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Magma Rich Events at Magma-Poor Rifted Margins: A South-East Indian Example

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The south-east Indian continental rifted margin, as imaged by the INE1-1000 deep long-offset seismic reflection section by ION Geophysical, is a classic example of a magma-poor rifted margin, showing highly thinned continental crust, or possibly exhumed mantle, within the ocean-continent transition (OCT). Outboard, the steady-state oceanic crust is between 4 and 5 km thickness, consistent with magma-poor continental breakup and sea-floor spreading. It is therefore surprising that between the hyper-extended crust showing thin or absent continental crust (of approximately 75 km width) and the anomalously thin steady-state oceanic crust, there appears to be a region of thicker magmatic crust of approximately 11 km thickness and 100 km width. Magmatic events, at or just after continental breakup, have also been observed at other magma-poor rifted margins (e.g. NE Brazil).

This interpretation of magma-poor OCT structure and thinner than global average oceanic crust separated by thicker magmatic crust on the SE Indian margin is supported by gravity inversion; which uses a 3D spectral technique and includes a lithosphere thermal gravity anomaly correction. Residual depth anomaly (RDA) analysis corrected for sediment loading using flexural backstripping, gives a small negative value (approximately -0.1 km) over the steady-state oceanic crust compared with a positive value (approximately +0.3 km) over the thicker magmatic crust. This RDA difference is consistent with the variation in crustal thickness seen by the seismic reflection interpretation and gravity inversion.

We use joint inversion of the time domain seismic reflection and gravity data to investigate the average basement density and seismic velocity of the anomalously thick magmatic crust. An initial comparison of Moho depth from deep long-offset seismic reflection data and gravity inversion suggests that its basement density and seismic velocity are slightly less than that of the outboard steady-state oceanic crust. Possible interpretations for this include (i) the presence of volcano-clastics or other sedimentary within the thicker magmatic crust, (ii) a mix of hyper-extended continental crust and magmatic material, (iii) wholly magmatic crust but with a lighter density than average oceanic crust.