Mapping southern Australian and Tasman sea rifted margin crustal thickness and ocean-continent transition using satellite gravity inversion

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Crustal thickness, continental lithosphere thinning factor and residual continental crustal thickness have been determined for the continental rift and transform margins of South Australia and its Antarctic conjugate, the Tasman Sea and New Zealand using gravity inversion incorporating a lithosphere thermal gravity anomaly correction using the method of Greenhalgh & Kusznir (2007). Satellite derived gravity anomaly data (Smith & Sandwell 1997), bathymetry data (Gebco 2003), and ocean isochron data (Mueller et al. 2003) have been used to derive the mantle residual gravity anomaly which is then inverted in 3D in the spectral domain to give Moho depth. Sediment thickness data provided by Geoscience Australia has been incorporated into the gravity inversion for the southern Australian and Antarctic conjugate margins. The results of the gravity inversion are shown in the form of: (i) maps of crustal basement thickness, continental lithosphere thinning factor and residual continental crustal thickness; and (ii) crustal cross-sections showing predicted Moho depth, and thicknesses of residual continental crust, volcanic addition and sediment. Regional 2D cross-sections have been constructed for the South Australian and conjugate Antarctic continental margins. The maps and cross-sections produced by gravity inversion may be used to constrain ocean-continent transition location, identify failed breakup basins, distinguish magma poor and volcanic margins, and refine plate reconstructions.

Thinning factor estimates determined from crustal thinning from gravity inversion require a correction for volcanic addition from decompression melting during breakup and sea-floor spreading. Parameterisations of volcanic addition as a function of lithosphere thinning factor (1-1/β) appropriate to volcanic, normal and magma-poor rifted margins have been used in the gravity inversion. The sensitivity of predicted crustal thickness and continental lithosphere thinning factor from the gravity inversion to volcanic addition is shown in map and cross-section form. Gravity inversion tests have also been carried out to examine the sensitivity of predicted crustal thickness and lithosphere thinning factor to breakup age and the age of the oldest oceanic isochrons used to condition the lithosphere thermal model. For the southern Australian and Antarctic conjugate margins the preferred age of continental breakup used in the gravity inversion is 84 Ma. The preferred age of the oldest oceanic isochron used to condition the oceanic component of the lithosphere thermal model is 44 Ma and is chosen to avoid errors in the oldest ocean isochrons pre-determining the location of the ocean-continent transition predicted by the gravity inversion. Sensitivity tests of the gravity inversion results to reference crustal thickness have been carried out. Gravity inversion results suggest that the reference crustal thickness is between 40 and 42.5 km; a reference crustal thickness of 37.5 km predicts too thin oceanic crust and a Moho that is in some locations shallower than top basement. Sensitivity tests for crustal basement density have also been carried out.

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