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Noble gas signatures of fluids at Santorini and Milos (Greece).

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The Cenozoic subduction of the African plate beneath Aegean continental microplate is responsible for the development of the Hellenic volcanic arc and back arc extension zone in the Aegean Sea (Greece). The study of the isotopic content of leaking gases in the volcanic arc enables to investigate magmatic and geodynamic processes. This study allows revealing the motion of the slab such as its tearing, as expected in the eastern part of the arc, as highlighted by the seismic tomography studies [1]. Thirty gas samples of fumaroles and bubbling springs from the Santorini and Milos volcanoes were collected and analyzed to determine the concentration of major species (CO_2, N_2, H_2,CH_4, etc.), as well as their isotopic ratio ($\delta^{13}C$-CO_2, $\delta^{13}C$-CH_4, $\delta^{15}N$-N_2 and δD-H_2). In addition, fifteen gas samples were analysed for noble gas concentrations (He, Ne, Ar, Kr and Xe) and their isotopic ratio ($^3He/^4He$, $^{20}Ne/^{22}Ne$, $^{21}Ne/^{22}Ne$, $^{38}Ar/^{36}Ar$ and $^{40}Ar/^{36}Ar$). On both islands CO_2 is the major non-atmospheric gas (>70%). In Santorini island CO_2 (85-100%), CH_4 (470-720ppm), and H_2 (0.19-1.2%) concentrations and $\delta^{13}C$-CO_2 values (+0.5 to +0.8‰) indicate volcanic stability since the 2011-2012 unrest [2]. The $^3He/^4He$ of gases from both Santorini and Milos islands range from 1.4 to 3.7 R_a and reflect a mixing between air and deep gas that is a mix of mantle and crust-derived Helium. One sample from Milos island might be indicative of a small amount of MORB-type mantle. The combination of $CO_2/^3He$ ratio with the $\delta^{13}C$-CO_2 (-10.7 to +0.8‰) suggests a mixing between mantle, crustal limestone, and superficial fluids. The $\delta^{15}N$-N_2 values (-0.2 to +0.5‰) coupled with the $N_2/^3He$ ratio require contributions from mantle and slab-derived sediments. Given the geological context, this mantle signature could be explained by the presence of a slab tear or a MORB-type mantle under Milos island.

[1] Piromallo and Morelli (2003), J. Geophys. Res. 108, B2, 2065.

[2] Tassi et al. (2013), Bull. Volcanol. 75, 4: 711.