstone belt.

Geophysical data

Topographic, Bouguer gravity and aeromagnetic data were sampled every 100 m along section A–B. This sampling distance is suitable for topographic and aeromagnetic data, but for the lower resolution gravity data the profile is oversampled. Topography, which defines the surface of the model, was sampled from the SRTM3 grid (Jarvis et al., 2006). Gravity stations on MEEKATHARRA are spaced in a 2.5 km grid and gravity data were sampled from the 2016 merged Bouguer gravity grid of Western Australia, cell size 400 m (GSWA, 2016a). Aeromagnetic data were sampled from the 2016 RTP merged magnetic grid of Western Australia, cell size of 80 m (GSWA, 2016b). The aeromagnetic grid is created from a government aeromagnetic survey (400 m line spacing and 180 degree line direction) and several higher resolution open-file company surveys.

Without local petrophysical data, densities from Williams (2009) were used to assign densities to the model. Model densities are listed in Table 1.

Forward modelling

The initial geology interpreted along section A–B has been tested and, where necessary, modified using 2D gravity and magnetic forward modelling to produce the final section (Fig. 1b). 2D gravity and magnetic forward modelling was performed in Oasis montaj GM-SYS (version 8.5). Gravity stations were placed 1 m above the topographic surface and the air was modelled with a density of 2.67 g/cm^3 to remove the effects of the topography. A linear regional trend was removed from the Bouguer gravity data and the DC shift was automatically applied to the gravity data. The section was modelled to a depth of 4 km and the units were extended horizontally beyond the ends of the section to avoid edge effects.

Results

The main feature of the observed gravity data along section A–B is a broad high (~30 mGal) in the centre of the profile (Fig. 1c) produced by a dense greenstone belt (2.75 – 3.00 g/cm^3). The greenstone belt is in contact with the less dense monzogranitic rocks of the Jungar

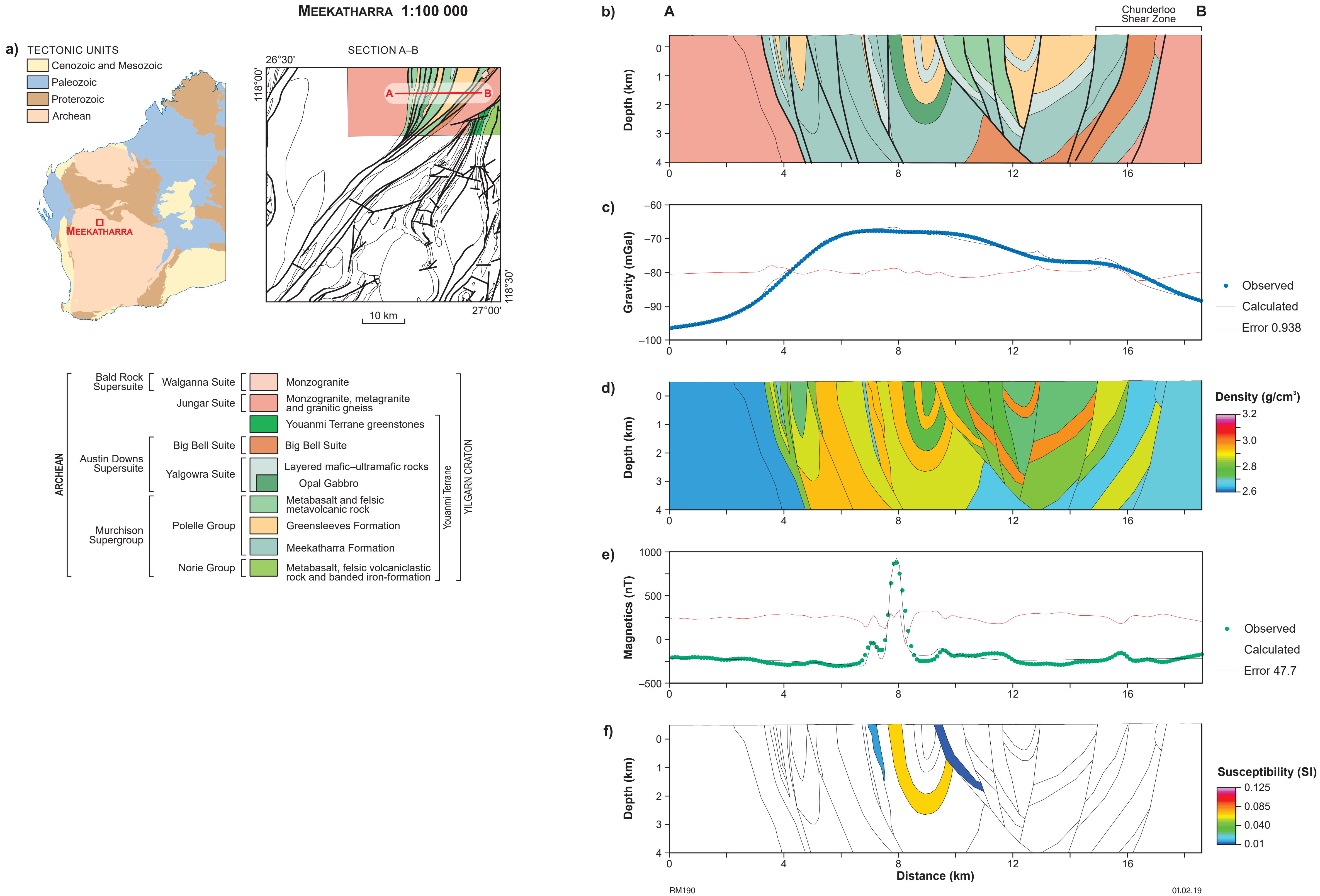

Figure 1. a) Location of cross-section A–B on the MEEKATHARRA 1:100 000 map sheet (Romano et al., 2017) showing simplified interpreted bedrock geology at 1:500 000 scale within 20 km of the line of section. Sections show: b) lithology from MEEKATHARRA (Romano et al., 2017), see a) for legend; c) observed and calculated Bouguer gravity data showing error; d) density model; e) observed and calculated RTP TMI data showing error; f) susceptibility model

Table 1. Petrophysical properties of modelled units and the corresponding map codes and lithologies

Name	*Map code*	*Rock type*	*Model density (g/cm^3)*	*Model susceptibility (SI)*
Jungar Suite	A-JU-gm, A-JU-mgms	monzogranite, metamonzogranite and minor metagranodiorite	2.65	0
Chunderloo Monzogranite	A-JUcl-mgms	biotite metamonzogranite	2.70	0
Big Bell Suite	A-SDB-mgms	metamonzogranite	2.69	0
Yalgowra Suite	A-SDY-xony-any	layered mafic–ultramafic intrusive rocks	2.95	0
	A-SDY-xod-og	massive dolerite interleaved with minor gabbro	3.00	0
	A-SDY-masr	tremolite–chlorite(–talc) schist derived from intrusive peridotite	2.90	0
Opal Gabbro	A-SDop-og	layered mafic–ultramafic intrusive rocks	2.95	0.075
Polelle Group	A-PO-xmb-mf	metabasalt and felsic metavolcanic rock	2.80	0
Greensleeves Formation	A-POg-f	andesitic to rhyolitic volcanic and volcaniclastic rocks; widely intruded by layered mafic–ultramafic sills	2.80	0
	A-POg-mhs	schistose pelite and psammite	2.70	0
	A-POg-xsn-b	sedimentary rock, undivided; interleaved with basalt	2.75	0
Meekatharra Formation	A-POm-mbs	metamorphosed mafic rock	2.85	0
	A-POm-bb	basalt	2.85 – 2.95	0
	A-POm-b	mafic volcanic rock	2.90	0
	A-POm-bk	komatiitic basalt	2.95	0
	A-POm-bko	pillowed komatiitic basalt	2.90	0
	A-POm-bs	pyroxene spinifex-textured basalt and minor basalt	2.95	0.020

Suite (2.65 g/cm^3) to the west, and the Chunderloo Monzogranite (2.70 g/cm^3) and monzogranitic rocks of the Big Bell Suite (2.69 g/cm^3) to the east. These granitic rocks produce the relative gravity lows at either end of the profile. The greenstone belt is dominated by dense basaltic rocks of the Meekatharra Formation (2.85 – 2.95 g/cm^3), mafic–ultramafic intrusive rocks and basaltic rocks of the Yalgowra Suite (2.90 – 3.00 g/cm^3), and intermediate density metasedimentary and volcanic rocks of the Greensleeves Formation (2.70 – 2.80 g/cm^3).

At the western granite–greenstone contact, foliation measurements from the Jungar Suite and the greenstones both dip steeply to the east (Romano et al., 2017). A steeply east-dipping contact in density model A–B is consistent with Bouguer gravity data. The eastern granite–greenstone contact is deformed by the Chunderloo Shear Zone. Within the shear zone, foliation measurements from the Big Bell and Jungar Suites are steeply west dipping, and bedding measurements from the Meekatharra Formation are moderately west dipping (Romano et al., 2017). A steeply west-dipping granite–greenstone contact is consistent with Bouguer gravity data if a slice of unexposed Meekatharra Formation is included to the east of the contact, within the Chunderloo Shear Zone.

The broad gravity high above the greenstone belt decreases in amplitude above the Greensleeves Formation (A-POg-xsn-b). The decrease in amplitude is produced by the intermediate density, metasedimentary rock-dominated Greensleeves Formation (2.75 g/cm^3), and monzogranitic rocks of the Big Bell Suite (2.69 g/cm^3) at depth.

Reduced-to-pole TMI data along the section are subdued, with two exceptions (Fig. 1e): a 1150 nT magnetic high, produced by the Opal Gabbro (0.075 SI units) and a 265 nT high produced by pyroxene spinifex-textured basalts of the Meekatharra Formation (0.020 SI units). Subtle variations in susceptibility include an increase in magnetic intensity above layered mafic–ultramafic intrusive rocks of the Yalgowra Suite (A-SDY-xony-any), and above the Polelle Group metabasalts and metafelsic rocks (A-PO-xmb-mf).

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MEEKATHARRA 2544
1:100 000 geological map, section C–D
(Youanmi Terrane, Yilgarn Craton)

LI Brisbout and SS Romano

Location

Map: MEEKATHARRA (2544)

Zone: MGA Zone 50

End coordinates: 619488E 7037422N to 648261E 7027037N

Length: 31 km

Interpetation scale: 1:100 000

Cross-section C–D is a west-northwesterly trending section traversing the southeast of the MEEKATHARRA Geological Series map (Romano et al., 2017; Fig. 1a).

Tectonostratigraphy

Section C–D traverses the northeast-trending greenstone stratigraphy of the Murchison Supergroup, in the southeast of the MEEKATHARRA map sheet. This stratigraphy is exposed in two greenstone sequences: one in the centre of the section and one in the east (Fig. 1b). The oldest units traversed on section C–D are the metasedimentary and felsic volcanic rocks of the 2815–2800 Ma Yaloginda Formation, which are exposed at the eastern end of the section. The overlying tholeiitic and high Mg-basalts of the 2800–2760 Ma Meekatharra Formation (Polelle Group) are exposed in the greenstone sequences in both the centre and east of the section. The Polelle Group is intruded by mafic and ultramafic rocks of the 2801–2792 Ma Warriedar Suite (Annean Supersuite). The younger 2735–2700 Ma Glen Group metasedimentary rocks include banded iron-formation and chert, and outcrop in the greenstones in the centre of the section.

The Murchison Supergroup stratigraphy is intruded by voluminous metagranitic rocks of Cullculli Suite (Annean Supersuite) including a large pluton, the Racecourse Tonalite, in the centre of the section. At the western end of the section, the c. 2655 Ma Chunderloo Monzogranite of the Jungar Suite intrudes the Chunderloo Shear Zone.

Structure

Cross-section C–D traverses the north-northeasterly trending, moderately to steeply dipping, Meekatharra greenstone belt in the northern Youanmi Terrane of the Yilgarn Craton. In the eastern central part of the cross-section, the Racecourse Tonalite (Cullculli Suite) forms the core of an anticline. To the west of the anticline cored by the Racecourse Tonalite, the Meekatharra Formation is tightly folded into syncline–anticline pairs.

The moderately to steeply dipping Chunderloo Shear Zone forms a major structural feature at the western end of the section.

Geophysical data

Topography, Bouguer gravity and aeromagnetic data were sampled every 100 m along section C–D. This sampling distance is suitable for topographic and aeromagnetic data, but for the lower resolution gravity data the profile is oversampled. Topography, which defines the surface of the model, was sampled from the SRTM3 grid (Jarvis et al., 2006). Gravity stations on MEEKATHARRA are spaced in a 2.5 km grid and gravity data were sampled from the 2016 merged Bouguer gravity grid of Western Australia, cell size 400 m (GSWA, 2016a). Aeromagnetic data was sampled from the 2016 RTP merged magnetic grid of Western Australia, cell size of 80 m (GSWA, 2016b). The aeromagnetic grid is created from a government aeromagnetic survey (400 m line spacing and 180 degree line direction) and several higher resolution open-file company surveys.

Densities from Williams (2009) were used to assign densities to the model. Model densities are listed in Table 1.

Forward modelling

The initial geological interpretation of section C–D has been tested and, where necessary, modified using 2D gravity and magnetic forward modelling to produce the final section (Fig. 1b). 2D gravity and magnetic forward modelling was performed in Oasis montaj GM-SYS (version 8.5). Gravity stations were placed 1 m above the topographic surface and the air was modelled with a density of 2.67 g/cm^3 to remove the effect of the topography from the Bouguer gravity data. No regional trend was removed from the Bouguer gravity data and the gravity DC shift was automatically applied to the gravity data. The section was modelled to a depth of 4 km and units were extended horizontally beyond the ends of the section to avoid edge effects.

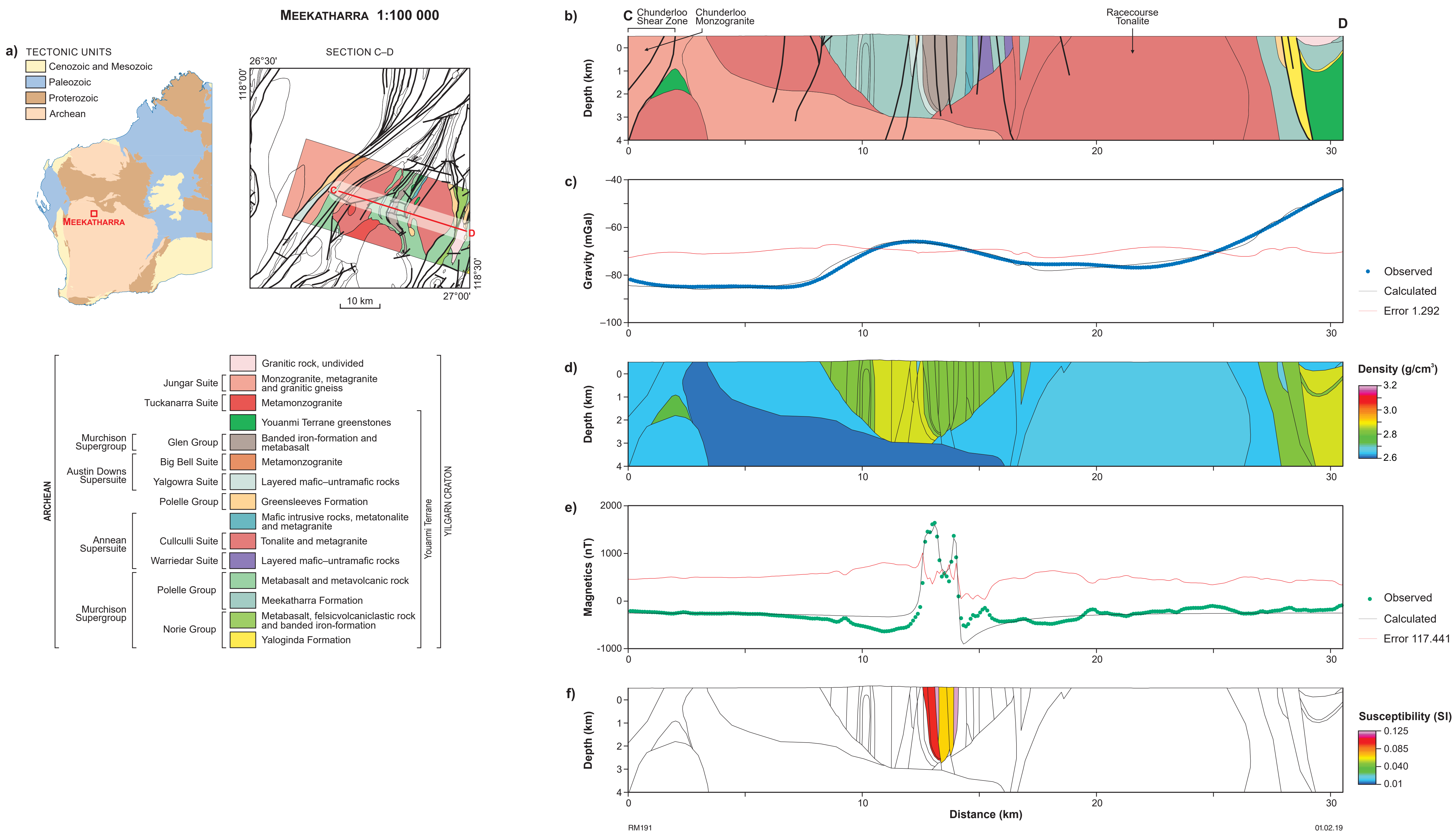

Figure 1. a) Location of cross-section C–D on the MEEKATHARRA 1:100 000 map sheet (Romano et al., 2017) showing simplified interpreted bedrock geology at 1:500 000 scale within 20 km of the line of section. Sections show: b) lithology from MEEKATHARRA (Romano et al., 2017) see a) for legend; c) observed and calculated Bouguer gravity data showing error; d) density model; e) observed and calculated RTP TMI data showing error; f) susceptibility model

Table 1. Petrophysical properties of modelled units and the corresponding map codes and lithologies

Name	*Map code*	*Rock type*	*Model density (g/cm^3)*	*Model susceptibility (SI)*
Archean granite	A-gn-Y	granitic rock	2.66	0
Jungar Suite	A-JU-mgm, A-JU-xmgs-mbs	metamonzogranite, metamonzogranite interleaved with minor mafic rock	2.65 – 2.66	0
Chunderloo Monzogranite	A-JUcl-mgms	biotite metamonzogranite	2.66	0
Archean mafic unit	A-xmbs-cx-YYO	mafic schist interleaved with chert, banded iron-formation and quartzite	2.80	0
	A-xb-og-YYO	mafic volcanic rock with minor gabbro	2.90	0
Glen Group	A-GL-mbbs	metabasalt and local amphibolite	2.85	0
	A-GL-xc-masr	chert, banded chert and banded iron-formation	2.85	0.07 – 0.18
Yalgowra Suite	A-SDY-xony-any	layered mafic–ultramafic intrusive rocks	2.85	0
	A-SDY-og	gabbro	2.90	0
Annean Supersuite	A-AN-og, A-AN-o	gabbro	2.85	0
Cullculli Suite				
Nanine Tonalite	A-ANnn-mgta	hornblende metatonalite	2.67	0
Racecourse Tonalite	A-ANrc-mgt, A-ANrc-mg	tonalite and metagranite	2.69	0
Warriedar Suite	A-ANW-xax-og, A-ANW-og	basal pyroxenite to pyroxene peridotite and gabbro	2.85	0
Polelle Group				
Greensleeves Formation	A-POg-f	andesitic to rhyolitic volcanic and volcaniclastic rocks	2.70	0
	A-POg-xf-s	felsic volcaniclastic and volcanic rocks interleaved with sedimentary rocks	2.68	0
Meekatharra Formation	A-POm-bb, A-POm-bko, A-POm-bbo, A-POm-bs	basalt, pillowed komatiitic basalt, and pyroxene spinifex-textured basalt	2.85 – 2.90	0
	A-POm-mb, A-POm-mbs	metamorphosed mafic rock	2.85	0
Bassetts Volcanic Member	A-POmb-bs	pyroxene spinifex-textured basalt with boninitic affinity	2.85	0
Norie Group				
Yaloginda Formation	A-NOy-xf-cib	felsic volcanic rocks and banded iron-formation	2.85	0

Results

Bouguer gravity data along profile C–D show relative gravity highs above the two greenstone belts and relative lows above the granitic rocks (Fig. 1c,d). The broadly symmetrical gravity high in the centre of the profile is interpreted to be produced by a greenstone belt with a symmetrical, bowl-shaped geometry and a maximum depth of ~3 km. This central greenstone belt is dominated by dense mafic rocks of the Meekatharra Formation and Warriedar Suite (2.85 – 2.90 g/cm^3). The western contact between the central greenstone belt and the Nanine Tonalite (Cullculli Suite; 2.69 g/cm^3) is interpreted to dip ~50–55° to the east. The eastern contact between the greenstone belt and the Cullculli Suite metagranite (2.66 g/cm^3) is steeply dipping at the surface, consistent with foliation measurements (Romano et al., 2017). At depth, a wedge of Racecourse Tonalite (2.69 g/cm^3) is interpreted to intrude the eastern margin of the central greenstone belt, producing a symmetric geometry and a fit to the observed Bouguer gravity data (Fig. 1d).

In the density model, the dips of the granite–greenstone contacts are dependent on the densities used. For example, if the greenstone belt were modelled with a higher density of 3.00 g/cm^3, and the densities of the granitic rocks were kept the same, the dips of the contacts with the greenstone would be much shallower (~20–30°) and the greenstone belt would only extend to a depth of ~2.5 km.

At the eastern end of section C–D, the Racecourse Tonalite is in contact with the eastern greenstone belt that extends past the end of the section. This produces a larger amplitude gravity anomaly than the central greenstone belt and is interpreted to be produced by a greenstone belt that extends to the base of the section. The modelled steeply east-dipping contact between the metagranitic rocks and the greenstone belt is a reasonable fit to the gravity data, although small density deficits exist above the Cullculli Suite metagranitic rocks that surround the Racecourse Tonalite.

The main feature of the magnetic profile C–D are several high-frequency, high-amplitude anomalies (~2200 nT) produced by the Glenn Group chert, banded chert and banded iron-formation (A-GL-xc-masr), and modelled with susceptibilities of 0.07 to 0.18 SI units (Fig. 1e,f). Some of the more subtle features in the magnetic data include a higher magnetic intensity in the Racecourse Tonalite (Cullculli Suite), relative to the surrounding Cullculli Suite metagranitic rocks. A higher magnetic intensity is also observed in the eastern part of the Meekatharra Formation komatiitic basalts (A-POm-bko), the Warriedar Suite basal pyroxenite to pyroxene peridotite (A-ANW-xax-og), the Meekatharra Formation metamorphosed mafic rocks (A-POm-mb), and the Yaloginda Formation (A-NOy-xf-cib).

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Ninghan 2339
1:100 000 geological map, section A–B
(Yalgoo–Singleton greenstone belt, northwestern Youanmi Terrane, Yilgarn Craton)

RE Murdie and TJ Ivanic

Location

Map: Ninghan (2339)

Zone: MGA Zone 50

End coordinates: 500000E 6771710N to 517620E 6787976N

Length: 24 km

Interpretation scale: 1:100 000

This section is a southwest–northeast profile on the Ninghan 1:100 000 map sheet (Ivanic, 2018), crossing the Yalgoo–Singleton greenstone belt and Yilgarn Craton granites, northwestern Youanmi Terrane, western Yilgarn Craton (Fig. 1a).

Tectonostratigraphy

The Yalgoo–Singleton greenstone belt comprises Norie, Polelle and Glen Group (Van Kranendonk et al., 2013) supracrustal rocks, and Annean Supersuite mafic–ultramafic intrusive rocks. The supracrustal rocks are dominantly tholeiitic to komatiitic basalts with lesser banded iron-formation. The Mougooderra Formation of the Glen Group unconformably overlies the Polelle Group and is dominated by siliciclastic sedimentary rocks. Layered mafic–ultramafic bodies of the Warriedar Suite with dimensions in the order of tens of kilometres (Ivanic, 2016) have been locally dated at c. 2801 Ma (Lu et al., 2016) and were emplaced into the lowermost part of the Polelle Group. In the vicinity of Mount Mulgine, these have a large component of peridotitic and pyroxenitic cumulate lithologies. The predominantly ultramafic Fields Find Igneous Complex of the Boodanoo Suite intrudes the upper part of the Norie Group.

Crosscutting the supracrustal rocks are granitic rocks of the Rothsay, Big Bell and Walganna Suites (Ivanic et al., 2012), which underlie large parts of the section. This area is host to several gold and base metal occurrences.

Structure

The western part of the section cuts across a dome-shaped Rothsay Suite pluton (the Mulgine Granite) that has granite-up, greenstone-down lineations at its contact with metamafic rocks of the Meekatharra Formation, which dips approximately 25° to the northwest. Away from this contact, bedding in the Meekatharra Formation is more steeply inclined (70–80°E), whereas in the middle of the section, the overlying Mougooderra Formation (Glen Group) dips less steeply (40–70°E). A kilometre-scale fold is present within the Mougooderra Formation near Warriedar Hill and the formation is sheared along the Chulaar Shear Zone to the east. The Fields Find Igneous Complex intrudes into the Norie Group at the east of the section where all rocks are moderately to steeply west dipping. At the base of the section, granitic rocks of the Bald Rock Supersuite and Big Bell Suite are also intersected.

Geophysical data

A gravity profile was extracted from the GSWA gravity merged grid of Western Australia (GSWA, 2017a), with points sampled every 240 m (Fig. 1c). Total magnetic intensity data were extracted from the TMI map of Western Australia (GSWA, 2017b), and topography data were taken from SRTM3 at the same points.

Physical property data were estimated from tables of values of representative lithologies from Emerson (1990) or Dentith and Mudge (2014; Table 1).

Forward modelling

All modelling was performed in GM-SYS run within the Oasis montaj software. 2.5D modelling was performed were the polygons were extended by 100 m perpendicular to the strike of the profile.

Results

The gravity anomaly shows a rising trend to the northeast (Fig. 1c). The basement is modelled with the Seeligson Monzogranite of the Walganna Suite granite (Bald Rock Supersuite) in the west and undifferentiated Walganna Suite in the east (Fig. 1b,d). These both have low densities of 2.62 – 2.70 g/cm^3.

At the surface, the low density of the Mulgine Granite of the Rothsay Suite (Annean Supersuite) gives a gravity low at the west end of the profile. This is juxtaposed against high-density, ultramafic talc–tremolite–serpentinite–magnetite schist of the Warriedar Suite. This gives a rise in

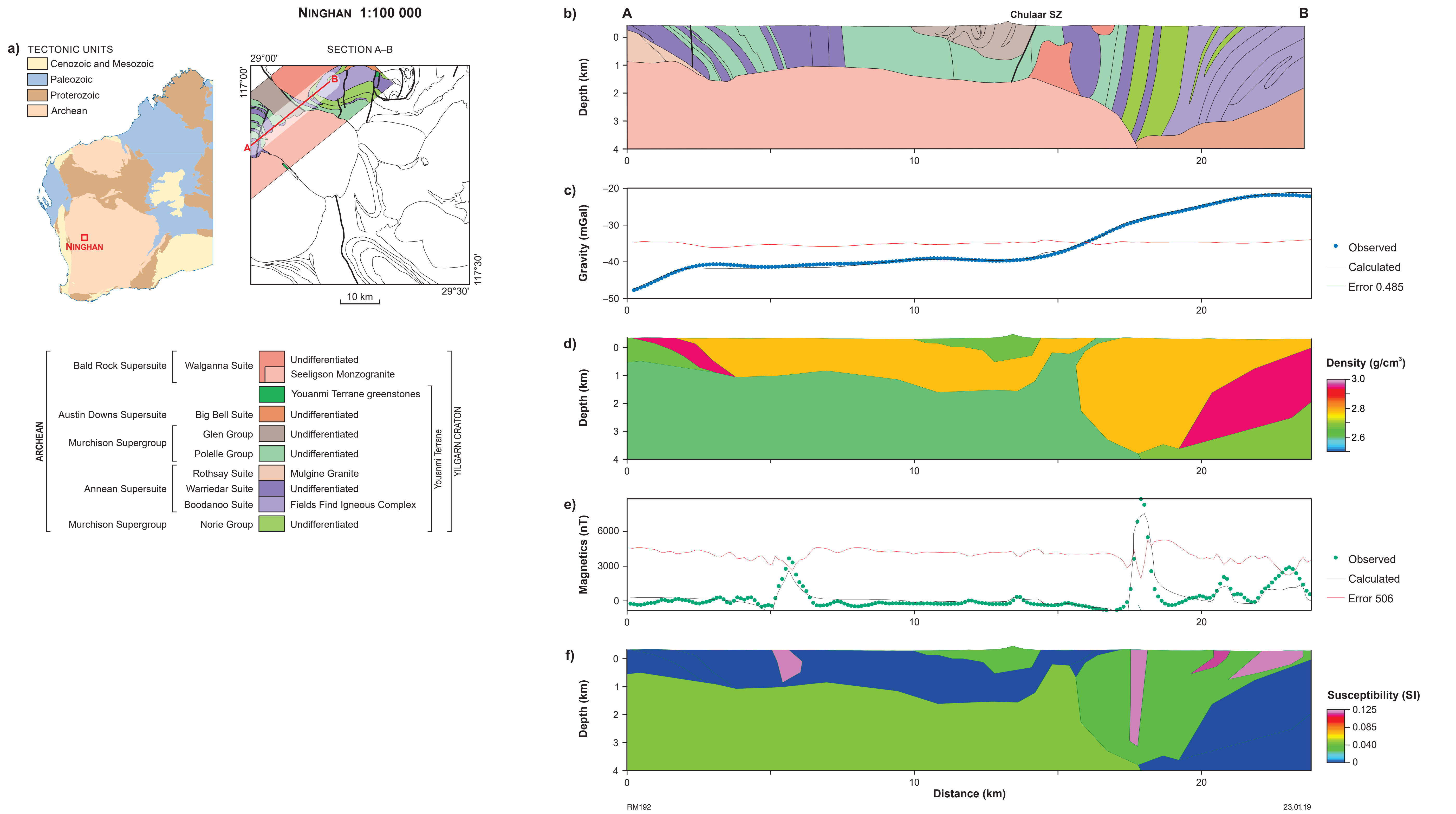

Figure 1. a) Location of cross-section A–B on the NINGHAN 1:100 000 map sheet (Ivanic, 2018) showing simplified interpreted bedrock geology map at 1:500 000 scale within 8 km of the line of section. Sections: b) lithology from NINGHAN (Ivanic, 2018), see a) for legend; c) observed and calculated gravity anomaly profile with error line; d) density; e) observed and calculated magnetic anomaly profile with error line; f) susceptibility

the gravity profile. The mid-gravity plateau is caused by a suite of basaltic rocks from the Polelle Group, which have been assigned a representative density of 2.8 g/cm^3.

The slight dip in the centre of the profile is caused by a combination of the outcropping basement granitic rocks, and also a syncline of metasedimentary rocks of the Glen Group with a relatively low density of 2.68 g/cm^3.

The Bouguer high at the eastern end of the profile is modelled by a westwards dipping body of Norie Group basaltic rocks of high density, underlain by a lens of high density (2.8 g/cm^3) Fields Find Igneous Complex, in which the lowest layer is a peridotite with density 2.95 g/cm^3.

The magnetic profile (Fig. 1e) shows a peak in the west where a banded iron-formation in the Polelle Group surfaces. In the east, gabbroic units within the Warriedar Suite and Fields Find Igneous Complex give large magnetic highs (Fig. 1e,f). They have not been modelled exactly as there has been no accounting for any remanent magnetism and the modelled bodies have been limited to a bulk susceptibility rather than trying to match any banding within the units.

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Table 1. Petrophysical properties of modelled units and the corresponding map codes and lithologies

Modelled unit	*Map code*	*Rock type*	*Density (g/cm^3)*	*Magnetic susceptibility (SI)*
Bald Rock Supersuite	A-BRG-gme	monzogranite	2.60	
Seeligson Monzogranite	A-BRse-gme	monzogranite	2.62	0.004
Glen Group				
Mougooderra Formation	A-GLm-bd, A-GLm-mhs, A-GLm-ml, A-GLm-xmd-mx, A-GLm-xmhs-mib	metasedimentary rocks and metamorphosed BIF	2.68	0.003
Austin Downs Supersuite	A-SDB-gmp	monzogranite	2.70	
Pollele Group	A-POm-bb, A-POm-bbd, A-POm-bbg, A-POm-bbo, A-POm-bs	basalt	2.80	
Annean Supersuite				
Mulgine Granite	A-ANmu-mg	granite	2.68	
Warriedar Suite	A-ANW-ax, A-ANW-masr, A-ANW-mat, A-ANW-mog, A-ANW-od, A-ANW-og, A-ANW-xog-od	metagabbro and dolerite	2.95	0.0 – 0.01
Fields Find Igneous Complex	A-ANff-ax, A-ANff-og, A-ANff-xaxh-apx	pyroxenite, gabbro and peridotite	2.80 – 2.95	
Norie Group	A-NO-mib, A-NO-bb	metamorphosed BIF and basalt	2.80	0.003

NINGHAN 2339
1:100 000 geological map, section C–D
(Yalgoo–Singleton greenstone belt, northwestern Youanmi Terrane, Yilgarn Craton)

RE Murdie and TJ Ivanic

Location

Map: NINGHAN (2339)

Zone: MGA Zone 50

End coordinates: 514398E 6736637N to 539373E 6745039N

Length: 26.3 km

Interpretation scale: 1:100 000

This section is a west–east profile on the NINGHAN 1:100 000 map sheet (Ivanic, 2018), crossing the Yalgoo–Singleton greenstone belt and Yilgarn Craton granites in the vicinity of Mount Singleton, northwestern Youanmi Terrane, western Yilgarn Craton (Fig. 1a).

Tectonostratigraphy

The Yalgoo–Singleton greenstone belt in the vicinity of Mount Singleton comprises Norie and Glen Group (Van Kranendonk et al., 2013) supracrustal rocks and Annean Supersuite mafic–ultramafic intrusive rocks. The supracrustal rocks are dominantly tholeiitic to komatiitic basalts with lesser banded iron-formation. The Mougooderra Formation of the Glen Group stratigraphically overlies the Norie Group and is dominated by siliciclastic sedimentary rocks. Layered mafic–ultramafic bodies of the Warriedar Suite on a scale of of tens of kilometres (Ivanic, 2016) were emplaced into unassigned Youanmi greenstones in the west, and composite sills of the Ninghan Gabbro into the Singleton Formation in the vicinity of Mount Singleton. The latter sills have a large component of peridotitic and pyroxenitic cumulate lithologies.

Granitic rocks of the Tuckanarra and Walganna Suites crosscut the supracrustal rocks (Ivanic et al., 2012), and comprise the eastern end of the section. This area is host to several gold and iron occurrences.

Structure

Bedding in the Singleton Formation is folded in the Ninghan Syncline in the east of the section where bedding dips inwards at approximately 40° on each limb. Bedding steepens up to 75° towards the sheared contact with the overlying Mougooderra Formation, which dips at about 70° to the west. At the western margin of the Mougooderra Formation, the beds are locally overturned with way up to the west, and the Mougooderra Formation is locally observed to unconformably overlie metabasaltic rocks of the unassigned Youanmi Terrane greenstones.

Geophysical data

A gravity profile was extracted from the GSWA gravity merged grid of Western Australia (GSWA, 2017a), with points sampled every 260 m (Fig. 1c). Total magnetic intensity data were extracted from the TMI map of Western Australia (GSWA, 2017b) and topography data were taken from SRTM3 at the same points.

Physical property data were estimated from tabled values of representative lithologies from Emerson (1990) or Dentith and Mudge (2014; Table 1).

Forward modelling

All modelling was performed in GM-SYS run within the Oasis montaj software. 2.5D modelling was performed were the polygons were extended by 100 m perpendicular to the strike of the profile.

Results

The west end of the profile is thought to be underlain by high-density rocks of the Warriedar Suite and unassigned Youanmi Terrane greenstones, which have been assigned densities that range between 2.82 and 2.88 g/cm^3 (Fig. 1b,d). Layering of the different rock types is inferred from extrapolation of surface mapping. The differing densities have been assigned using a combination of hypothesized shapes for the metasedimentary rocks above and attempting to fit the gravity profile.

The metasedimentary rocks of the Glen Group sit above the basement. These have been assigned a range of densities between 2.61 and 2.78 g/cm^3. It is possible that the high densities assigned to the westernmost Glen Group are either a product of relatively low-density sedimentary rocks interlayered with high-density banded iron-formations,

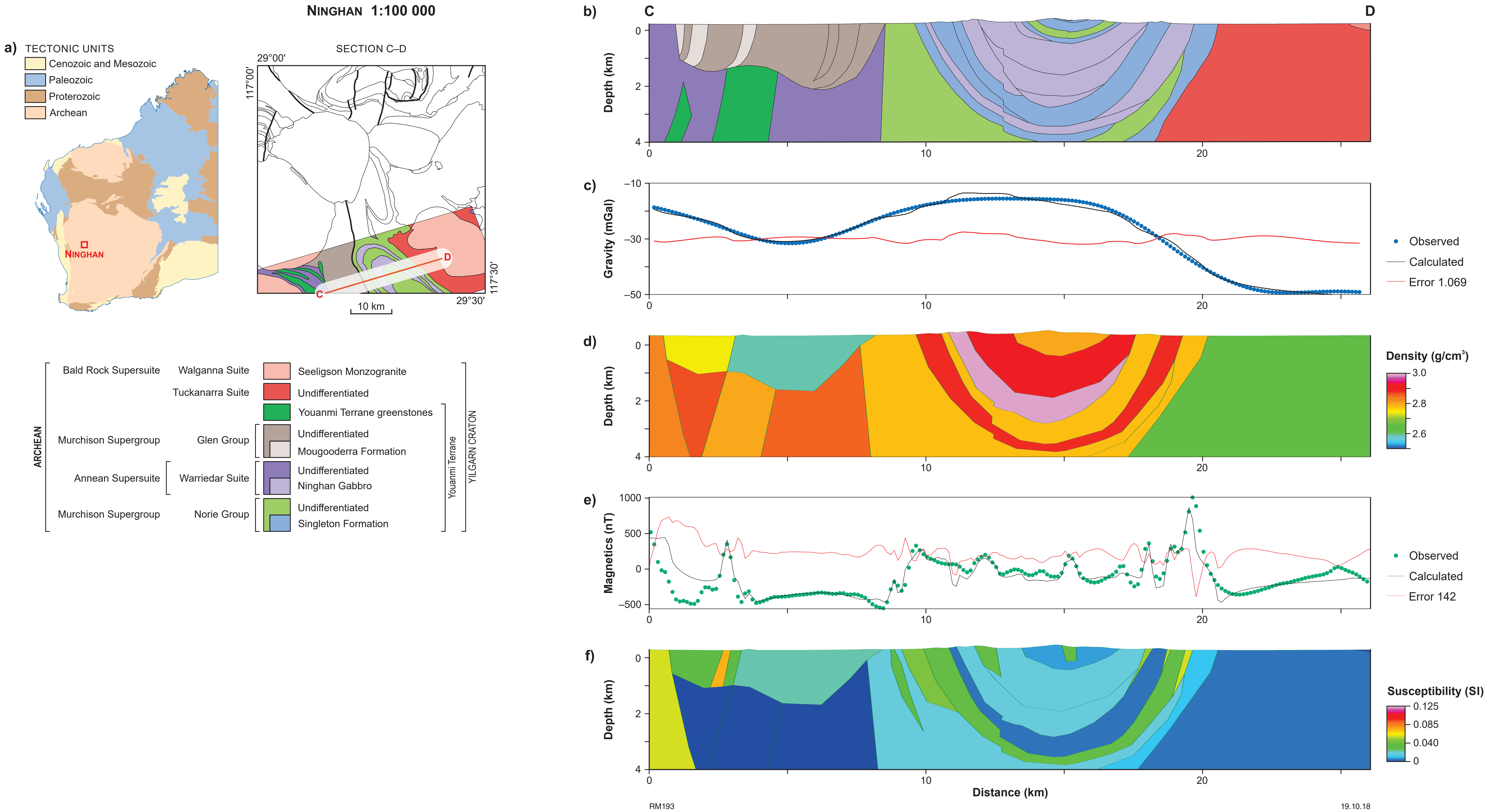

Figure 1. a) Location of cross-section C–D on the NINGHAN 1:100 000 map sheet (Ivanic, 2018) showing simplified interpreted bedrock geology map at 1: 500 000 scale within 8 km of the line of section. Sections: b) lithology from NINGHAN (Ivanic, 2018), see a) for legend; c) observed and calculated gravity anomaly profile with error line; d) density; e) observed and calculated magnetic anomaly profile with error line; f) susceptibility

or that the whole package is much thinner and the high-density basement is closer to the surface.

The gravity profile is dominated by a Bouguer high in the centre of the profile. This is modelled by a syncline of high-density rocks. The core of the syncline includes basaltic rocks of the Singleton Formation of the Norie Group with densities of 2.82 g/cm^3. These are interlayered by the Ninghan Gabbro with higher densities of 2.93 – 3.0 g/cm^3.

The far east of the profile is dominated by a low-density monzogranite from the Tuckanarra Suite.

The magnetic anomaly profile (Fig. 1e) shows a high in the far west due to dolerite in the Warriedar Suite. Banded iron-formations in the Glen Group give a sharp magnetic spike, whereas most of the rest of the metasedimentary rocks are non-magnetic (Fig. 1f).

The Norie Group generally has a low susceptibility. However, since it is interleaved with the Ninghan Gabbro, which does have a susceptibility, there is a high magnetic signal over the central syncline. Similarly the Glen Group had low susceptibility, although there is a body or area within the Glen Group which causes a magnetic spike. This may be related to the underlying greenstone rocks.

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Table 1. Petrophysical properties of modelled units and the corresponding map codes and lithologies

Modelled unit	*Map code*	*Rock type*	*Density (g/cm^3)*	*Magnetic susceptibility (SI)*
Bald Rock Supersuite	A-BRG-gmp	monzogranite	2.63	
Tuckanarra Suite	A-TU-mgmu	metamonzogranite	2.64	0.0005
Youanmi Terrane greenstones	A-mbb-YYO	greenstone	2.82	
Glen Group				
Mougooderra Formation	A-GLm-mhs, A-GLm-mib, A-GLm-ml, A-GLm-mxs, A-GLm-xmd-mx, A-GLm-xmhs-mib	metasedimentary rocks and metamorphosed BIF	2.61 – 2.76	0.002 – 0.006
Annean Supersuite				
Warriedar Suite	A-ANW-mog, A-ANW-od	metagabbro and dolerite	2.84 – 2.88	0.000 – 0.005
Ninghan Gabbro	A-ANni-ax; A-ANni-mat; A-ANni-od; A-ANni-og	pyroxenite, peridotite, dolerite, gabbro	2.90 – 3.00	0.001 – 0.005
Norie Group				
Singleton Formation	A-NOs-bb, A-NOs-bbo, A-NOs-xbbo-bbx, A-NOs-mu	basalt pillow lava, metamorphosed ultramafic rock	2.82	0.001 – 0.003

THUNDELARRA 2340
1:100 000 geological map, section A–B
(Youanmi Terrane, Yilgarn Craton)

LI Brisbout, I Zibra and TJ Ivanic

Location

Map: THUNDELARRA (2340)

Zone: MGA Zone 50

End coordinates: 500758E 6801253N to 547961E 6793005N

Length: 48 km

Interpretation scale: 1:100 000

Section A–B is oriented east-southeast and traverses the southern part of the THUNDELARRA Geological Series map (Zibra et al., 2017; Fig. 1a).

Tectonostratigraphy

Several northwesterly trending units belonging to the Murchison Supergroup (Van Kranendonk et al., 2013) outcrop in the southwest of the THUNDELARRA map sheet. The easternmost and oldest unit is the c. 2960 Ma Gossan Hill Formation, which is intruded by the c. 2951 Ma Gnows Nest Granodiorite (neither shown on section). South of the Gnows Nest Granodiorite, the western part of section A–B traverses metabasaltic rocks and several banded iron-formation horizons of the 2800–2735 Ma Polelle Group, which contains mafic–ultramafic sills of the 2801–2792 Ma Warriedar Suite. West of the section (at the westernmost edge of the map sheet) the 2735–2700 Ma Moogouderra Formation, of the Glen Group, consists of siliciclastic rocks that young to the west and unconformably overlie the Polelle Group. In the centre and east of the section, a large monzogranitic pluton of the 2735–2690 Ma Big Bell Suite intrudes the Polelle Group stratigraphy. In the central part of the section, a smaller monzogranitic pluton of 2650–2600 Ma Walganna Suite intrudes both the Polelle Group stratigraphy and the Big Bell Suite. At the eastern end of the section, a folded sequence of Polelle Group metasedimentary rocks and Warriedar Suite mafic and ultramafic rocks are intruded by monzogranitic rocks of the Big Bell Suite.

Structure

At the western end of cross-section A–B, greenstone sequences belonging to the Polelle Group and Warriedar Suite have been folded into an open antiform with a gently curved (in map view), north-trending, upright axial plane and a south-plunging fold axis. The eastern limb of the antiform has been intruded by a monzogranite pluton of the Walganna Suite (Bald Rock Supersuite).

At the eastern end of the section, monzogranitic rocks of the Big Bell Suite are intruded into metasedimentary rocks of the Polelle Group and mafic–ultramafic intrusive rocks of the Warriedar Suite. The Polelle Group and Warriedar Suite are tightly folded. These folds have north-northeasterly trending axial planes and south-plunging axes. Due to poor exposure, regional-scale fold axial traces are interpreted from aeromagnetic data. The core of the synform in the western portion of this structure is interpreted to be intruded by a small syenogranite pluton assigned to the Big Bell Suite.

Geophysical data

Topographic, Bouguer gravity and aeromagnetic data were sampled every 100 m along section A–B. Topography was sampled from the SRTM3 grid (Jarvis et al., 2006). On THUNDELARRA, gravity stations are spaced in a 2.5 km grid and gravity data were sampled from the 2016 merged Bouguer gravity grid of Western Australia (cell size 400 m; GSWA, 2016a). Aeromagnetic data were sampled from the 2016 RTP merged magnetic grid of Western Australia (cell size 80 m; GSWA, 2016b). On THUNDELARRA, this aeromagnetic grid has been created from a government survey with 100 m line spacing and 90° line direction, and several higher resolution open-file company surveys in the south.

Rock densities from Williams (2009) were used to assign densities to the model. Model densities are listed in Table 1.

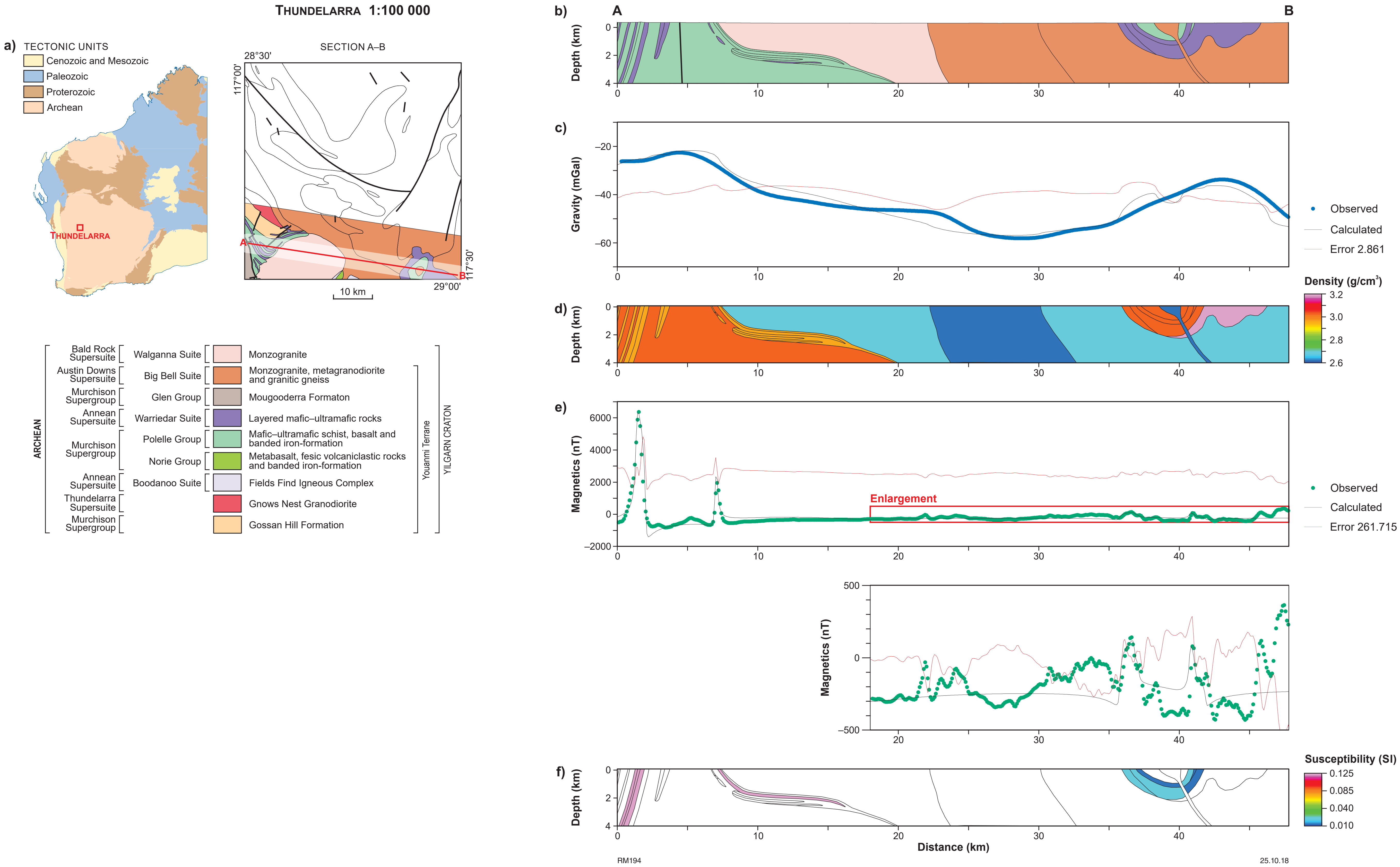

Figure 1. a) Location of cross-section A–B on the THUNDELARRA 1:100 000 map sheet (Zibra et al., 2017) showing simplified interpreted bedrock geology at 1:500 000 scale within 8 km of the line of section. Sections show: b) lithology from THUNDELARRA (Zibra et al., 2017), see a) for legend; c) observed and calculated Bouguer gravity data with error; d) density model; e) observed and calculated RTP TMI data with error; f) susceptibility model

Forward modelling

The initial geology interpreted along section A–B has been tested and, where necessary, modified using 2D gravity and magnetic forward modelling to produce the final section (Fig. 1b). 2D gravity and magnetic forward modelling was performed in Oasis montaj GM-SYS (version 8.5). Gravity stations were placed 1 m above the topography and the air was modelled with a density of 2.67 g/cm^3. No regional trend was removed from the Bouguer gravity or aeromagnetic data and the DC shift was automatically applied to both the gravity and magnetic data. The section was modelled to a depth of 4 km and units were extended horizontally beyond the ends of the section to avoid edge effects.

Results

The gravity profile along section A–B shows relative highs above the two greenstone belts at either end of the section and a relative low above the Walganna and Big Bell Suite granitic rocks (Fig. 1c). The western greenstone belt includes Polelle Group metabasaltic rocks and metamorphosed banded iron-formation, and Warriedar Suite peridotite, gabbro and dolerite (2.85 – 2.90 g/cm^3) that extend to the base of the section. Metamorphic foliations from the greenstone belt, near the contact with the Walganna Suite, dip steeply to the east. This is consistent with gravity forward modelling that also suggests the eastern contact of the greenstone belt dips to the east.

East of the greenstone belt, a monzogranitic pluton of Walganna Suite intrudes older monzogranitic to syenogranitic rocks of the Big Bell Suite. These two rock types would be expected to have similar densities, and hence similar Bouguer gravity response, however, the contact between the two suites is associated with a 10 mGal decrease in Bouguer gravity (Fig. 1c). There are several possible density models that will produce this 10 mGal decrease in Bouguer gravity above the Big Bell Suite. In one model, the western greenstone belt extends at depth beneath the Walganna Suite (Fig. 1b,d). The granite–greenstone contact is interpreted to dip steeply to the east in the near surface, consistent with structural measurements. This geometry is consistent with a thrust ramp and flat, where the granitic rocks are thrust on top of the greenstones. In another model, the Walganna Suite monzogranite must have a density of 2.72 g/cm^3; however, this is unlikely for a granitic rock. A third model suggests that the density contrast is in the basement beneath the contact between the two granitic suites.

The eastern greenstones include metamorphosed banded iron-formation (2.90 – 3.00 g/cm^3) of the Polelle Group and gabbro and ultramafic schist of the Warriedar Suite, surrounded by granitic rocks of the Big Bell Suite (2.68 g/cm^3). The Warriedar Suite (A-ANW-mog) is modelled with a higher density of 3.00 g/cm^3. Using these densities the eastern greenstone belt extends to a maximum depth of 2.3 km. Syenogranitic and monzogranitic rocks of the Big Bell Suite (2.66 gcm^3) intrude a synform in the eastern greenstone belt. These granitic rocks are not coincident with a decrease in gravity, possibly because it is below the resolution of the gravity data, but in magnetic data have a subdued response with magnetic margins.

Reduced-to-pole total magnetic intensity data along profile A–B are dominated by the extremely high-amplitude (~7000 and 2500 nT), high-frequency anomalies produced by banded iron-formation (A-PO-mib) and modelled with susceptibilities of 0.25 – 0.35 SI units (Fig. 1e,f). More subtle features of the magnetic data include small amplitude increases in magnetic intensity above basaltic rocks of the Polelle Group (APO-bb), and dolerite (A-ANW-od) and gabbro (A-ANW-og) of the Warriedar Suite. Several high-frequency, ~200 nT magnetic anomalies occur at the contact between monzogranitic rocks of the Walganna Suite and Big Bell Suite.

Table 1. Petrophysical properties of modelled units and the corresponding map codes and lithologies

Name	*Map code*	*Rock type*	*Density (g/cm^3)*	*Magnetic susceptibility (SI)*
Bald Rock Supersuite				
Walganna Suite	A-BR-gme	monzogranite	2.67	0
Big Bell Suite	A-SDB-gmfe	monzogranite to syenogranite	2.63	0
	A-SDB-gmp	monzogranite	2.66	0
Polelle Group	A-PO-mbs	mafic schist with minor ultramafic schist	2.85	0
	A-PO-bb	fine- to very fine-grained basalt	2.90	0 – 0.360
	A-PO-mib	metamorphosed banded iron-formation locally with recrystallized quartz and magnetite	2.85 – 2.90	0 – 0.360
Annean Supersuite				
Warriedar Suite	A-ANW-ap	peridotite	2.85 – 2.90	0 – 0.360
	A-ANW-od	dolerite	2.85 – 2.90	0 – 0.023
	A-ANW-og	gabbro	2.90	0.010 – 0.023
	A-ANW-masr	ultramafic talc–tremolite–serpentinite–magnetite schist	2.90	0.010 – 0.020
	A-ANW-mog	metagabbro	3.00	0

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WOODLEY 2642
1:100 000 geological map, section A–B
(Windimurra Igneous Complex, Youanmi Terrane, Yilgarn Craton)

RE Murdie and TJ Ivanic

Location

Map: WOODLEY (2642)

Zone: MGA Zone 50

End coordinates: 647784E 6906003N to 693557E 6912741N

Length: 46.3 km

Interpretation scale: 1:100 000

Cross-section A–B from the WOODLEY Geological Series map (Ivanic, 2015) is an east–west section that passes from the northeastern region of the Windimurra Igneous Complex into granitic rocks of the Youanmi Terrane (Fig. 1a).

Tectonostratigraphy

The Windimurra Igneous Complex is a large mafic–ultramafic layered intrusion assigned to the voluminous Meeline Suite, Annean Supersuite (Ivanic et al., 2010), dated at 2813 ± 3 Ma (Wingate et al., 2012). It is located in the central Youanmi Terrane, western Yilgarn Craton, and hosts several orthomagmatic Ti–V and Cr–Ni–Cu–PGE deposits. The complex is bounded by sheared supracrustal rocks of the Yaloginda Formation of the Norie Group (Van Kranendonk et al., 2013) and metamonzogranitic rocks of the Big Bell Suite (Ivanic et al., 2012). Significant volumes of monzogranitic rocks of the Walganna Suite, Bald Rock Supersuite (Ivanic et al., 2012), intrude the Big Bell Suite.

At the top of the complex are several small plutons of the roof zone, which are overlain by the Kantie Murdana Volcanics Member of the Yaloginda Formation, dated at 2813 ± 3 Ma (Nelson, 2001). It comprises felsic volcanic and volcaniclastic rocks, banded iron-formation and a few subordinate lithologies.

Structure

The northern part of the Windimurra Igneous Complex has a synformal geometry, which is steeper at its margins along large-scale, north–south trending shear zones. This geometry is evident in Youanmi Seismic lines 10GA-YU1 and 10GA-YU2 (Ivanic et al., 2014). Along these sheared margins is a mantle of a thin (<1 km thick) sequence of metasedimentary rocks of the Yaloginda Formation of the Norie Group. The central part of the complex is composed of a tabular carapace of roof zone plutons, which intrude into the base of the overlying Kantie Murdana Volcanics Member. The top of the member not exposed, hence its 1 km thickness is a minimum estimate.

Metagranitic rocks of the Big Bell Suite are foliated parallel to the shear zone to the east of the igneous complex. Large tabular plutons of the Walganna Suite intrude the Big Bell Suite on the central and eastern part of the map sheet, and their tabular form is evident on the 10GA-YU2 seismic line 10 km to the south of the modelled section (Ivanic et al., 2014).

Geophysical data

A gravity profile was extracted from the GSWA gravity merged grid of Western Australia (GSWA, 2015), with points sampled every 230 m (Fig. 1c). Total magnetic intensity data were extracted from the TMI map of Western Australia (GSWA, 2016) and topography data were taken from SRTM3 at the same points.

Physical property data were compiled from Ivanic et al. (2014) and Ivanic and Brett (2015). These values were interpolated to corresponding lithologies in the vicinity of this section (Table 1).

Forward modelling

All modelling was performed in GM-SYS run within the Oasis montaj software. 2.5D modelling was performed were the polygons were extended by 100 m perpendicular to the strike of the profile.

Results

The section was modelled down to 6 km but only displayed to 4 km (Fig. 1d,f). The model was refined across the cross-section of the same location (Fig. 1b) from the WOODLEY map (Fig. 1) extending down to 4 km.

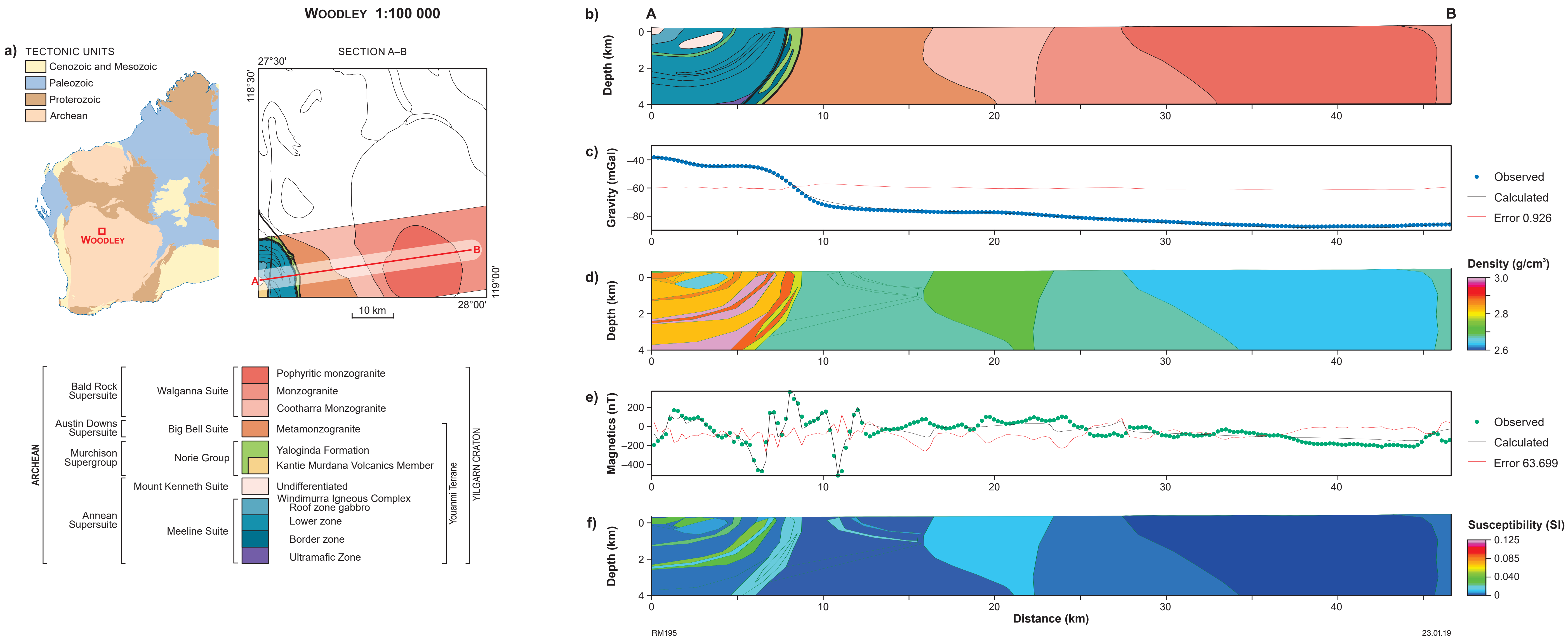

Figure 1. a) Location of cross-section A–B on the WOODLEY 1:100 000 map sheet (Ivanic, 2015) showing simplified interpreted bedrock geology map at 1:500 000 scale within 8 km of the line of section. Sections: b) lithology from WOODLEY (Ivanic, 2015), see a for legend; c) observed and calculated gravity anomaly profile with error line; d) density; e) observed and calculated magnetic anomaly profile with error line; f) susceptibility

Table 1. Summary of physical properties used to model the Windimurra Igneous Complex and surrounding granites of the Youanmi Terrane

Modelled unit	*Map code*	*Rock type*	*Density (g/cm^3)*	*Magnetic susceptibility (SI)*	*Remanence*[a]
Proterozoic dykes		dolerite	2.69[b]	0.0008 – 0.0019	remanent
Bald Rock Supersuite					
Walganna Suite	A-BRG-gmp	porphyritic monzogranite	2.65	0	
	A-BRG-gme	monzogranite	2.68	0.0006	
Cootharra Monzogranite	A-BRco-gm	monzogranite	2.70	0.001	
Big Bell Suite	A-SDB-mgm	metamonzogranite	2.69	0.0004	
Norie Group					
Yaloginda Formation	A-NOy-mib, A-NOy-mts	metasedimentary rocks and metabasalt	2.80	0.0009	remanent
Annean Supersuite					
Mount Kenneth Suite	A-ANK-gg	granitic rock	2.70	0 – 0.0008	
Windimurra Igneous Complex					
roof zone gabbro	A-ANwr-ogp	gabbro	2.88	0.0033	
lower zone	A-ANwl-otl	leucotroctolite	2.88	0.0023	remanent
	A-ANwl-ax, A-ANwl-ap	pyroxenite or peridotite	3.00	0.0038	remanent
	A-ANwl-ol	olivine gabbro	2.90	0.0014	
	A-ANwl-ogl	leucogabbro	2.87	0.0006 – 0.0029	
border zone	A-ANwb-od	dolerite	2.90	0.0025	remanent
ultramafic zone	A-ANwu-xmad-oa	metadunite	3.00	0.0006	

(a) Remanence has been included in the model in order to fit the profile; however, without any field data to constrain it, this is a mathematical exercise and the modelled values probably bear little relationship to the actual values and are hence not detailed

(b) This is not a representative density as the unit is too narrow to feature in the gravity signal

The eastern two-thirds of the section is underlain by granitic rocks which are typical in terms of their densities. The slight differences in densities allow the fitting of small inflections of the gravity profile (Fig. 1c) by modelling the slopes of the contacts between the granitic bodies. Generally they have no or very low susceptibilities. There are some high TMI features within the granitic rocks (Fig. 1e), and these are interpreted to coincide with mapped Proterozoic dolerite dykes with strong magnetic properties, including a component of remanent magnetism. These are either subvertical or moderately northeast dipping (typically ~30°). Field observations indicate that they are 1–40 m thick and are thus too thin to affect the gravity profile. Hence they have been assigned the same density as their surrounding unit. Smaller magnetic features within the granitic units are not modelled, but are attributed to small dykes or bands of granitic rocks that have high concentrations of biotite and a little magnetite and are present on the scale of 50 m wide and 10 km along strike.

The western end of the profile traverses the Windimurra Igneous Complex, the eastern boundary of which is modelled as steeply west dipping. The unit adjoining the complex, the Norie Group metasedimentary rocks, which includes units of banded iron-formation, has a moderate density of 2.8 g/cm^3 and a moderate susceptibility with a remanent component.

The basal part of the complex is the ultramafic zone, modelled as a high-density layer (3.00 g/cm^3) with moderate susceptibility.

The outer unit of the igneous complex is the dolerite of the border zone. This has a higher density than the granitic rocks, but not as high as the ultramafic rocks at 2.9 g/cm^3.

The main component of the complex in this section is a leucogabbro of the lower zone. Within this unit, layers of pyroxenite, peridotite and olivine gabbro are curviplanar in form, following the overall synformal shape of the northern part of the complex. The leucogabbro has a density of 2.88 g/cm^3, within which lenses have a higher density of 2.9 – 3.0 g/cm^3. The pyroxenite and peridotite lenses both have a remanent component to their magnetic signal whereas the gabbros do not.

There is an inflection in the gravity signal within the western part of the complex in this section. This has been modelled as a subsurface granodiorite pluton of the Mount Kenneth Suite. Other plutons of this suite outcrop farther west and southwest, extending onto the WYNYANGOO 1:100 000 map sheet.

Gabbroic rocks of the roof zone of the complex are modelled with a moderately high density of 2.88 g/cm^3 and a moderate susceptibility without remanence. These extend relatively shallowly, overlying the lower zone.

The TMI profile (Fig. 1e) shows a magnetic high over the igneous complex and strong signals over the Norie Group rocks on the eastern border of the complex. Strong magnetic anomalies over the Big Bell Suite are probably due to shallow-dipping Proterozoic dolerite sills belonging to the Warakurna Supersuite.

The slightly elevated magnetic signal in the centre of the profile is attributed to the Cootharra Monzogranite, which may have a slightly higher biotite content although field outcrops are very weathered.

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