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Crustal thickness mapping using satellite gravity data: Implications for the formation of the southern Rockall Trough

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Satellite gravity and bathymetry data has been used to derive an upper bound of crustal basement thickness for the Rockall Trough and adjacent regions using a gravity inversion methodology incorporating a correction for the large negative thermal gravity anomaly component present in oceanic and stretched continental lithosphere. Previous studies have concluded that the Rockall Trough may either be an intra-continental rift floored with highly extended continental crust, or a failed oceanic rift formed by Cretaceous sea-floor spreading. We use the upper bound of crustal thickness and a forward model of rifted-margin formation to investigate the structure and formation of the Rockall Trough. The marine Bouguer anomaly derived from satellite free air gravity (Sandwell & Smith 1997) and Gebco 2003 bathymetry is inverted using the method of Oldenberg (1974) to give Moho depth. The thermal anomaly correction is applied iteratively, and is calculated for continental crust using lithosphere beta stretching estimates from gravity derived crustal basement thickness and an assumed rift age, and for oceanic crust using isochrons (Muller). Sediments and volcanic addition are not included in the gravity inversion and as a consequence the gravity inversion gives an upper bound of crustal thickness and a lower bound of lithosphere beta stretching factor. Comparison with published wide-angle seismic data (e.g. Joppen & White, Roberts et al 1988) shows that the gravity inversion method with thermal correction gives a reliable estimate of crustal thickness in this region. In the Rockall Trough south of 57 N, where Tertiary volcanic additions are minimal, the gravity inversion gives a crustal basement thickness upper bound of approximately 8 km flanking axial crust up to 15 km thick. Inclusion of sediments in the gravity inversion further reduces these thickness estimates. The crustal thickness map derived from gravity inversion

shows an axial thickening of Rockall Trough crust running from the Barra Volcanic centre to the Anton Dohrn sea-mount. Normal-incidence seismic data and magnetic data shows few faults and fault blocks in the basin and the axial region of thicker crust to be volcanic. This is not consistent with an intra-continental rift basin origin for the southern Rockall Trough. The formation of the southern Rockall Trough has been investigated using SfMargin, a new model of continental lithosphere thinning leading to breakup and sea-floor spreading initiation. Comparisons of the geometry of the southern Rockall Trough predicted by SfMargin with that observed are consistent with a short period (˜20Ma) of slow Cretaceous seafloor-spreading, followed by thermal subsidence to present day. This work forms part of the NERC Margins iSIMM project. iSIMM investigators are from Liverpool and Cambridge Universities, Badley Geoscience & Schlumberger Cambridge Research supported by the NERC, the DTI, Agip UK, BP, Amerada Hess Ltd, Anadarko, Conoco-Phillips, Shell, Statoil and WesternGeco. The iSIMM team comprises NJ Kusznir, RS White, AM Roberts, PAF Christie, A Chappell, J Eccles, R Fletcher, D Healy, N Hurst, ZC Lunnon, CJ Parkin, AW Roberts, LK Smith, V Tymms & R Spitzer.