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Clinopyroxene-host disequilibrium (Sr-Nd-Pb isotope systematics) in ultra-potassic magmas from East-African Rift: Implications for magma mixing and source heterogeneity

Natalya Muravyeva (1), Boris Belyatsky (2), and Valeriy Senin (1)

(1) Vernadsky Institute of Geochemistry and Analytical Chemistry RAS, Moscow, Russian Federation (nmur@mail.ru), (2) VNIIOkeangeologia, Antarctic Geology, St.Petersburg, Russian Federation (bbelyatsky@hotmail.ru)

Nd, Pb and Sr isotope ratios have been determined for kamafugite lava and clinopyroxene and phlogopite phenocrysts from Toro-Ankole and Virunga volcanic fields of the East African Rift. The whole rock Sr – Nd isotopic signatures of kamafugites (87Sr/86Sr: 0.70463 – 0.70536; 143Nd/144Nd: 0.51249 – 0.51255) suggest derivation from an EM1-type mantle source. In contrast, Pb isotopic compositions of the same samples (206Pb/204Pb: 19.00 – 19.57; 207Pb/204Pb: 15.69 – 15.74; 208Pb/204Pb: 39.30 – 40.26) reveal a similarity to EM2-type mantle. New Nd, Pb and Sr isotopic data for clinopyroxene (87Sr/86Sr: 0.70473 – 0.70503; 143Nd/144Nd: 0.51250 – 0.51254; 206Pb/204Pb: 18.04 – 18.17; 207Pb/204Pb: 15.58 – 15.60; 208Pb/204Pb: 38.09 – 38.23) suggest derivation from an EM1-like source, and indicate Sr and Pb isotope disequilibrium between clinopyroxene and corresponding host rock. Moreover, clinopyroxenes demonstrating a greater degree of isotopic disequilibrium with their host rock are more sodic in composition. The isotopic disequilibrium is corroborated by the presence of chemical zoning within clinopyroxene, which suggests rapid magma ascent rates preventing melt homogenization.

The Pb isotopic ratios for both mineral and corresponding whole rock, together with published data on East African rift-related alkaline centers, define a trend interpreted to represent a mixing line for melts derived from sources such as EM1 and as HIMU. The similar isotopic compositions for clinopyroxene from the different volcanic rocks within the East African Rift suggest the existence of a common, older mantle source for their parental melts. The origin of these melts can be attributed to an enrichment event $\sim$ 400-500 Ma, i.e. significantly prior the younger (Quaternary) ultrapotassic magmatism. Our preferred interpretation for the results reported here involves the mixing of the melts derived from EM1- and HIMU-like sources, which were rapidly transported to the Earth's surface. The primary magmas formed as the result of melting of a heterogeneous (on kilometer scale) mantle source consisting of peridotite and pyroxenite.