Geophysical Research Abstracts
Vol. 16, EGU2014-9156, 2014
EGU General Assembly 2014

Structural and stratigraphic evolution of the Iberia and Newfoundland hyper-extended rifted margins: A quantitative modeling approach

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Rifted margins develop through polyphased extensional events leading eventually to break-up. Of particular interests are the stratigraphic and subsidence evolutions of these polyphased rift events. In this contribution, we investigate the spatial and temporal evolution of the Iberia-Newfoundland rift system from the Permian, post-orogenic development of European crust to early Cretaceous break-up on the continental lithosphere between Iberia and Newfoundland. Based on seismic reflection and refraction and ODP drill data combined with a kinematic and flexural model for the deformation of the lithosphere, we explore the general tectono-stratigraphic evolution of Iberia-Newfoundland rift system and its relationship to repeated lithospheric thinning events. Our results emphasize the kinematic and isostatic interactions engendered by the distinct distribution, amplitude and depth-partitioning of extensional events that allowed the formation of the Iberia-Newfoundland rift system.

The initial stratigraphic record is controlled by Permian, post-orogenic topographic erosion, lithospheric thinning, and its subsequent thermal re-equilibration that lead to a regional subsidence characterized by non-marine to marine sedimentation. During late Triassic and early Jurassic time, extensional deformation was characterized by broadly-distributed depth uniform thinning related to minor thinning of the crust. From the Late Jurassic onward, extensional deformation was progressively localized and associated with depth-dependent thinning that finally lead to the formation of hyper-extended domains pre-dating the Late Aptian/Early Albian break-up of the Iberia-Newfoundland continental lithosphere. In particular, extension was diachronous, propagating in severity from south to north - while the southern Iberian margin was undergoing significant thinning in the Tithonian-early Berriasian, the northern margin (i.e. Galicia Bank) had yet to start rifting. Break-up is likewise diachronous. These hyper-extended domains were characterized by regional subsidence with little attendant normal faulting. To match the distribution and the magnitude of the subsidence, we required significant depth-dependent middle/lower crustal and mantle thinning achieved via major decoupling horizons within the ductile middle crust.

We believe that these results may provide crucial insights into the subsidence history of hyper-extended rifted margins as well as on the mechanisms of continental lithosphere extension and thinning.