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Evidence for mass deficiency within the lithosphere of the Iberian, Newfoundland, Nova Scotian and Labrador margins from residual depth anomalies

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A documented feature of the Iberia and Newfoundland conjugate magma poor margins is that the Newfoundland margin is elevated relative to the Iberian margin. This work employs residual depth anomalies (RDA) to investigate this misfit whilst exploring the mass and density distribution across the wider region. Observed bathymetry has been compared to the global oceanic bathymetry-age models of Parsons and Sclater (1977) and Stein and Stein (1992) in order to calculate RDA. Seismically derived cross-sections have been flexurally backstripped to correct the RDA for sediments. A correction has also been made to the RDA for seismically observed variation in oceanic crustal thickness, about the global mean thickness, using local isostasy. Key observations of the corrected RDA are: (1) oceanic crust on the Labrador and the Newfoundland margins are over a kilometer shallower than predicted by the global bathymetry-age models; (2) oceanic crust on the Newfoundland margin is elevated by 700 to 900m relative to its conjugate Iberian margin; (3) the RDA decrease ocean-wards; (4) the RDA decrease southwards on both sides of the North Atlantic.

Potential sources of the observed RDA have been investigated, including flexural coupling of oceanic and continental lithosphere, mantle plume uplift, serpentinization, magmatic intrusions and lithospheric mantle geochemical heterogeneity. Modeling shows flexural coupling of oceanic and continental lithosphere, during thermal subsidence of the oceanic lithosphere, may be the sole source of the ocean-wards decrease in RDA. However, the elevation of the Newfoundland margin relative to the Iberian

margin can not be explained by flexural isostatic coupling. The Iceland plume might be the source of the southerly decrease in RDA; however, this is unlikely, due to its large distance from the margins. Moreover, the Iceland and Azores plumes are unlikely to be the source of the elevation of the Newfoundland margin relative to the Iberian margin, since the plumes are approximately the same distance from the margins. A possible explanation for the elevation of the Newfoundland margin relative to the Iberian margin, is a compositional mass deficiency within the ocean-continent transition (OCT) of the Newfoundland margin. Possible compositional deficiencies include gabbroic intrusions, serpentinized lithospheric mantle and lithospheric mantle depletion. The quantities of these compositional deficiencies, required to generate the observed positive RDA, has been estimated using local isostasy. If all the observed positive RDA is caused by a compositional mass deficiency then the required thicknesses of gabbroic intrusions, fully serpentinized mantle or partially serpentinized ($\sim$ 50 %) mantle are 3.5 – 8.5 km; 2.5 - 7 km or 4.5 - 14 km respectively. Partial depletion of the entire lithospheric mantle, within the OCT of the Newfoundland margin is an alternative explanation for its elevation relative to the Iberian margin. If mantle depletion is the sole source of the positive RDA of the Galicia Bank (northern Iberia) and Flemish Cap (northern Newfoundland) margins, then the entire lithospheric mantle within their OCT must be depleted by 10 and 21% respectively. These depletion levels are consistent with the measured depletions of mantle rocks from the two margins (Muntener and Manatschal, 2006).