Temporal change in geochemistry of volcanic rocks in northern Kenya Rift: Insights from $^{40}Ar/^{39}Ar$ geochronology at Paka

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Kenya rift is known as one of the most tectonically active on shore rift due to the analysis of the morphology of the fresh Quaternary caldera volcanoes. In the northern Kenya rift, six volcanic centers locate, erupt basalts and trachytes and form the trachytic shield volcanoes.
One of those volcanic centers, Paka, was investigated by systematic $^{40}Ar/^{39}Ar$ dating of 32 latest fresh volcanics from lava flows and was found that the eruptive activities range continuously from 0.58 Ma to 0.012 Ma. Three relatively pronounced eruptive periods were found as around 0.4 Ma, 0.15 Ma and younger than 0.05 Ma by relative frequency of eruption events. The division of whole Paka eruptive events to three episodes of 0.6-0.35 Ma (I), 0.35-0.1 Ma (II) and 0.1-0 Ma (III) based on the pronounced periods clearly shows that the spatial change of eruptive locations gradually converge to NNE-SSW direction, which is similar to that of the Kenya Rift.
Combination of obtained ages with C.I.P.W. norm mineral calculation of all rocks brought the different figures of the volcanic history of Paka, previously deduced in the report of the geological survey of northern Kenya Rift by Dunkley et al. (1993). The volcanic activity started at 0.58 Ma by the eruption of the nepheline-normative basalt (Lower Basalt), meanwhile hyperthene-normative basalts erupted together with nepheline-normative basalts only in the period from 0.3 to 0.1 Ma, which is the intermediate period of the whole trachytic activities lasted since 0.43 Ma to 0.01 Ma (Fig.).
Dunkley et al. (1993) and our whole-rock geochemical data show that the hyperthene-normative basalts cover the surface more widely around Paka than the nepheline-normative basalts and that the nepheline-normative basalts distribute only at Paka. Additionally, Dunkley et al. (1993) suggested that Paka sits on the hyperthene-normative basaltic lava flows and also that the youngest hyperthene-normative basalts (Young Basalt) erupted as the upper units than Paka and distribute among volcanic centers of Paka, Silali and Korosi. However, the obtained ages did not support this age-model. Instead the hyperthene-normative basalts actually erupted only in the middle period during the formation of Paka and the oldest eruption at Paka was the nepheline-normative basalt.
Nevertheless, this new order of the eruptions could rather more easily be explained as the following simple model for a magma-plumbing system by the high-pressure experimental petrology; a single hot mantle-diapir uprised beneath Paka firstly separates smaller amounts of nepheline-normative basaltic magmas under higher pressures and causes their eruptions, then at the shallower depth separates more voluminous hyperthene-normative basaltic magmas by the higher degree of melting and causes their eruptions.
Furthermore, it is also observed that the incompatible elemental ratios of Nb/Zr in the rocks gradually decrease along the above three episodes. This is also consistent with the model of the single hot mantle-diapir beneath Paka and its repeated segregation of basaltic magmas, because the Nb/Zr ratios in those basaltic magmas separated by the fractional melting decrease due to the slightly higher partitioning coefficient of Zr against mantle minerals and are maintained in the differentiated trachytic magmas.
From these discussions, we conclude that the volcanic activities at Paka could rather simply be explained by the single mantle-diapir model. Although the flood basalts and trachytic shield volcanoes in northern Kenys Rift are often considered as the separate products, our results imply that those magmas could be derived from the identical magma plumbing system and erupt as the products from the identical volcano

in some cases. We also propose the new volcanic stratigraphy at Paka by our $^{40}A/^{39}Ar$ ages.

Reference: Dunkley P. M., M. Smith, D. J. Allen and W. G. Darling (1993): International Series, Research Report SC/93/1, 185pp, British Geological Survey

Keywords: Kenya Rift, Ar/Ar dating, Quaternary volcano, basalt, trachyte, whole-rock chemistry

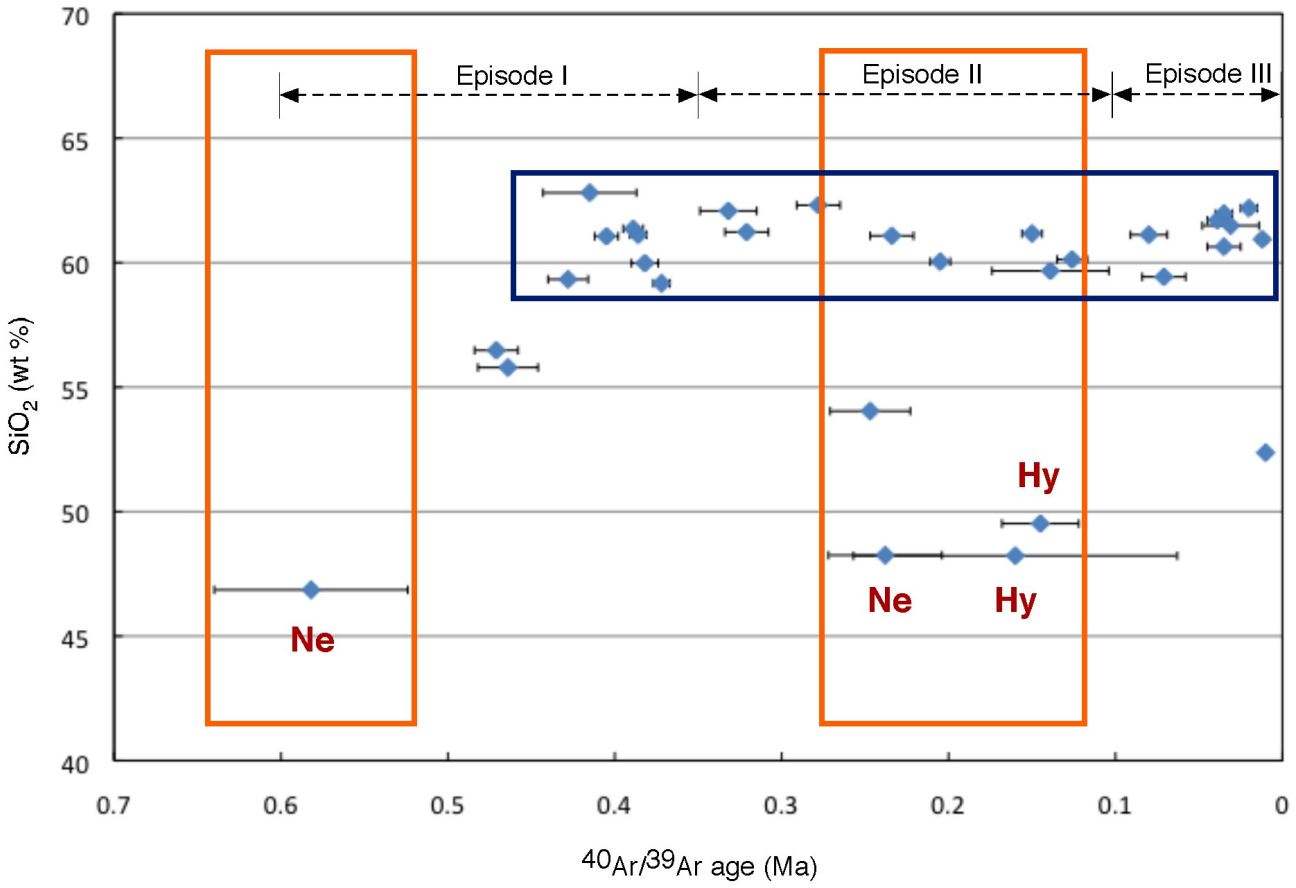

Fig. Plot of SiO_2 contents against $^{40}Ar/^{39}Ar$ ages of volcanic rocks from Paka. Ne; nepheline-normative basalts, Hy; hyperthene-normative basalts.

