EGU22-7462
https://doi.org/10.5194/egusphere-egu22-7462
EGU General Assembly 2022

Seismological and petrophysical properties of the lithospheric mantle in a nascent rift

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The North Tanzanian Divergence (NTD) is a rift initiation zone situated at the southern tip of the Eastern Branch of the East African Rift. This zone is a unique continental open-air laboratory to study the beginning of the continental break-up. The rift surface expression results from the interaction between tectonic and magmatic processes. However, the role of each process on the observed surface activity is still debated, as their respective signal is difficult to differentiate. In order to consider the various factors that may interact in this complex zone, a multi-disciplinary study was carried out, combining seismological and petrophysical approaches.

First, our recent development of a new hybrid tomographic method for both P and S-body waves permitted to image at depth the main suture zones between the inherited structures (Archean craton and Proterozoic orogenic belts) and the mantle plume extension (Clutier *et al.* 2021). We also inferred zones of fluid (melt or gas) presence from the Vp/Vs ratio maps deduced from these P and S independent inversions. Then, to quantify the proportion of fluid from the tomographic images, we carried out a petrophysical study on mantle xenoliths from the Pello Hills volcano, situated in the rift axis. The clinopyroxene-amphibole-phlogopite vein-bearing xenoliths allowed to compute, at a sample scale, the seismic properties of the mantle with and without crystallised or fluid-filled veins. By varying the composition and increasing the proportion veins in the samples, the P and S-wave maximum velocities can decrease from 9.2 down to 5.3 km/s and from 5.1 down to 3.1 km/s, respectively. Those velocity models point out anisotropy in the mantle below the NTD, and particularly in highly metasomatized zones. Finally, despite the difference in spatial and temporal scales between the petrological and geophysical studies, we managed to combine the tomographic velocity anomalies and the xenolith's seismic properties to infer a maximum volume of fluid in the lithospheric mantle below Pello Hills volcano. This volume may be intermediate between 20% of clinopyroxene-phlogopite-amphibole crystallised vein and 10% melt/fluid-filled vein.