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Topographic asymmetry of the South Atlantic from global models of mantle flow and lithospheric stretching

Nicolas Flament (1), Michael Gurnis (2), Simon Williams (1), Maria Seton (1), Jakob Skogseid (3), Christian Heine (1), and Dietmar Müller (1)

(1) Earthbyte Group, School of Geosciences, The University of Sydney, Australia (nicolas.flament@sydney.edu.au), (2) Seismological Laboratory, California Institute of Technology, Pasadena, CA 91125, USA, (3) Statoil ASA, Martin Linges vei 33, 1364 Fornebu, Norway

The relief of the South Atlantic is characterized by elevated passive continental margins along southern Africa and eastern Brazil, and by the bathymetric asymmetry of the southern oceanic basin where the western flank is much deeper than the eastern flank. We investigate the origin of these topographic features in the present and over time since the Jurassic with a model of global mantle flow and lithospheric deformation. The model progressively assimilates plate kinematics, plate boundaries and lithospheric age derived from global tectonic reconstructions with deforming plates, and predicts the evolution of mantle temperature, continental crustal thickness, long-wavelength dynamic topography, and isostatic topography. Mantle viscosity and the kinematics of the opening of the South Atlantic are adjustable parameters in multiple model cases. Model predictions are compared to observables both for the present-day and in the past. Present-day predictions are compared to topography, mantle tomography, and an estimate of residual topography. Predictions for the past are compared to tectonic subsidence from backstripped borehole data along the South American passive margin, and to dynamic uplift as constrained by thermochronology in southern Africa. Comparison between model predictions and observations suggests that the first-order features of the topography of the South Atlantic are due to long-wavelength dynamic topography, rather than to asthenospheric processes. We find the uplift of southern Africa to be best reproduced with a lower mantle that is at least 40 times more viscous than the upper mantle.