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First assessment of the noble gas and CO2 isotopic composition of fluid inclusions hosted in mantle xenoliths from El Hierro (Canary Islands)

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Studying the isotopic composition of fluids trapped in mantle xenoliths opens avenues to understanding the origin and cycling of volatiles in the Earth's upper mantle. Here, we present the first isotopic results for noble gases and CO_2 in fluid inclusions (FI) trapped in mantle xenoliths from El Hierro the youngest island of the Canarian archipelago. Our results are based on 6 mantle xenolith samples (3 Spinel-lherzolites and 3 Spinel-harzburgites) collected from the El Julan cliff valley (Oglialoro et al., 2017), from which we hand-picked crystals of Ol, Opx, and Cpx. Isotopic determinations were performed at the INGV (Sezione di Palermo) noble gas and stable isotopes laboratories, following the preparation methods and analytical procedures described in Rizzo et al. (2018 and references therein).

The Ne-Ar isotopic compositions reveal the presence of an atmospheric component in the FI. Most of the samples exhibit $^{4}He/^{20}Ne$ ratios > 60, $^{20}Ne/^{22}Ne$ ratios between 9.84 and 10.49, $^{21}Ne/^{22}Ne$ ratios from 0.0295 to 0.0330, and $^{40}Ar/^{36}Ar$ > 800, suggesting mixing between MORB-like mantle fluids and an air-derived component. We argue this latter may (at least in part) derive from upper mantle recycling of atmospheric fluids via paleo-subduction event(s). Excluding samples possibly affected by diffusive fractionation processes, the average Rc/Ra ratio ($^{3}He/^{4}He$ ratio corrected for atmospheric contamination) measured in El Hierro xenoliths is ~7.45 + 0.26 Ra, within the MORB range (8 + 1 Ra; Graham, 2002). The He homogeneous signature of these xenoliths agrees well with the $^{3}He/^{4}He$ compositions previously reported in lava phenocrysts and cumulates (Day and Hilton, 2011) and is slightly below the maximum ratios measured in groundwater samples during the 2012 volcanic unrest (~8.2 Ra; Padron et al., 2013). All these pieces of evidence argue against a primordial source involved in the local lithospheric mantle. Putting these data in the context of previous literature results for FI and surface gases in the Canary Islands (La Palma, La Gomera, Tenerife, Gran Canaria, and Lanzarote), we identify an eastward $^{3}He/^{4}He$ decreasing trend that

parallels a corresponding increase of the oceanic crust thickness. In addition to the mantle heterogeneity, we propose that part of the $^3He/^4He$ east-to-west variation along the archipelago is caused by the variable thickness of the oceanic crust (and hence, different interactions with ^4He-rich crustal fluids during emplacement).

The FI $\delta^{13}C(CO_2)$ isotopic composition ranges from -2.38 to -1.23‰ in pyroxenes and -0.2 to +2.0‰ in olivine. These unusually positive $\delta^{13}C$ compositions support the existence of a recycled crustal carbon component in the local source mantle, likely pointing to mantle metasomatism (Oglialoro et al., 2017) from fluids carrying carbon from subducted sediments and/or altered oceanic crust (AOC).