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Geochemical and petrophysical characterization of mantle metasomatism beneath the North Tanzanian Divergence, East African rift.

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The North Tanzanian Divergence (NTD) is the prolongation of the eastern branch of the East African Rift and is a place of intense volcanism. Numerous volcanoes erupted deep subalkaline to highly alkaline magmas, including the particular active natrocarbonatite Oldoinyo Lengai. On the North-South axis (Natron to Manyara basins), three highly alkaline volcanoes, Pello Hills, Lashaine and Labait, erupted melilite magmas that originated from low degree of partial melting of asthenospheric mantle (depth > 120 km). The particularity of these volcanoes is that they sampled numerous mantle xenoliths during ascent. This represents a unique opportunity to study the composition and the rheology of lithospheric mantle. Mantle xenoliths are deep garnet-bearing peridotites (120 km depth), amphibole and phlogopite peridotites and phlogopitites. They contain abundant hydrous minerals as isolated crystals or veins that attest to an important metasomatism beneath the NTD. Previous geochemical and petrological studies have highlighted interactions of alkaline magmas and the thick cratonic lithosphere as metasomatic agent. However, the presence and composition of magmas, the degree of metasomatism, and the role of metasomatism on mantle rheology below the NTD is still debated.

To characterize these previous parameters, in this study we performed geochemical and petrophysical analyses on metasomatized, fertile and refractory mantle xenoliths from Labait (on-craton volcano) and Pello Hills (in-rift volcano). Using mineral compositions and thermobarometer calibrations, we estimated the depth of mantle xenoliths between 40 and 140 km (14 to 47 kbar) and temperatures from 930 to 1340°C. EBSD analysis on thin sections indicate that peridotites and amphibole/phlogopite-bearing mantle xenoliths display a moderate to strong deformation induced crystal preferred orientation. In contrast, weak mineral orientations have been observed in phlogopite-amphibole-clinopyroxene-bearing veins. Calculation of seismic properties using MTEX program show that peridotites are seismically anisotropic, up to 12.4% for P-wave velocity (Vp) and 6.8% for S-wave velocity (Vs). The Vp and Vs in hydrous veins are lower than in peridotites (Vp: 7.5-7.9 and 8.3-9.6 km/s; Vs: 4.4-4.6 and 5.0-5.3 km/s respectively) and therefore the Vp and Vs velocities decrease with the increasing proportion of metasomatic minerals. We estimate that a

peridotite with 20 vol.% metasomatic vein has a velocity decrease of 3.5% for Vp and 2.9% for Vs, compared to a fertile peridotite.

These geochemical and petrophysical approaches are important to understand P- and S-wave propagation in the lithospheric mantle beneath the NTD and more specifically in metasomatized lithospheric mantle. The new in situ data and models from mantle xenoliths will be compared to tomographic acquisition and discussed in term of temperature, presence of melt or metasomatism processes. Both petrophysical and geophysical data will help to precisely determine the structure and rheology of the lithospheric mantle, which may control the propagation of the rift at early stage rifting between the Tanzanian craton and the mobile Proterozoic belts.