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Sulfur isotopes of Fani Maoré glasses and the composition of mantle plumes

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Sulfur isotopes are a powerful tool to trace the origin of mantle-derived rocks. Indeed, variations of both $\delta^{34}S$ and $\Delta^{33}S$ provide clues on the past history of the source region and the origin of the material melting to produce volcanic rocks. Here, we present new sulfur contents and isotope data obtained on volcanic glasses from Fani Maoré, a new submarine volcano that erupted between 2018 and 2021 next to Mayotte in the Comoros archipelago (Indian Ocean).

The sulfur contents vary between 908 and 1285 ppm in basanites and are less than 200 ppm in phonolites. Basanites have $\delta^{34}S_{V\text{-}CDT}$ between +0.15 and +1.12‰ and $\Delta^{33}S_{CDT}$ at 0.013±0.005 ‰, while phonolites have more positive $\delta^{34}S_{V\text{-}CDT}$ values (2.33±0.22 ‰) and lower $\Delta^{33}S_{CDT}$ at 0.002±0.010 ‰. The near-zero $\Delta^{33}S$ values do not favor any significant mass-independent fractionation, thus precluding a significant presence of Archean sediments in the source of magmas. Interestingly, the basanites $\delta^{34}S_{V\text{-}CDT}$ are slightly positive and higher than the range estimated for depleted mantle (-1.28±0.33‰ [1]). Since S is reduced in the glasses, sulfide segregation does not affect the $\delta^{34}S$. No evidence for post-eruption seawater alteration and degassing are observed in the basanites, thus the positive $\delta^{34}S_{V\text{-}CDT}$ represent the mantle source. In contrast, the higher $\delta^{34}S_{V\text{-}CDT}$ of phonolites are due to S degassing.

At Fani Maoré, $\delta^{34}S_{V\text{-}CDT}$ defines mixing hyperbolas with $^{87}Sr/^{86}Sr$ and $^{206}Pb/^{204}Pb$. The mixing arrays do not point towards sources such as depleted mantle and recycled sediments as suggested by others [2] but highlight local heterogeneities within the plume source. More generally, the new data obtained for Fani Maoré increase the limited available dataset for ocean island basalts. We suggest that plume volcanism samples sources with variable $\delta^{34}S_{V\text{-}CDT}$ (both positive and negative) and systematically slightly positive $\Delta^{33}S_{CDT}$, in contrast to the MORB source with its negative $\delta^{34}S_{V\text{-}CDT}$ and $\Delta^{33}S_{CDT}$ values at about zero. The sulfur isotopic characteristics of plume magmatism appears to be dominated by the presence in the deep mantle of recycled materials such as altered oceanic crust with/without various types of sediments.

[1] Labidi et al., 2013, Nature. [2] Labidi et al., 2015, EPSL.