Kinematic Constraints On Mantle-Lithosphere Interactions in East Africa

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Rifting of the continental lithosphere is a fundamental process controlling the growth and evolution of continents and the birth of ocean basins. It plays a crucial economical role by controlling the formation of hydrocarbon and thermal resources in rift basins and their successfully rifted counterparts, passive continental margins. Continental rifting involves the entire mantle-lithosphere system through heat transfer and magmatism, and possibly through the mechanical effect of mantle flow on lithospheric deformation. Continental rifts are therefore a prime setting for the study of coupling and exchanges between the deeper and shallower parts of our planet.

Sparse GPS and earthquake skip vector data in the East African Rift (EAR), (Figure 1) coupled with recent tomographic images of sub-lithospheric structures and seismic anisotropy data, suggest that mantle flow, possibly associated with the African Superplume, interacts with the 200-km thick lithospheric keel of the Tanzanian craton, driving lithospheric motions and continental rifting in eastern Africa. We are currently testing this hypothesis by (1) establishing the kinematics of the EAR using GPS measurements at new and existing sites in Tanzania, (2) assessing asthenospheric flow from an inversion of GPS velocities and seismic anisotropy data and from plume-lithosphere interactions models, (3) using the modeled and "estimated" flow as boundary conditions to a three-dimensional finite element model of asthenosphere-lithosphere interactions.

This work addresses some of the fundamental questions of continental plate tectonics: First, are extensional strains broadly distributed or initially localized to narrow zones? Second, do interactions between mantle flow fields and cratonic keels influence the localization and orientation of strain within continental plates?

In addition to these global tectonic issues, our work will answer the following questions specific to East Africa: First, what is the origin of the magma-poor Western rift system? Second, what are the kinematics of linkage between the Western and Eastern rift systems?

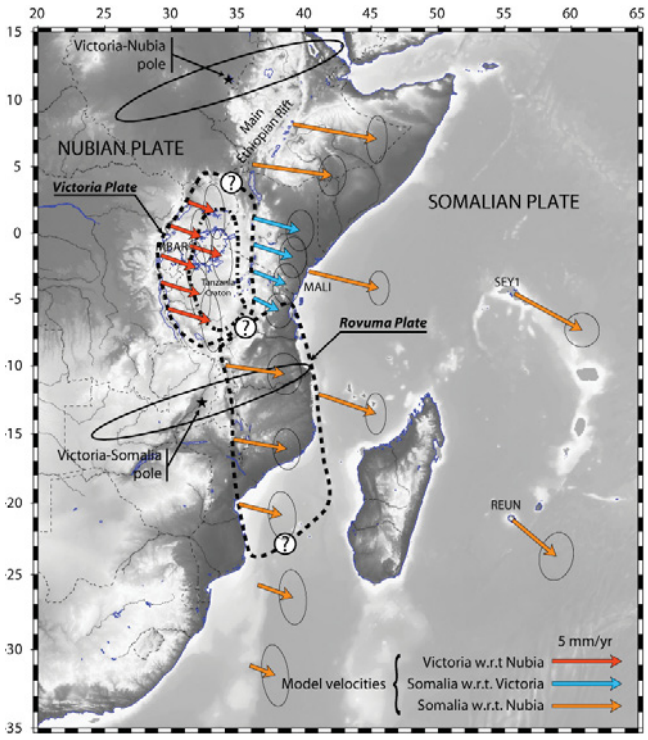

Figure 1. Preliminary inematic model of the East African Rift (EAR). Stars show the Euler pole of the Victoria plate and the associated 1-sigma error ellipse. Arrows show predicted velocities along main branches of the EAR and at GPS sites.

References

Calais, E., C. Hartnady, C. Ebinger, and J.M Nocquet, Kinematics of the East African Rift from GPS and earthquake slip vector data, In: Yirgu, G., Ebinger, C.J. \& Maguire, P.K.H. (eds) Structure and Evolution of the Rift Systems within the Afar volcanic province, Northeast Africa, Geological Society Special Publications, in press, 2006.

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