Geophysical Research Abstracts
Vol. 13, EGU2011-558-2, 2011
EGU General Assembly 2011

Magmatic History and Rift Initiation in the North Tanzanian Divergence Zone, East African Rift System

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The North Tanzanian Divergence (NTD) is part of one of Earth's few currently active intra-continental rift systems, representing the southern sector of the eastern branch of the East African Rift. The NTD depicts a complex tectono-magmatic evolution of a rift in its early stage of activity. The oldest magmatism in the NTD is the centrally located Essimingor volcano. We have produced 12 new $^{40}Ar/^{39}Ar$ ages, 26 major and trace element analyses, and several radiogenic isotopic signatures (Sr-Nd-Pb) on accurately located lava samples representing the observable variation in lithology and stratigraphy from the S and SW slopes of the Essimingor volcano.

Laser-incremental heating $^{40}Ar/^{39}Ar$ analyses of whole rock, matrix and nepheline separates from our Essimingor samples yield plateau ages that range from 5.76 ± 0.02 Ma to 5.91 ± 0.01 Ma, and suggested duration of about 150 kyr. Our $^{40}Ar/^{39}Ar$ ages are roughly 2 myr younger than K-Ar ages of ~ 8 Ma previously reported by Bagdasaryan *et al.* (1973). It is unclear if this difference in age is due to limitations of the K-Ar method or if the K-Ar ages were obtained from flows unsampled by our team. The location from which the Bagdasaryan samples were collected is unknown and therefore not re-testable. However, nepheline separates from some of our dated samples give anomalous integrated (K-Ar equivalent) ages as old as 16 Ma. We interpret these old ages as possible excess or trapped Ar in nepheline. Incorporation of anomalously old nepheline in the whole rock samples of Bagdasaryan *et al.* could explain their older ages. None-the-less, our $^{40}Ar/^{39}Ar$ ages continue to support Essimingor as the oldest NTD volcano.

Major element data obtained on our Essimingor samples define narrow compositional variations consistent with fractional crystallization. Open system processes of mixing or contamination are inferred from the observed increase in Sr isotopic values with indices of fractionation. Ce/Pb values present a large range of variation (59 to 7), the lower end of which imply crustal assimilation overprinting the mantle signature. The wide variation in trace element and radiogenic isotope ratios of the more primitive samples suggest mixing between a HIMU-like mantle source domain and an enriched component. The trace elements of the lavas with MgO > 9 wt% indicate a low degree of partial melting of a metasomatised lithospheric mantle that includes garnet, phlogopite, amphibole and apatite.

The Essimingor study is part of an ongoing program focused on providing detailed geochemical and geochronological data for key northern Tanzanian volcanoes (Mollel *et al.*, 2008, 2009, *in press*, and work in progress). Our work so far on NTD volcanoes in the Ngorongoro volcanic highland allow us to distinguish two magma series based on separate sub-parallel fractionation arrays on the TAS diagram: a tephrite to phonolite magma series and a basalt to trachyte magma series. These magma series can be ascribed to either different sources or a different degree of melting of the same source. Interestingly, while the tephrite to phonolite magma series occurs during the whole evolution of the rifting, the basalt to trachyte magma series seems to be temporarily restricted between 2.4 and 1.6 Ma right before the rifting event dated by MacIntyre *et al.* (1974) at 1.2 Ma. Further investigation of other volcanic centers and better understanding of the isotopic variations is needed to provide a more complete magmatic history of the NTD.