Asymmetry of the margins of the Atlantic Ocean from geodynamic models of mantle convection with lithospheric deformation

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ABSTRACT:

The margins of the Atlantic Ocean are topographically asymmetrical. In the South Atlantic, the depth of the Argentine Basin contrasts with the Elevated Passive Continental Margins (ECPMs) of Northeast Brazil and Southern Africa. In the North Atlantic, EPCMs occur in the Labrador Sea, East Greenland and Scandinavia, contrasting with the low-lying margins in Senegal and Florida (Japsen et al., 2011). These topographic asymmetries are difficult to explain in traditional lithospheric stretching and thermal subsidence models, and other processes are required to explain their formation. For instance, the deep bathymetry in the Argentine basin has been attributed either to shallow asthenospheric flow or dynamic topography, while the Brazilian Highlands have been attributed either to continental-scale far-field stresses associated with Andean convergence or to the interaction of a plume tail with thick cratonic lithosphere.

We studied the origin of Atlantic margin asymmetry using a workflow that incorporates the effect of mantle dynamics on deforming continents. This workflow consists of a) global plate reconstructions, generated using *GPlates*, that account for continental deformation deduced from published geological and geophysical data and plate reconstructions; b) forward global mantle flow models, computed using a 3D-spherical finite-element solution of flow with compositionally distinct crust and continental lithosphere embedded within the thermal lithosphere with imposed plate kinematics and subduction zones. For the South Atlantic, we compared the plate reconstructions of Torsvik *et al*. (2009) and Heine *et al*. (*in prep.)*. Both reconstructions account for intraplate deformation in Africa and South America, lithospheric stretching at passive margins, and growth of the Andes. For the North Atlantic, we used the reconstruction of Seton et al. (2012).

This workflow allows us to investigate the interaction between mantle flow and lithospheric stretching and their relative contributions to surface topography in passive margins systems, for the case of pure shear of the lithosphere. Our models reproduce the first-order asymmetry of the margins of the Atlantic Ocean. We attribute the large subsidence of the Argentine margin to the dynamic topography low induced by ongoing subduction along the narrow southern portion of South America. Similarly, the low-lying margin in Florida lies over the dynamic topography low associated with the Farallon slab. Our subduction-driven models do not fully explain the EPCMs in the North Atlantic that are likely related to the Iceland plume swell. In the South Atlantic, the models suggest that part of the uplift of Southern Africa can be attributed to its relative motion away from a dynamic topography low.

REFERENCES:

Japsen et al., 2011, *Global and Planetary Change, in press.*

Seton et al., 2012, *Earth Science Reviews, accepted.*

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