Process-oriented gravity modelling in the Browse Basin: constraints on crustal structure, stretching and thermal state

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For many basins along the western Australian margin, knowledge of basement and crustal structure is limited, yet both play an important role in controlling basin evolution. To provide new insight into these fundamental features in the Browse Basin, we present the results of process-oriented gravity modelling along a NW–SE profile across the basin through the Brecknock gas condensate field. Process-oriented gravity modelling is a method that considers the rifting, sedimentation and magmatism that led to the present-day gravity field. The crustal structure associated with rifting can be inferred by backstripping the sediment load under different isostatic assumptions (i.e. range of flexural rigidities). Combining the gravity anomalies caused by rifting and sedimentation and comparing them to observed gravity provides insight into the presence of magmatic underplating, the location of the continent–ocean boundary and the thermal history of a margin. For an effective elastic thickness of 25 km, backstripping syn- and post-rift sediments (Jurassic and younger) along the Browse Basin profile suggests moderate Jurassic stretching ($\beta \approx 1–2$) and shows that rifting and sedimentation generally explain the observed free-air gravity signature for most of the Scott Plateau and Caswell Sub-basin. Over the Leveque Shelf and Wilson Spur, predicted gravity is less than observed and predicted Moho is also shallower than interpreted from seismic refraction data. We suggest that these misfits reflect the presence of magmatic underplating beneath the Leveque Shelf and outermost parts of the basin, an inference that has some support from interpretation of refraction and crustal-scale seismic reflection data.