

Geochemistry Study of Gabbroic Xenoliths in Hualalai Lavas

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The post-shield stage alkali lava flows from Hualalai Volcano, Hawaii contain abundant xenoliths of dunite, wehrlite and gabbro. Geochemical properties of the gabbroic xenoliths can provide valuable information for further understanding of the structure of lower oceanic crust and its interaction with the Hawaiian magmas. Clinopyroxenes from one group (Group 1) of the gabbroic xenoliths have rare earth element (REE) pattern in equilibrium with light rare earth elements (LREE) enriched lava. Their Sr-Nd isotopic compositions are also consistent with Hualalai lavas ($^{87}\text{Sr}/^{86}\text{Sr} = 0.7035\text{-}0.7038$, $\epsilon \text{ Nd} = 4.4\text{-}6.7$). These characteristics suggest Group 1 gabbros are associated with plume magmas. Clinopyroxenes from another group (Group 2) show REE pattern in equilibrium with LREE depleted lava and Sr-Nd isotopic compositions that overlap the range of East Pacific Rise (EPR) basalts ($^{87}\text{Sr}/^{86}\text{Sr} = 0.7025\text{-}0.7028$, $\epsilon \text{ Nd} = 6.4\text{-}10.6$). Therefore, Group 2 gabbros are believed to be gabbroic cumulates from ancient oceanic-crustal layer 3. There is one Group 2 sample have more enriched radiogenic isotopic composition and elevated La/Sm ratio than all the other Group 2 gabbros, which may be results of interaction between the ancient Pacific oceanic crust and the Hawaiian plume magma. Oxygen isotopes are measured for plagioclase and clinopyroxene separates from the xenoliths. Plagioclases of Group 1 xenoliths have elevated $\delta^{18}\text{O}$ values ($\sim 6.2\text{‰}$) which is consistent with Hualalai lavas. In contrast, Group 2 xenoliths have relatively uniform $\delta^{18}\text{O}$ values in equilibrium with fresh MORB lavas ($5.7\text{‰}\text{-}5.9\text{‰}$), while $\delta^{18}\text{O}$ values of plagioclase and clinopyroxene of Group 2 xenoliths are in good equilibrium with each other ($\Delta_{\text{plag-cpx}} = 0.5\text{-}0.7\text{‰}$). The non-depleted $\delta^{18}\text{O}$ values would suggest no significant hydrothermal alteration in the lower layer 3 oceanic crust, which tend to support accretion of lower oceanic crust from “gabbro glacier” instead of multiple sills. It also preclude the possibility that the enriched and various $\delta^{18}\text{O}$ in Hawaiian lavas is obtained from crustal assimilation.

Keywords: gabbroic xenoliths, geochemistry, Hualalai Volcano, lower oceanic crust, accretion model, crustal assimilation