Emplacement of regularly spaced volcanic centers in the East African Rift: Melt production or melt extraction?

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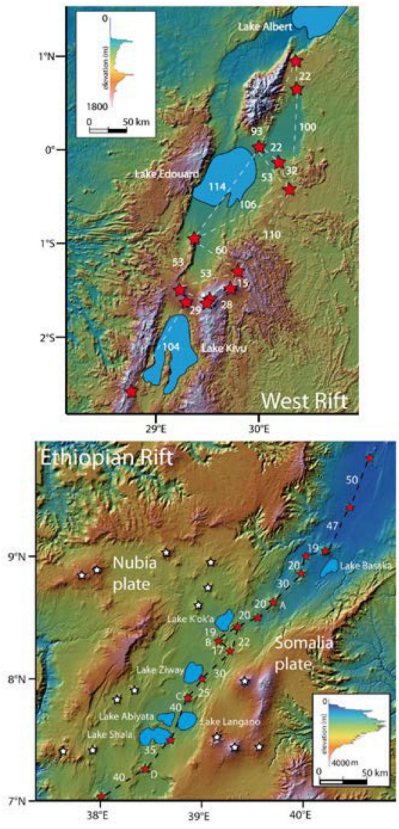

Figure 1. The active volcanoes during the last 10 ka of the West and Ethiopian Rift axis. The red and white stars indicate axial and off-axis volcanoes, respectively. The white number indicates the spacing between volcanoes.

PROJECT GOAL: This project will use coupled laboratory and numerical experiments to quantitatively assess the contribution of both melt production and melt extraction processes on the distribution of volcanic activity along the three main branches of the actively spreading East African Rift System.

As continental rifts evolve, volcanic centers within rift valleys often develop a characteristic spacing, or wavelength, such as observed in the Red Sea Rift and within the Afar depression, the Main Ethiopian Rift (MER), and the Kenya (Gregory) Rift of the East African Rift System (EARS) (Fig. 1). The surprisingly regular spacing of the volcanic centers within the EARS is attributed to lithosphere thickness, pre-existing fault systems, and mantle processes. However, little quantitative assessment of these hypotheses has been undertaken and few studies attempt to include the visco-elastic-plastic rheology of the lithosphere. The primary goal of this work is to use data from coupled numerical and laboratory experiments along with observations from the East African Rift System (EARS) to quantitatively assess the contribution of both melt production and melt extraction processes on the distribution of volcanic activity along the three main branches of the actively spreading EARS. We will perform two groups of coupled laboratory and numerical experiments; the first will simulate Rayleigh-Taylor type instabilities within the partially molten mantle (melt production), and the second will simulate the importance of pre-existing fractures and volcano loading on surface volcanism (melt extraction). Numerically, we will use a 3D marker-in-cell, finite difference code to initially match the laboratory experiments and then expand the parameter range beyond that possible in the laboratory. Both sets of experiments will vary rift opening rate, lithospheric thickness, pre-exiting fractures, and volcanic loading. Finally, we will develop predictive scaling laws that relate volcano spacing and volume to the above parameters. These scaling laws will permit the use of surface observations to estimate the relative importance of melt production below the lithosphere versus melt extraction through the lithosphere in both the EARS and other continental rifts.

CURRENT PROGRESS: This project was funded a few months ago and work has just recently began. Currently, we are determining appropriate fluids and testing laboratory experimental set-ups. Initial experiments with a mixture of Ludox and salted water (forming a gel) show great promise. Initial numerical simulations are scheduled to begin in the Fall of this year.