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Systematic patterns of asymmetric extension and breakup based on seismic models of the Iberia-Newfoundland and other North Atlantic non-volcanic conjugate margins

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The Iberia and Newfoundland margins represent the best studied non-volcanic conjugate pair in the North Atlantic. A compilation of observations from three recent seismic profiles across the Newfoundland margin with previous results from the Iberia margin now provides detailed insight into the development of the entire margin segment and the nature of crustal extension and breakup. Results suggest that as rifting between Newfoundland and Iberia proceeded to breakup, mantle was exhumed first in the south within the Newfoundland Basin and the Iberia Abyssal Plain. Breakup to the north between Flemish Cap and Galicia Bank was delayed as the extension of Galicia Bank compensated for the space taken up by the exhumed mantle to the south. This resulted in a major along-strike variation in the width of extended continental crust and exhumed mantle and in the pattern of asymmetry across the conjugates. The southern boundary of Galicia Bank is interpreted as a transfer zone over which the orientation of breakup asymmetry changed as breakup shifted from the Iberia side in the south to the Newfoundland side in the north. Crustal models of other North Atlantic non-volcanic margin conjugate pairs, from the Labrador Sea to the Nova Scotia-Morocco margins, are compared and show similar patterns of asymmetry in two distinct styles. Conjugates that have undergone asymmetric crustal thinning, such as the Flemish Cap-Galicia Bank conjugates, are those in which lithospheric scale brittle detachments are evidenced. Conjugates that have experienced symmetric crustal thinning followed by an asymmetric continental breakup, such as the Newfoundland Basin-Iberia Abyssal

Plain conjugates, do not show such detachments and thus, may represent evidence for ductile deformation in the lower crust. In both cases, a layer of serpentinized upper mantle $\sim$45-210km wide and 6 $\pm$ 2km thick is observed wherever the crustal thickness is $<$6-8km according to p-wave velocity models. This layer always terminates seaward by the formation of oceanic crust $\sim$6km thick, which is normal for North Atlantic spreading rates. Despite the variations in crustal thinning and patterns of asymmetry mentioned earlier, these later features suggest a uniform pattern among North Atlantic non-volcanic margins in mantle processes and their interaction with the formation of oceanic crust.