The Recent Prehistoric Geochemical Evolution of Summit Lavas From Kilauea Volcano, Hawaii

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Lavas from Kilauea Volcano display rapid geochemical and isotopic variations (e.g., $^{206}Pb/^{204}Pb$ or Nb/Y ratios) on a time scale of decades to centuries. The wall of Kilauea Caldera at Uwekahuna Bluff exposes a sequence of recent prehistoric, caldera-filling lavas (erupted mostly between AD 900-1400). Here we present a detailed geochemical study (major element abundances, and Pb, Sr, and Nd isotope ratios) for lavas from the lower portion of the Uwekahuna Bluff section as well as trace element abundances for the entire section. The $^{206}Pb/^{204}Pb$ ratios of the lavas from the lower Uwekahuna Bluff display small variations that merge with an isotopic excursion towards low $^{206}Pb/^{204}Pb$ ratios in the lavas from the upper portion of the section. At least four distinct source components within the Hawaiian mantle plume are required to explain the variations in Pb, Sr, and Nd isotope ratios. Two of these components were previously thought to be restricted to the neighboring active volcanoes, Mauna Loa and Loihi Seamount. The occurrence of Mauna Loa- and Loihi-like mantle sources in Kilauea's melting region (in addition to Kilauea's typical mantle source) suggests that (1) the Hawaiian plume contains three large-scale compositional heterogeneities and (2) all three heterogeneities extend into Kilauea's melting region. However, the source region of Kilauea lavas must also be heterogeneous on a small scale to explain the rapid variations in the Pb, Sr, and Nd isotope ratios of the lavas. The fourth component appears to be common to all three of the active Hawaiian volcanoes, and thus, might represent the plume matrix. The Uwekahuna Bluff lavas also reveal a systematic temporal excursion in ratios of highly over moderately incompatible trace elements (e.g., Nb/Y) towards the lowest values yet observed at Kilauea. These low Nb/Y ratios (which correlate with the low $^{206}Pb/^{204}Pb$ ratios) are thought to result from relatively high degrees of partial melting of the plume matrix. Based on a correlation between high inferred degrees of partial melting and high eruption rates historically at Kilauea, the low Nb/Y ratios of the Uwekahuna Bluff lavas suggest that the eruption rate at Kilauea's summit may have been unusually high in recent prehistoric times.