Geophysical Research Abstracts
Vol. 20, EGU2018-15380-2, 2018
EGU General Assembly 2018

3-D spherical high-resolution modelling of the influence of rifting on South Atlantic plume and mantle flow using a new embedded global modelling approach

Jorge M. Taramón (1), Jason P. Morgan (1), Marta Pérez-Gussinyé (2), and Jörg Hasenclever (3)

(1) Royal Holloway University of London, Department of Earth Sciences, Egham, United Kingdom (jorge.taramongomez.2014@live.rhul.ac.uk), (2) MARUM – Center for Marine Environmental Sciences, University of Bremen, Germany, (3) Institute of Geophysics, Hamburg University, Germany

The treatment of far-field boundary conditions is one of the most poorly resolved issues for regional high-resolution modelling of geodynamic processes. The mantle velocity field along the side-walls and base of a local model region is typically much more poorly known than the geometry of past global motions of the surface plates, as constrained by global plate motion reconstructions. For regional 3-D rifting models, researchers typically apply highly simplified 'plate spreading' or 'uniform rifting' boundary conditions to a 3-D model that limit its ability to simulate the geodynamic evolution of a specific rifted margin. One way to improve the capabilities of regional models is to include more accurate boundary conditions by using a nested modelling approach, in which a global model is used to determine a large-scale flow pattern that is then imposed as a constraint along the boundaries of the region to be modelled. Here we explore a different approach by applying global plate motion boundary conditions on a spherical coarse mesh over the entire Earth with an embedded high-resolution mesh in the region of interest.

We use this approach to study the potential mantle flow associated with the first $\sim$25 Ma of rifting evolution in the South Atlantic, exploring in particular the influence of the Tristan da Cunha plume and initial lithospheric thickness variations on plume and mantle flow during rifting. The model contains a single 'hot Tristan Plume' with a temperature anomaly of 150°C with respect to background mantle, and a volume flux ranging from 5-20 km^3/yr. Global plate motion boundary conditions and plate boundaries are updated using GPlates every 1 Myr. While surface plate motions are prescribed everywhere on the sphere, buoyancy forces are only considered within the 4200 km (N-S) x 1800 km (E-W) x 300 km (depth) high-resolution sub-region to avoid convective instabilities in the coarse mesh regions.

Our models show the migration of hotter and weaker plume material towards the rifting region before break-up. This flow is strongly influenced by the lateral thickness variations in the initial structure of the lithosphere. Once the plume material reaches the rifting region it preferentially migrates southwards. This preferential southward flow appears to be due to a combination of increased rift velocities in the South and the presence of thicker São Francisco and conjugate Congo cratonic roots in the North. Regions of plume-influenced rifting are found to have significant early uplift in comparison to 'non-volcanic' rifting sectors.