Geophysical Research Abstracts
Vol. 14, EGU2012-8332, 2012
EGU General Assembly 2012

Kinematics of the South Atlantic rift

C. Heine (1), S. Brune (2), A. Young (1), J. Zoethout (3), N. Flament (1), and R. D. Müller (1)

(1) EarthByte Group, School of Geosciences, The University of Sydney, Australia (Christian.Heine@sydney.edu.au), (2) Sec. 2.5, Geodynamic Modeling Group, GFZ-Potsdam, Potsdam, Germany , (3) Global Exploration, Statoil, Stavanger, Norway

Extensional deformation along the South Atlantic, Central African and West Africa rift systems heralded in the breakup of the western half of the Gondwana supercontinent. The interplay between a complex series of intraplate rifts profoundly affected the spatio-temporal localisation of extensional deformation and the resulting geometries of the conjugate South Atlantic margins. We present a new plate kinematic model which quantitatively integrates lithosphere deformation and observations from both passive margins and intracontinental rifts in Africa and South America. Our model eliminates the need for previously inferred large offset continental shear zones in southern South America such as the Gastre Fault system while satisfying most observations of the onset of subsidence, deformation and rifting along the conjugate rifted margins and related marginal sedimentary basins.

The model indicates that extension became focussed in the South Atlantic rift basin by the Earliest Cretaceous, continuing at low extensional velocities, predominantly controlled by African intraplate deformation while there was no deformation along the future Equatorial Atlantic. The Patagonian part of South America acted as an independent plate between Antarctica, Africa, and South America during the Latest Jurassic to Aptian times, hereby opening rift basins striking at high angles to the present-day South American margin. By about 125 Ma (Barremian/Aptian) deformation and subsequent weakening along the Equatorial Atlantic rift branch yielded a large increase in extensional velocities and a change in extension direction between South America and Africa, while lithospheric extension had progressed far enough to create the enigmatic sub-salt basins in the central South Atlantic. The change in spreading direction largely eliminated intraplate deformation in Patagonia and subsequently resulted in the onset of post-rift thermal subsidence in the southern South American basins. Rupture of extended continental lithosphere in the central South Atlantic followed a few million years after this major change in kinematics and is likely responsible for the observed first-order present day margin geometry.

We compare our model-derived kinematics against predictions from forward numerical models of lithosphere extension along the conjugate West-African/Brazil and the Equatorial Atlantic margins. We conclude that the multi-velocity, multi-directional rift history can consistently explain the first order margin geometry observed in the South Atlantic. We further couple our plate kinematic model with predictive forward mantle flow models that integrate lithospheric deformation to test the influence of mantle-driven topography on the evolving rift.