Geochemistry of noble gases and radiogenic isotopes of ultramafic mantle xenoliths from La Grille volcano (Grand Comore Island, Indian Ocean)

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Grand Comore is the youngest island of the Comoros volcanic chain and it is composed of two alkali shield volcanoes, Karthala and La Grille. Karthala is one of the most active volcanoes of the Indian Ocean (together with Piton de la Fournaise at La Reunion Island) with last volcanic activity recorded in January 2007, while there are no available historic eruptions from La Grille. However, contrary to those of Karthala, La Grille lavas often enclose xenolithic nodules of ultramafic rocks resulting from phreatomagmatic maar-like eruptions. Here we report the first ever analyses of light noble gases (He, Ne and Ar) in fluid inclusions coupled with radiogenic isotopes (Sr, Nd and Pb) of olivine, clinopyroxene and orthopyroxene (hereafter Ol, Cpx and Opx) mineral separates from ultramafic peridotite xenoliths collected at La Grille volcano during 2017-2018 field campaigns with the aim of constraining the mantle source beneath Grand Comore Island. Xenoliths are lherzolites, harzburgites, dunites and wehrlites with a protogranular to porphyroclastic texture, overprinted by Type A, B and C metasomatic reactions (Coltorti et al. 1999). Previous investigations of Grand Comore lithotypes were focused on bulk samples and mineral separates from lavas (i.e., Class et al. 1998; Class et al. 2005), while major and trace element data from clinopyroxenes and glasses from La Grille mantle xenoliths were reported in the literature by Coltorti et al. (1999). The 3He/4He isotopic signature in fluid inclusions (up to 7.3Ra) in Ol, Cpx and Opx is in good agreement with that from Class et al. (2005) and falls in a range that overlaps the SCLM (Sub Continental Lithospheric Mantle) and the MORB mantle signature. These values are systematically higher than those measured on gases from crater fumaroles (Istituto Nazionale di Geofisica e Vulcanologia and Institute de Physique du Globe de Paris dataset) and fluid inclusions in olivine phenocrysts from Karthala lavas (Class et al. 2005), indicating that Karthala volcano is still degassing volatiles with a He isotopic signature similar to those in volcanic products of the last eruption. The 20Ne/22Ne, 21Ne/22Ne and 40Ar/36Ar isotope ratios in fluid inclusions are indistinguishable from those of volatiles in typical MORB-type
reservoirs. Sr-Nd-Pb systematics in Opx and Cpx from La Grille xenoliths displays higher variability than La Grille bulk lavas (Class and Goldstein 1997; Class et al. 1998). Sr-Nd isotopic ratios of these mantle minerals fall along a mixing line between Depleted MORB and Enriched Mantle reservoirs, but for two samples whose higher Sr isotope signatures point towards an EM2 source. They show isotopic similarities with carbonatite rocks from the East African Rift System and central-northern Madagascar Cenozoic alkaline rocks. These results contribute to highlight the geochemical features of Gran Comore volcanic system (La Grille-Karthala) and its relationships with the underlying mantle, providing useful tools for future geochemical monitoring of an active, dangerous and very poorly explored natural system.

References
Coltorti et al. (1999) – J. Petr., vol. 40
Class & Goldstein (1997) – EPSL 150
Class et al. (1998) - J. Petr., vol. 39
Class et al. (2005) – EPSL 233