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Does the extension by brittle crustal faulting explain the total crustal thinning at conjugate rifted margins? The Iberia-Newfoundland conjugate margins example

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Rifted margins have been extensively studied, however, there are still key unknowns related to their formation process. An important remaining question is how much extension is required to produce continental crustal breakup. The answer to this question may vary depending on several parameters such as the crustal rheology, obliquity and width of the margin, crustal inheritances, magmatism and extension rate. In this study, we use the Iberia-Newfoundland conjugate rifted margins as a natural laboratory to explore how much extension the continental crust and lithosphere underwent to generate continental crustal breakup and thus form this pair of conjugate rifted margins.

To achieve our aim we use; (i) gravity inversion to measure continental crustal thinning, (ii) subsidence analysis to measure continental lithosphere thinning and (iii) seismic interpretation to measure brittle extension from fault heave summation. Integration of thinning from gravity inversion and subsidence analysis is used to determine continental crust extension and continental lithosphere extension respectively. We identify the distal end of continental crust on the Lusigal-12/TGS and Screech-2 conjugate seismic profiles. We then calculate continental crustal extension and continental lithosphere extension from the proximal edge of continental crust to their distal end. Results are 177 km continental crustal extension while 192 km for continental lithosphere extension. In contrast, brittle extension from fault heave summation from seismic interpretation is 135 km. These measurements show an apparent discrepancy between observed brittle crustal extension (i.e. faults heaves) and total calculated continental crustal extension at the scale of the whole conjugate Iberia-Newfoundland margins system.

Fault population analysis has been carried out to examine whether sub-seismic resolution faulting significantly contributes to an under-estimate of brittle crustal extension. In addition, we explore the observed apparent extension discrepancy by analysing the relationship between the fault extension in the brittle crust and the total measured crustal thinning using a kinematic model (RIFTER) which is tested against quantitative target data.

In conclusion, kinematic modelling and fault population analysis suggest that this discrepancy may be caused by sub-seismic resolution faulting and/or non-brittle deformation. This extension discrepancy should not be confused with depth-dependent lithosphere stretching and thinning.