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# Numerical Models of Multi-Velocity Rift Evolution

S. Brune (1) and C Heine (2)

(1) GFZ-Potsdam, Geodynamic Modeling Group, Potsdam, Germany (brune@gfz-potsdam.de), (2) EarthByte Group, School of Geosciences, The University of Sydney, Australia

Numerical models are a useful tool to combine present-day knowledge on plate kinematics and lithosphere rheology in order to reveal the complex relations between deformation modes, margin asymmetry and crustal hyperextension. We investigate how long rift duration and distinct successive extensional velocities influence lithospheric localization and final margin geometry. Our scenarios are computed using a thermo-mechanical, finite element model that includes elasto-visco-plastic rheology and a free surface. The model allows for high resolution of 1 km in a 2d setup with 500 km width and 200 km depth range. We highlight the importance of strain hardening for slow rifting ($\sim$ 5 mm/yr full extension velocity) where cooling of uplifted mantle material promotes continuous lateral migration of the rift center. Despite initially symmetric extension, strain hardening can lead both to significant late rift asymmetry and to crustal hyperextension.

We use our model to understand the South Atlantic conjugate margin geometries. We thereby build upon a new plate kinematic model for the South Atlantic rift which integrates time-dependent information on crustal deformation within a global self-consistent plate rotation framework. Here, the intial continental separation between South America and Africa starts in the Early Cretaceous at low velocities, controlled by African intracontinental rifting. After 20-25 Ma of rifting, loss of lithospheric strength in the Equatorial Atlantic domain results in a significant increase in extensional velocities and a change in extensional direction from 120 Ma onwards. We investigate the impact of this multi-velocity extension history on the spatio-temporal margin evolution and compare our results with conjugate margin cross-sections at representative locations in the South Atlantic. We couple observations on continental extension from global scale plate tectonic models with high resolution, thermo-mechanical models of lithosphere deformation. This approach offers a powerful way of converging to robust regional tectonic models and link plate-scale kinematics to lithospheric deformation modeling and smaller scale tectonics analysis.