Interpretation of magnetic and gravity data of the Madura and Coompana Provinces along the deep crustal seismic survey 13GA–EG1

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Neoproterozoic to Cenozoic sedimentary rocks below the Nullarbor Plain cover basement components that hold the key to understanding how the Archean building blocks in South Australia and Western Australia are connected. Recently acquired geophysical data and stratigraphic drill cores provide fundamental information that allow the area between the Archean Yilgarn Craton in the west and the Gawler Craton in the east to be divided into distinct Proterozoic tectonic units: the Albany-Fraser Orogen, the Madura Province, and the Coompana Province. Here we present a first interpretation of gravity and magnetic data collected along the deep crustal seismic survey 13GA–EG1, with a focus on the Madura and Coompana Provinces.

The northeast trending Rodona Shear Zone that separates the Albany-Fraser Orogen from the Madura Province is imaged on the deep crustal seismic line 12GA-AF3, the westward continuation of 13GA-EG1. The Rodona Shear Zone is divided into a set of western and eastern segments that in the vicinity of line 12GA-AF3 bound a magnetic high. Susceptibility models suggest the highly magnetic unit within the Rodona Shear Zone dips to the east .The Madura and Coompana Provinces contain several distinct features, including large-scale shear zones imaged by discrete linear highs or demagnetization lows. Potential field data have been inverted over these features to produce susceptibility and density models that constrain the geometry of these features at depth. The Madura Province section of 13GA–EG1 is characterised by large amplitude variations in magnetic susceptibility and an eastwards increasing gravity signature. Both magnetics and gravity show a sharp drop in valueS, possibly due to local fracturing and demagnetization, at the N–S oriented Mundrabilla Shear Zonewhich separates the Madura Province from the Coompana Province. In models produced from both magnetic and gravity inversion the Mundrabilla Shear Zone is imaged as a subvertical structure, consistent with interpretations from the13GA–EG1 deep seismic reflection line.

The Forrest Zone (western Coompana Province) is characterised by relatively low amplitude smooth magnetic anomalies and does not show peaks as strong as the provinces on either side. The eastern boundary of the Coompana Province is defined by the west-dipping Jindarnga Shear Zone, separating overall lower gravity Coompana Province from the higher gravity domains of the Gawler Craton. Within the Gawler Craton, the Nawa, Fowler and Christie domains show a strong long wavelength gravity high which extends northeastwards in an arc around the gravity low of the Nuyts and Wilgena domains, which form a semi-circular region dominated by magmatic rocks with high magnetic signature and relatively low densities.

Multi-scale edge detection (worms) of the gravity and magnetic fields outline features that correlate well with structures interpreted from 13GA–EG1. In the west these features include the Rodona, Boonderoo and Serpent Shear Zones, and sections of the Mundrabilla Shear Zone; in the east the Jindarnga, the Karari, and the Tallacootra Shear Zones also show associated worms. Our work shows that interpreting potential field data in conjunction with deep crustal seismic profiles is essential to enable a 3D understanding of basement rocks under cover.