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Melt/rock interaction in sub-continental lithospheric mantle (Tanzanian Craton)

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The North Tanzanian Divergence (NTD) corresponds to the early stage rifting of the eastern branch of the East African Rift. Quaternary volcanoes of the Natron-Manyara-Balangida rift have erupted primary melilitite and nephelinite with numerous metasomatized mantle xenoliths.

The geochemical modelling indicates that CO_2-rich melilitite magmas resulted from deep and low partial melting of a carbonate-rich (0.3–0.5%) garnet peridotite containing ~2 vol% phlogopite. The depth of partial melting is estimated close to or below the lithosphere-asthenosphere boundary (>130 km). Hydrous mineral such as phlogopite is ubiquitous in asthenospheric mantle source, primary magma as liquidus phase, and metasomatized continental lithosphere. Lithospheric mantle phlogopites have high Al_2O_3 and MgO content (12.7-15 wt.% Al_2O_3, Mg#=83-93) and high water and Cl content (2.6-5.3 wt% H_2O, 100-200 ppm Cl), with major element composition close to magmatic phlogopites. They have very low incompatible element contents compared to phlogopite in melilitite and differs significantly from phlogopite in phlogopite-rich PIC and MARID xenoliths as deep-seated segregations from melts genetically linked to kimberlitic magmas. The veins in peridotites are calc-potassic, FeO and TiO_2-rich. The mineral equilibria of olivine and pyroxenes indicate that fluid/melt-rock interactions occurred at depth from 40 km to 90 km. Percolation of deep asthenospheric CO_2-H_2O-alkaline magmas during ascent may have produced the strong heterogeneities in the thick sub-continental lithospheric mantle beaneath the East part of the Tanzanian craton by inducing metasomatism and phlogopite crystallization in spinel lherzolite and phlogopitite lithologies. Using EBSD analyses and AnisEulerSC program, we computed the seismic properties of the mantle xenolith. A comparison with seismic velocities allows to discuss the current state of the lithospheric mantle. The best agreement obtained between P teleseismic tomography (Vp anomalies between -9% and -15%) and vein-bearing peridotites (depth 40-90 km) corresponds to 14-25% of crystallized veins or 7-14% for fluid filled-veins for a vertical foliation and transtensional strain regime in the mantle lithosphere beneath the southern part of the East-African rift.