

Post-rifting relaxation at a subaerial spreading center

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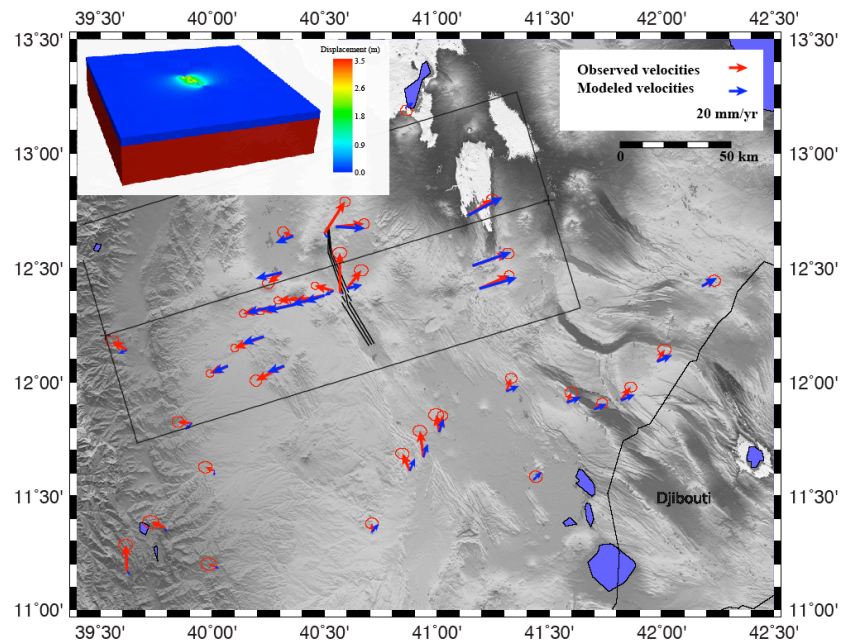
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Most segments of spreading centers are difficult to study since they are deep under water. Iceland and the Afar are the two places on earth where spreading centers are subaerial. In September of 2005 a sequence of hundreds moderate-sized earthquakes in Afar was detected at Addis Ababa, Ethiopia. This marked the first major subaerial spreading center dike intrusion event of the space geodetic era. InSAR data indicated that the dike opened $\sim 6\text{m}$ along a 60 km long line (Wright et al, 2006). Also, several meters of normal fault offset deepened a graben along the trace of the dike.

The uniqueness of this event has sparked major observational effort that includes deployments of seismometers and continuous GPS receivers. Since the first large event at least 8 more dike intrusion/propagation events have been detected. Results from GPS surveys indicate that the current horizontal surface motions greatly exceed the secular divergence rate of $\sim 1.7\text{ cm/yr}$.

The modeling of the viscoelastic deformation driven by the opening of dikes within the Dabbahu Segment of the Afar is being done jointly between Lamont-Doherty Earth Observatory and the Purdue University. At Lamont we have used *PyLith* to construct a 3D finite element model of the region to model viscoelastic relaxation of the crust following the on-going diking events. Our model consists of an elastic layer over a Newtonian viscoelastic layer with an embedded dike made up of five finite length segments. The dike geometry and opening distributions were determined from InSAR by Wright et al. (2006). We varied both the thickness of the elastic layer and the viscosity of the of the viscoelastic layer to obtain the best fit to the observed surface deformation from GPS. Our best model has a 17 km thick elastic layer underlain by a viscoelastic layer with viscosity of $4 \times 10^{18}\text{ Pas}$. The results of this work were presented at the AGU meeting in December, 2008 (Bennati et al., 2008) and we have a paper in preparation (Nooner et al., in prep). Without the help of Charles Williams, one of the developers of *PyLith*, our work would have been far more time consuming.

Figure Caption *Insert shows model geometry of a 3D block with an elastic layer (blue) overlaying a visco-elastic lithosphere (red). Surface displacements (m) for the best fitting model to the September 2005 dike are shown on the surface expression of the mesh used to build the model. Map comparing model results and GPS observations.*



References:

- (1) Bennati, L., Calais, E., Wright, T., Hamling, I., Lewi, E., Nooner, S., Buck, R., and Ebinger, C. (2008), *Eos Trans. AGU*, 89 Fall Meet. Suppl., Abstract T43A-1981.
- (2) Nooner, S. L., Bennati, L., Calais, E., Wright, T., Hamling, I., Buck, R., and Ebinger, C. (in prep).
- (3) Wright, T. J., C. Ebinger, J. Biggs, A. Ayele, G. Yirgu, D. Keir, and A. Stork (2006), *Nature*, 442, 291-294.