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Constraining lithosphere deformation mode evolution for the Iberia-Newfoundland rifted margins

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The deformation of lithosphere and asthenosphere and its evolution during continental rifting leading to breakup and seafloor spreading initiation is poorly understood. The resulting margin architecture and OCT structure is complex and diverse, and observations at magma poor margins includes hyper-extended continental crust and lithosphere, detachments faults, exhumed mantle, continental slivers and scattered embryonic oceanic crust.
A coupled kinematic-dynamic model of lithosphere and asthenosphere deformation has been used to investigate the sequence of lithosphere deformation modes for 2 conjugate margin profiles for the Iberia-Newfoundland rifted margins. We use the observed water-loaded subsidence and crustal thickness, together with subsidence history and the age of melt generation, to test and constrain lithosphere and asthenosphere deformation models.
A sequence of lithosphere deformation modes is represented by a succession of flow-fields, which are generated by a 2D finite element viscous flow model (FE-Margin), and is used to advect lithosphere and asthenosphere temperature and material. FE-Margin is kinematically driven by divergent deformation in the upper 15-20 km of the lithosphere inducing passive upwelling below. Buoyancy enhanced upwelling (e.g. Braun et al. 2000) is also kinematically included. The methodology of Katz et al., 2003 is used to predict melt generation by decompressional melting. The magnitude of extension used in the modelling is consistent with that proposed by Sutra et al (2013).
The best fit calibrated models of lithosphere deformation evolution for the Iberia-Newfoundland conjugate margins require (i) an initial broad region of lithosphere deformation and passive upwelling, (ii) lateral migration of deformation, (iii) an increase in extension rate with time, (iv) focussing of deformation and (v) buoyancy induced upwelling. The preferred calibrated models predict faster extension rates and earlier continental crustal rupture and mantle exhumation for the Iberia Abyssal Plain - Flemish Pass conjugate margin profile than for the Galicia Bank – Flemish Cap profile. The predicted N-S difference in deformation mode evolution give insights into the northward propagation of the Iberia-Newfoundland margin breakup.