Abstract

Differences in Pb isotope ratios between lavas from Loa- and Kea-trend volcanoes have been used to infer geochemical information in the Hawaiian plume. However, the significance of Kea geochemical signatures in Loa-trend volcanoes and vice versa is debated. The longevity of these differences is also uncertain. Weiss et al. [1] claim that geochemical zonation has persisted for at least 5 million years; however, Abouchami et al. [2] suggested that the geochemical differences “terminate at the Molokai Fracture Zone” (~2 Ma). We have determined the geochemical characteristics of three contemporaneous zonars whose strikes cross that of the Loa- and Kea-trends, specifically late-shield and postshield lavas, ~1.5 to 7.5 Ma, from East Molokai volcano, the northernmost Kea trend volcano recognized by Jackson et al. [3], shield and postshield lavas, ~1.7 to 1.9 Ma, from West Molokai, a Loa trend volcano [4,5], and shield lavas, undated but inferred to be 1.8 to 2.0 Ma, from Penguin Bank lava. West Molokai and Penguin Bank are inferred to be a distinct Hawaiian west Loa trend of the West. These Loa- and Kea-trend lavas are distinguished by incompatible element mantle-normalized abundances (ZNd and ZHf) and Sr, Nd, Hf and Pb. East Molokai lavas are clearly Kea-like whereas West Molokai and Penguin Bank lavas range from Kea to Loa-like. This trend is consistent with more geochemical heterogeneity in Loa volcanoes than in Kea volcanoes [1,2].

These results are consistent with a randomly distributed heterogeneity model with Loa volcanoes sampling a higher proportion of components with low solids, perhaps recycled oceanic crust and sediments, whereas Kea volcanoes, which are closer to the plume center, sample a higher proportion of components with high solids such as peridotites.

1. Sample location

2. Trace element characteristics

3. Sr-Nd-Hf isotopic ratios

4. Pb isotopic compositions on Molokai island

5. Hawaiian mantle plume zonation

6. Summary

(1) Although Pb isotope ratios have been emphasized in documenting the geochemical difference between volcanoes forming the Loa- and Kea- spatial trends (Fig. 1a), we find that isotopic ratios of Sr, Nd and Hf and incompatible element abundance ratios such as ZNd and ZHf also distinguish Loa- from Kea-trend volcanoes.

(2) The transect from East Molokai to West Molokai to Penguin Bank includes the oldest volcano (East Molokai) that is obviously on the Kea trend, West Molokai on the Loa trend and Penguin Bank west of Molokai (Fig. 1c).

(a) The late- and post-shield East Molokai lavas are exclusively Kea-like in geochemical characteristics.

(b) The shield lavas of West Molokai include lavas with both Loa- and Kea-like geochemical characteristics including an extreme Loa sample which is similar to Lō‘ihi (Makahiki) lava. In contrast post-shield West Molokai lavas have Kea geochemical characteristics.

(3) We emphasize that the occurrence of Kea lavas in Loa trend volcanoes (e.g., West Molokai, Penguin Bank and Makahiki) and vice versa (e.g., Mauna Kea) is a common observation (note the overlap of 208Pb/204Pb for East and Kea lavas in Fig. 7). This result requires that Loa- and Kea-like sources are present in the sources of all Hawaiian shields (Fig. 8).

References