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Melt Flux from the Mantle Regulates the Crustal Processing and δ¹⁸O Variations of Kamaʻehuakanaloa Magmas

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Kamaʻehuakanaloa (formerly Lōʻihi) is an active submarine Hawaiian pre-shield volcano. Basalts from Kamaʻehu (for short) are derived from a distinctive ^{3}He-rich deep mantle source within the Hawaiian plume, yet they experience at least two types of crustal contamination based on enrichments in seawater-derived Cl and ^{234}U. Here we present oxygen isotopic analyses of volcanic glasses and olivine crystals for tholeiitic, transitional, and alkalic basalts, and three hawaiites from Kamaʻehu. The average δ^{18}O values of both glass and olivine from the North Rift Zone and NE summit platform (~5.6‰ and 5.1‰, respectively) are higher than those from the South Rift Zone and the SW summit platform (~5.3‰ and 4.9‰). Glass incompatible element enrichment (K_2O/TiO_2) increases with decreasing MgO and CaO/Al_2O_3. Northern Kamaʻehu glasses are more frequently alkalic (~68%), enriched, and differentiated than those from southern Kamaʻehu (~81% tholeiitic or transitional). Radium-226 model eruption ages indicate that the transition from alkalic to tholeiitic volcanism at Kamaʻehu was nearly complete by ~2 ka. Thus, the mostly alkalic northern lavas record an earlier phase of the volcano's eruptive history that has since been covered by more recent eruptions of tholeiitic basalts to the south. These observations suggest that melt flux from the mantle regulates the crustal processing and δ^{18}O variations of Kamaʻehu magmas. The higher average δ^{18}O values of the glass and olivine from northern Kamaʻehu result from assimilation of volcanic edifice that was altered by seawater-rock interaction at low temperature, and vice versa for southern Kamaʻehu. This difference can be explained if the mantle-controlled transition from alkalic to tholeiitic volcanism led to the more frequent supply of larger magma batches produced at higher degrees of mantle melting, establishment of an active shallow hydrothermal system for high-temperature alteration of the volcanic edifice, and a decreasing extent of clinopyroxene fractionation. The average δ^{18}O values of glass (~5.4‰) and olivine (~5.0‰) from Kamaʻehu—similar to depleted MORB—represent the best estimate for mantle-derived Kamaʻehu magma. This relatively low δ^{18}O mantle signature can be explained if the volcano's source within the Hawaiian plume contains recycled upper basaltic oceanic crust that was strongly dehydrated in an ancient subduction zone.