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Formation of hyperextended rifted margins: Insights from flexural isostatic structural-stratigraphic modeling and observations from present-day rifted margins

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The understanding of how continental lithosphere extends, thins and ruptures leading to the formation of a new divergent plate boundary represent a fundamental question in Earth Sciences. In particular the mechanisms controlling the extreme pre-breakup stretching and thinning of the continental crust and lithosphere, documented at many present-day rifted margins, are still poorly known.
Many questions remain of the fundamental processes controlling the extensional deformation of the continental crust and lithosphere, including fault geometries and their evolution in space and time, the occurrence of decoupling horizons within the continental crust and the importance of depth-dependent lithosphere thinning processes. We investigate the control of these key factors on continental crust and lithosphere thinning processes by combining seismic reflection and drill-hole observations from present-day Iberia-Newfoundland rifted margins with flexural isostatic forward tectonic and stratigraphic modeling. These observations made at present-day rifted margins constrain the input parameters used in the flexural isostatic forward modeling. At the same time, the forward tectonic and stratigraphic modeling provides validation of the interpretation of the seismic reflection data.
Through this modeling, we produce isostatically and thermally balanced sections reproducing the geometries observed along the Iberia-Newfoundland rifted margins. Our results suggest that crustal and lithospheric thinning results from the combination of both pure- and simple-shear deformation. The model predicts the critical role of intra-crustal decoupling horizons confirming the importance of depth-dependent thinning through polyphased rifting events.