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Antarctic and Southern Ocean Crustal Thickness and Ocean-Continent Transition Location from Gravity Inversion

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Using gravity anomaly inversion, we have produced the first comprehensive regional maps of crustal thickness and oceanic lithosphere distribution for Antarctica and the Southern Ocean. We determine Moho depth, crustal basement thickness, continental lithosphere thinning (1-1/β) and ocean–continent transition location using a 3D spectral domain gravity inversion method (Chappell and Kusznir 2008) which incorporates a lithosphere thermal gravity anomaly correction. Lithosphere thermal model re-equilibration (cooling) times, used to calculate the lithosphere thermal gravity anomaly correction, are conditioned by ocean isochron information, and continental rifting and breakup ages. The continental lithosphere thinning distribution, used to define the initial thermal model temperature perturbation are derived from the gravity inversion and use no a priori isochron information; as a consequence the gravity inversion method provides a prediction of OCT location which is independent of ocean isochron information. The gravity anomaly contribution from ice thickness is included in the gravity inversion, as is the contribution from sediments which assumes a compaction controlled sediment density increase with depth. A correction to the predicted continental lithospheric thinning derived from gravity inversion is made for the addition of volcanic material produced by decompression melting during continental rifting, breakup lithosphere thinning and seafloor spreading. Data used in the gravity inversion are elevation and bathymetry, free-air gravity anomaly, sediment and ice thickness from Smith and Sandwell (2008), Sandwell and Smith (2008) and Laske and Masters (1997) respectively, supplemented by Bedmap2 data south of 60 degrees south. Our gravity inversion study predicts thick crust (> 45 km) under interior East Antarctica penetrated by continent scale rifts. Intermediate crustal thickness with a pronounced rift fabric is predicted under Coates Land. An extensive region of either thick oceanic crust or highly thinned continental crust is predicted offshore Oates Land and north Victoria Land. Thin crust is predicted under the West Antarctica Rift System and the Ross Sea. Crustal thickness and lithosphere thinning derived from gravity inversion allows the determination of circum-Antarctic ocean-continent transition structure and the mapping of continent-ocean boundary location. Superposition of illuminated satellite gravity data onto crustal thickness maps from gravity inversion provides improved determination of Southern Ocean rift orientation, pre-breakup rifted margin conjugacy and continental breakup trajectory.