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South China Sea crustal thickness and lithosphere thinning from satellite gravity inversion incorporating a lithospheric thermal gravity anomaly correction

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The distribution of ocean crust and lithosphere within the South China Sea (SCS) are controversial. Sea-floor spreading re-orientation and ridge jumps during the Oligocene-Miocene formation of the South China Sea led to the present complex distribution of oceanic crust, thinned continental crust, micro-continents and volcanic ridges. We determine Moho depth, crustal thickness and continental lithosphere thinning (1- 1/beta) for the South China Sea using a gravity inversion method which incorporates a lithosphere thermal gravity anomaly correction (Chappell & Kusznir, 2008). The gravity inversion method provides a prediction of ocean-continent transition structure and continent-ocean boundary location which is independent of ocean isochron information. A correction is required for the lithosphere thermal gravity anomaly in order to determine Moho depth accurately from gravity inversion; the elevated lithosphere geotherm of the young oceanic and rifted continental margin lithosphere of the South China Sea produces a large lithosphere thermal gravity anomaly which in places exceeds -150 mGal. The gravity anomaly inversion is carried out in the 3D spectral domain (using Parker 1972) to determine 3D Moho geometry and invokes Smith's uniqueness theorem. The gravity anomaly contribution from sediments assumes a compaction controlled sediment density increase with depth. The gravity inversion includes a parameterization of the decompression melting model of White & McKenzie (1999) to predict volcanic addition generated during continental breakup lithosphere thinning and seafloor spreading. Public domain free air gravity anomaly, bathymetry and sediment thickness data are used in this gravity inversion.

Using crustal thickness and continental lithosphere thinning factor maps with superimposed shaded-relief free-air gravity anomaly, we improve the determination of pre-breakup rifted margin conjugacy, rift orientation and sea-floor spreading trajectory. SCS conjugate margins are highly asymmetric and have several striking features such as the Macclesfield Bank, Xisha Trough, Reed Bank and Dangerous Grounds. Thin continental crust is predicted extending westwards from thin oceanic crust north of Macclesfield Bank into the Quiondongnan (QDN) basin and is interpreted as being generated ahead of westward propagating sea-floor spreading most in the Oligocene. Further south, highly thinned continental crust or possibly serpentinised exhumed mantle is predicted in the Phu Khanh Basin. Ahead of the failed propagating tip of seafloor spreading, offshore southern Vietnam, thinned continental crust is predicted for the Cuu Long and Nam Con Son Basins. Crustal thicknesses from gravity inversion confirms that the southern margin of the SCS consists of fragmented blocks of thinned continental crust separated by thinner regions of continental crust that have undergone higher degrees of stretching and thinning. The Reed Bank is predicted to have a crustal thickness of 20 to 25km, similar to that of Macclesfield Bank. The Dangerous Grounds, west of the Reed Bank, are also predicted to consist of continental crust. This region has been thinned to a higher degree than the Reed Bank, with continental crustal thickness ranging between 10 and 20km thick.