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Evidence for Lateral Variation in Lithospheric Mantle Density across the Ocean-Continent Transition of the Iberia and Newfoundland Conjugate Rifted Margins

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Residual depth anomalies (RDA) and gravity anomaly inversion have been used to infer lateral variation in lithospheric mantle density across the ocean-continent transitions (OCT) of the Iberia-Newfoundland conjugate rifted margins. RDAs were calculated by subtracting the bathymetry predicted by thermal plate models from the observed bathymetry. The OCT of the Newfoundland margin has a mean RDA which is around 650m more positive (shallower) than that of the Iberian margin. After correction for the flexural isostatic response to sediment loading, the mean difference in RDA between the margins increases. Intriguingly, there is no discontinuity in sediment corrected RDA between the Newfoundland Basin and Galicia Abyssal Plain segment of the margins when reconstructed to approximately 120 Ma. Sediment corrected RDA increases from approximately -1000 m to around + 800 m from east to west across the reconstructed OCT of the two margins with a roughly constant and continuous gradient. The present day separation of the margins is around 3500 km, which is believed to be much greater than the wavelength of topography from a dynamic source. It is unlikely that separate dynamic sources could produce the observed distribution of RDA.

Gravity anomaly inversion has been used to infer lateral mass heterogeneity across the OCTs of the Iberia and Newfoundland margins. Using local isostatic considerations the observed sediment corrected RDA can be reproduced from the mass heterogeneity seen in the gravity anomaly signal. Therefore, the same lateral distribution of mass heterogeneity is seen by both the free air gravity and bathymetric anomalies. Upwards-continuation suggests most of the mass anomaly is reasonably shallow. The density anomaly cannot solely be located within the seismically determined crustal thickness, since this would require unrealistic crustal densities of below 2500 kg m-3. Three percent variability in the lithospheric mantle density could account for the mass heterogeneity responsible for the observed RDA and gravity anomaly, though some of the mass heterogeneity having a sub-lithospheric origin cannot be discounted. ODP drilling results demonstrate differences in the mantle at the OCTs of the two margins. Mantle from the Iberian margin is infiltrated with melt and is significantly less depleted than that of the Newfoundland margin. A key scientific question is: are the observed compositional and density differences between the Iberia and Newfoundland margins inherited pre-breakup lithospheric heterogeneities, or the result of the breakup process?