Goldschmidt 2022 Abstract
https://doi.org/10.46427/gold2022.10580

Evolution of $^{3}He/^{4}He$ ratios in the 2021 Cumbre Vieja lavas

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The Canary Islands are an intraplate volcanic island chain that may be associated with a deeply-rooted mantle plume [1]. $^{3}He/^{4}He$ measurements are a powerful tool for investigating the sources of hotspot lavas and may provide important geochemical context for the 2021 Cumbre Vieja eruption (19 September–13 December), with respect to other historical La Palma eruptions and the Canary Islands hotspot in general. We measured 3He/4He ratios in clinopyroxene and olivine phenocrysts from lavas erupted on 28 September and 13 October. Vacuum crushing experiments done on clinopyroxene from the earlier lava yielded 3 x 10^{-8} cm^{3} $^{4}He/g$ (at standard temperature and pressure) and an average $^{3}He/^{4}He$ ratio of 7.3 ± 0.3 Ra (1 SD, n=3), where Ra is the atmospheric $^{3}He/^{4}He$ (1.384 x 10^{-6}). Olivine and clinopyroxene mineral separates from the later lava flow yielded three times as much $^{4}He/g$ and average $^{3}He/^{4}He$ ratios of 7.7 ± 0.5 Ra (n=3) and 7.3 ± 0.4 Ra (n=3), respectively. Thus, within uncertainty, $^{3}He/^{4}He$ did not change in the Cumbre Vieja lavas over the two-week period spanned by our samples. Our results are within the uncertainty of $^{3}He/^{4}He$ measured for olivine and clinopyroxene from previous eruptions on La Palma (7.6 ± 0.8 Ra) [2]; they are also within the range of mid-ocean ridge basalt $^{3}He/^{4}He$ ratios of 8 ± 1 Ra [3]. We conclude the 2021 lavas contain helium and volatiles from the same source as previous eruptions: mantle containing a high $^{238}U/^{204}Pb$ (HIMU) component [4]. Surprisingly, hydrothermal fluids collected on La Palma in 1995 and 2006 had higher $^{3}He/^{4}He$ ratios of 9.1 ± 0.1 Ra [5]. Expansion of our $^{3}He/^{4}He$ dataset to lavas from the remainder of the 2021 eruptive sequence may shed light on any isotopic variability during the early and late stages of the eruption.

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