Geophysical Research Abstracts
Vol. 13, EGU2011-5818-1, 2011
EGU General Assembly 2011

Interplay between tectonics and magmatism during the last stages of continental breakup: the Dabbahu rift segment, Afar, Ethiopia.

Sarah Medynski (1), Raphaël Pik (1), Charlotte Vye (2), and Peter Burnard (1)

(1) Centre de Recherches Pétrographique et Géochimique, Noble Gaz, Nancy, France (medynski@crpg.cnrs-nancy.fr), (2) British Geological Survey

Good geochronology of young volcanism and fault activity is essential in order to understand the interactions between magmatism and tectonics during the last stages of continental breakup. The Dabbahu rift segment in Afar (Ethiopia), a very active rift segment surrounded by two differentiated off-axis volcanoes, (Dabbahu and Baddi volcanoes) represents an ideal natural laboratory to study the evolution of the rift morphology during dike injection. Segmentation in rift settings can be created either by faulting or magmatism (combined dyke injection and volcanism). Both mechanisms result in creation of topography and in a continuous magma supply to the rift segment. Our approach allows us to constrain several key issues central to development of segmentation such as:
- the timing of fault growth relative to the creation of rift topography and the timing of its' infilling by lava flows;
- the influence of a volcanic edifice on rift development;
- the time scales of lava differentiation and whether single or multiple sources are implied;
- the supply rate of the magma or magmas which produced the lavas.
Our study provides time constraints on tectonic and volcanic events in the Quaternary evolution of the Dabbahu segment in order to address the above uncertainties.

The Dabbahu rift is currently experiencing an intense magmatic event which started in autumn 20051 with a small eruption on the flank of the Dabbahu volcano, associated with significant seismicity. This has been interpreted as the emplacement of a megadyke followed by 12 subsequent dyke intrusions. Advances in remote sensing techniques allow for accurate surveying of the magmatic and tectonic interplay during this event. However, there is a lack of data on time scales of 1 to 100 kyr, the period over which the main morphology of a rift is acquired. We use cosmogenic nuclides (3He) in order to determine the ages of young (<100 kyr) lava flows and to date the initiation and movement of fault scarps which cut the lavas. We have also determined major and trace element compositions and have mapped a portion of the segment using remote sensing data (Landsat, Spot & ASTER) which allow the geomorphology to be linked to the magmatic and tectonic activity dated by cosmogenic isotopes.

The results show that there is an old rift floor outcropping in the northern part of the depression, dated at 75 kyr and older. The depression is filled mainly by massive aa flows issued from Dabbahu which defines the northern extent of the segment, whereas the youngest sampled lava flow (<2 kyr) was clearly issued from the mid-rift axis and shows a trace element different signature, which may indicate a different magma source. The Dabbahu lavas were emplaced between 40 to 20 kyr, and follow a single, continuous differentiation trend through time. Their emplacement is partially controlled by a limited pre-existing topography (built by fault-scarps) and then shifted by new or reactivated fault which gives a relative chronology for the fault activity, confirmed by cosmogenic exposure dating. It appears that the main scarps were formed coevally with the filling of the depression by Dabbahu lavas.

The topography moreover is significantly higher in the northern extend than in the mid-axis segment of the rift. The presence of the shield volcano appears therefore to be a major controlling factor on the evolution of the rift topography and in the magma supply: either because the Dabbahu was more active between 40 to 20 kyr than the Southern axial part of the segment; or either because the volcano injected more differentiated and viscous magma in dykes, inducing a different topography response compared to the rift axis - which is continuously supplied with basic magmas.

1 Wright, T., Ebinger, C., Biggs, J., Ayele, A., Yirgu, G., Keir, D., Stork, A., Magma-maintained rift segmentation at continental rupture une the 2005 Afar dyking episode. Nature, 2006. 442: p. 291-294.