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Olivine Phenocrysts Reveal Evidence of Core-Mantle Interaction in Hawaiian Mantle Sources

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Hawaiian lavas provide striking evidence for chemical interactions with the Earth's outer core including radiogenic Os isotopes, unradiogenic W isotopes [1] and high Fe/Mn ratios [2]. Chemical interactions between the core and mantle are expected to enrich the mantle in Fe, but not in Mn, so a high Fe/Mn is expected in mantle sources that interacted with the core. However, Mn partitioning during melting of a polylithologic mantle (eclogite, peridotite, etc.) is complex [3] and Mn-deficiency could create a false impression of Fe-enrichment. A more compelling argument could be made from correlated Fe/Mg variation with Fe/Mn induced by Fe metasomatism from the core, but the Fe/Mg of a basaltic lava is strongly affected by olivine fractionation. Here, we adopted a new approach to constraining the primary Fe/Mg of basalts using the core compositions of olivine grains. Taking advantage of a large and precise database for chemical compositions of olivine phenocryst cores from Hawaiian lavas and MORBs [3], we found that the Fe/Mg of the most magnesian Hawaiian olivine cores (> 0.103) are systematically higher than that of MORB olivine cores (> 0.087). On a plot of Fe/Mn ratios vs. Fe/Mg ratios measured on the same olivine cores, the Hawaiian olivines (red) plot to higher Fe contents than MORB olivines (blue) at constant Mn/Mg ratios (Fig. 1). This data indicates that mantle sources for Hawaiian lavas are about 10 % higher in Fe than MORB mantle, consistent with Fe-gain by metal-silicate exchange in the sources of Hawaiian lavas. This data provides an important constraint on the nature of chemical interaction occurring at the core-mantle boundary beneath Hawaii. The fact that only Fe is affected is not consistent with the deep mantle beneath Hawaii originating from the remains of a moon-forming impactor or other accretionary residues.

[1] Rizo H. et al. (2019) *Geochemical Perspectives Letters* 11, 6-11.

[2] Humayun M., Qin L and Norman M. D. (2004), *Science* 306, 91-94.

[3] Sobolev A. V. et al. (2007), *Science* 316, 412-417.