Geophysical Research Abstracts,
Vol. 11, EGU2009-7480-1, 2009
EGU General Assembly 2009

Second and third order African Stress Pattern from formal inversion of focal mechanisms data. Implications for rifting dynamics

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The kinematic models and the associated orientation of extensional stress of the East African Rift System have been subjected to much debate since a long time. In the past decades, the proposed models relied on the interpretation of the overall rift geometry, geological fault-slip data and the few focal mechanisms available. These models generally suffer of a poor time control and an underestimation of the possible changes in the stress field and geodynamic regime with time and space. In the recent years, there has been a significant increase in the number of focal mechanisms available for the entire rift system, and it is now possible to estimate the present-day stress field in relative detail based on seismotectonic data alone.

We compile 347 focal mechanism data from the Global/Harvard CMT catalogue and various other sources and grouped 332 of them in 24 distinct regions (boxes) on the basis of their geographical proximity, kinematic homogeneity and tectonic setting. For each box and for the same data set, reduced stress tensors have been obtained by formal stress inversion using both the TENSOR program (Delvaux & Sperner, 2003) and the SLICK method (Michael, 1984/1987). Both inversion methods show in general similar horizontal stress axes orientations and tectonic stress regimes. The first- and second-order stress field could be determined with confidence for the whole East African Rift System and in some regions the data allow to access the third- order stress field.

The obtained stress pattern reflects a complex interaction between 1st order effects as different driving forces, including plate boundary forces, and 2nd and 3rd order effects as gravitational potential of topography, intra-lithospheric processes, and the influence of structural heterogeneities of the rift structures.