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First insights into the noble gas signature of the 2021 Cumbre Vieja eruption, La Palma (Canary Islands)

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The 2021 eruption of Cumbre Vieja volcano (La Palma Island) is one of the largest natural disasters in Europe in recent times, but also a unique opportunity for monitoring the evolution of a volcanic system and its underlying mantle source.

Geophysical and geochemical evidence suggests that volcanism in Canary Islands is driven by the presence of a mantle plume, even though helium isotopes highlight this lower mantle component ($^3He/^4He$>9 Ra) only in the Dos Aguas spring gases and the older lavas from the Taburiente caldera (north of La Palma). Conversely, fluid inclusions in lavas and spring gases from the recent Cumbre Vieja system have a MORB-like signature (8±1 Ra). These distinct signatures were ascribed to the mixing between different mantle components (Day and Hilton, 2020). In this framework, the 2021 Cumbre Vieja eruption opens new avenues to investigate the current composition of the local mantle and test the pre-existing models.

Here, we present the first insights into the $^3He/^4He$ signature of volcanic gases and phenocryst-hosted fluid inclusions from lavas erupted by the Cumbre Vieja in September-November 2021. For comparison, we analyzed the poorly evolved lavas from 1677 San Antonio eruption bearing mantle xenoliths (South of Cumbre Vieja) and a 3 Ma old picrite cropping out in the Taburiente caldera, close to the Dos Aguas spring (Day et al., 2010).

The 2021 lavas belonging to the October 27th and November 9th flows are basanite tephrites, with an average Mg# of 58.6, being more mafic than those from the September opening phase (Mg# = 50.3; Pankhurst et al., 2022). Olivine phenocrysts have Fo content mostly of mostly 78-83, and elevated Al and Cr contents. The estimated T based on the Cr and Al in olivine thermometers (DeHoog et al., 2010) is 920-960°C.

The $^{3}He/^{4}He$ ratio in phenocryst-hosted fluid inclusions from the 2021 products is 7-7.5 Ra, confirming the MORB-like signature of the volcanic products and gases dissolved in water of the Cumbra Vieja system (Day and Hilton, 2020; Torres-Gonzalez et al., 2020). Instead, the olivines in the Taburiente picrite yield 9.4±0.1 Ra, comparable to values in the Dos Aguas spring, confirming the existence of a lower mantle component below this sector of the island.

The distinct $^{3}He/^{4}He$ signature observed at Taburiente and Cumbre Vieja products is preliminary interpreted as due to either (i) small-scale heterogeneities in the local mantle, and/or (ii) a plumbing system effect that lowers the $^{3}He/^{4}He$ of the recently erupted magmas. In the latter case, magma differentiation and degassing at the crust-mantle boundary or even deeper in the mantle, coupled to the production and accumulation of radiogenic ^{4}He, would play a central role.

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