Oxygen Isotope Evidence for Chemical Interaction of Kilauea Magmas with Basement Rocks

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David Green has shown us that the geochemistry of basaltic volcanoes is largely governed by mantle processes. However, Kilauea volcano, one of the most active volcanoes on Earth, also records interaction with its crustal rocks. Kilauea is built on a ~ 6 km thick crustal basement of ~100 Ma oceanic crust [1] overlain by 8-10 km of young lavas (<1 Ma) from the adjacent growing shield volcano, Mauna Loa. The contribution of these basaltic basement rocks on the geochemistry of Kilauea magma was thought to be negligible based on major, trace element and Pb, Nd and Sr isotope analyses of historical lavas from this volcano [2]. New oxygen isotope results provide evidence for extensive exchange between Kilauea magmas and the volcano's basement. This exchange is documented by analyses of basalt matrix material and olivine-matrix pairs for historical lavas. The matrix oxygen isotope ratios are lower and the disequilibrium between olivine and matrix is greatest following summit explosions and collapses in 1790 and 1924. The source of this contamination is not likely to be shallow because blocks from the 1924 explosions (derived from depths <400 m) have relatively high O isotope ratios (5.5 per mil). In contrast, lavas from the volcano's deeper (2-3 km) and hotter interior (at least 300^{o}C) have much lower O isotope ratios (1.7-2.3 per mil). These deeper rocks are more appropriate for lowering O matrix ratios following summit collapses via assimilation of hydrothermally altered rock. The positive correlation between Pb and O isotopes is consistent with Mauna Loa basement rocks being contaminants for recent Kilauea lavas. Our results show that oxygen isotopes are a sensitive indicator of crustal interaction in basaltic lavas and can help eliminate an exotic mantle source component as the cause for isotopic variations.

References

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