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Deep mantle chemical heterogeneities: new insight from the measurement of the ^{138}La-^{138}Ce and ^{146,147}Sm-^{142,143}Nd systematics in Hawaiian basalts

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The Hawaiian mantle plume rises from the northeastern edge of the Pacific LLSVP near the core-mantle boundary (Garnero et al., Nat. Geo. 2016). Geochemical studies of Hawaiian lavas have shown that during the past 5 Myr, two parallel volcanic chains were formed, Loa and Kea, with distinct geochemical compositions. The more enriched Loa material is sourced from within the Pacific LLSVP, whereas the ambient lower mantle supplies the more depleted Kea lavas (Weis et al., Nat. Geo. 2011; G3 2020). The heterogeneous nature of the lower mantle reflects the long-term recycling of surface material and the potential preservation of early-formed reservoirs in the deep Earth. To provide new insight into the nature of deep mantle chemical heterogeneities, we present measurements of ^{138}La-^{138}Ce and ^{146,147}Sm-^{142,143}Nd systematics in ~30 Hawaiian basalts. All these samples were previously measured for an extensive range of isotopic systematics (Weis et al., G3 2020; Williamson et al., G3 2021).

Results obtained on the two long-lived ^{138}La-^{138}Ce and ^{147}Sm-^{143}Nd systematics confirm that samples from the Kea Trend have the most depleted isotopic composition (eps^{138}Ce down to -1.2 and eps ^{143}Nd up to 7.4). The most enriched signatures are measured in samples from Koolau volcano that represent the enriched Loa end-member (eps^{138}Ce and eps^{143}Nd values close to 0). The La-Ce isotopic system is a potential proxy to trace the recycling of pelagic sediment in the mantle. All Hawaiian basalts plot along the eps^{138}Ce-eps^{143}Nd mantle array, and we did not identify any correlation between eps^{138}Ce and heavy Tl isotopic compositions measured in some Kea samples.

The ^{146}Sm-^{142}Nd systematics have been measured on 20 samples collected in volcanoes from the two trends. All samples analyzed so far have ^{142}Nd/^{144}Nd ratios similar to the value measured in the JNd-1 terrestrial standard (2SD=5ppm). In a few Hawaiian samples ^{182}W tungsten isotopic data correlate negatively with ^{3}He/^{4}He (Mundl et al., Science 2017). The lack of variation in ^{142}Nd/^{144}Nd in these samples 1) supports the ^{182}W anomalies to be related to the core, and 2) questions the preservation of magma ocean crystallization products in the deepest part of the mantle.