Petrogenesis of nephelinites at early stage of East African rift (Manyara basin, North Tanzania)

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The North Tanzanian rift is the southern area of the east part of the East African Rift. Manyara basin is the south part of North Tanzanian rift and represents early stage rifting. The Manyara basin has different type of lavas with Mg-nephelinites (Labait and Kwaraha) and evolved Mg-poor nephelinites. In this study, we used geochemical signature of Mg-nephelinite lavas in order to constrain the composition of the mantle source and deep magmas/fluids that percolate into the lithosphere beneath Manyara basin.

Mg-nephelinites from Labait and Kwaraha are mafic alkaline magmas (35.4-40.7 wt% SiO_2, Na_2O+K_2O=2.5-5.6 wt%) with Mg# ranging from 76-79 to 58-67, respectively, and variable CaO content (7.8-10.9 and 12.9-15.6 wt % CaO, respectively). Mg-nephelinites are olivine-rich and cpx-rich primary magmas (+/- phlogopite). The water content in the melt in equilibrium with olivine and cpx (1-4 ppm H_2O, FTIR) corresponds to 0.1-0.4 wt% H_2O. Trace element concentrations of lavas have negative anomaly in K and Zr-Hf, high Rb/Sr ratio (up to 0.05), and variable LREE/HREE fractionation (La/Yb=69-72 and 46-62; Ce/Y=8.4-8.7 and 6.1-7.6, respectively).

Geochemical modelling indicates that primary magmas result from a low degree of partial melting (0.2-1%) of carbonate-rich (0.3-0.5%) garnet peridotite with phlogopite (~2%). The occurrence of mantle xenoliths in Labait nephelinites with equilibrium conditions at 100-150 km (3.2-4.9 GPa), suggests that partial melting of nephelinite occurred at ≥150 km. The depth of partial melting for Kwaraha magma estimated from major element compositions (SiO_2 and MgO) was ~ 120 km (4 GPa) corresponding to the lithosphere-asthenosphere boundary. Asthenospheric CO_2-rich and H_2O-poor magmas percolation generate fluid-rock interaction and metasomatism of the lithospheric mantle.