Combining petrology, noble gas geochemistry and CO_2 abundance to constrain the mantle features recorded in ultramafic mantle xenoliths from La Grille volcano (Grande Comore Island, Indian Ocean)

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Petrology and fluid inclusions (FI) geochemistry are increasingly used in tandem to constrain the compositional evolution of the lithospheric mantle. Here, we combine petrography and mineral chemistry with the first analyses of noble gases (He, Ne and Ar) and CO_2 concentrations in olivine-, opx- and cpx-hosted FI from ultramafic xenoliths collected at La Grille volcano in Grande Comore Island, in the attempt to characterize one of the most controversial portions of the western Indian Ocean lithospheric mantle. Xenoliths have been divided in three groups on the basis of their textural features: Group 1 (Opx-bearing), characterized by protogranular to porphyroclastic texture overprinted by metasomatic reactions; Group 2 (Opx-free), with ad-cumulitic, infiltrated characteristics, and Group 3 (Cumulate), showing ortho-cumulitic texture. Petrography and mineral chemistry indicate that the sampled lithospheric portion experienced variable degrees of melting (from 5% to 35%), recorded by Group 1 harzburgites and lherzolites, as well as metasomatic processes as evidenced by the severe recrystallization of cpx at the expenses of opx in Group 1 lherzolites and wehrlite and by Group 2 xenoliths. Crystallization of oversaturated basic silicate melts seems also to have occurred, as shown by Group 3 xenolith. The variability of the He/Ar ratio (0.005-0.42), below typical values of a fertile mantle (He/Ar =

1-5), can be explained by variable degrees of partial melting coupled to metasomatism enrichment that may account for increasing He/Ar, as also indicated by the mineral composition. He-Ar-CO_2 relationships support the presence of a metasomatic process post-dating the melt extraction as suggested by Coltorti et al. (1999). The $^{3}He/^{4}He$ isotopic signature (6.30 to 7.36 Ra) are intermediate between the lower limit of MORB mantle signature (8±1Ra) and the higher values of SCLM (6.1±0.9Ra). The Ne and Ar isotopic signatures are consistent with a mixing between an air-derived and a MORB-like component, supporting the hypothesis for a lithospheric origin of the Comoros magmas. This is also corroborated by combining Ne with He isotopes, showing that La Grille ultramafic xenoliths are far from the typical plume-type compositions.

Coltorti M., Bonadiman C., Hinton R. W., Siena F. and Upton B. 1999. Carbonatite metasomatism of the oceanic upper mantle: evidence from clinopyroxenes and glasses in ultramafic xenoliths of Grande Comore, Indian Ocean. J Petrol 40, 133-165.