

The chemical structure of the Hawaiian mantle plume

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The Hawaiian - Emperor volcanic island and seamount chain is attributed to a hot mantle plume, located beneath the Pacific lithosphere, that delivers material sourced from deep in the mantle to the surface. The shield volcanoes of the Hawaiian islands are distributed in two curvilinear, parallel trends (termed Kea and Loa), and whole rocks are characterized by general geochemical differences (Frey & Rhodes, 1993; Frey et al., 1994; Hauri, 1996; Lassiter et al., 1996). This has led to the proposition that Hawaiian shields sample compositionally distinct, implying concentrically zoned, regions of the plume (Hauri, 1996; Lassiter et al., 1996). Melt inclusions, or samples of local magma frozen in olivine phenocrysts during crystallization, are better than whole rocks at recording complexities of mantle sources (Sobolev, 1996), thereby providing insight into the chemical structure of plumes. We report the discovery of both Kea- and Loa-like major and trace element compositions in olivine-hosted melt inclusions in individual, shield-stage Hawaiian volcanoes, and even in unique rock samples. Our new data imply that one mantle source component may dominate a single lava flow, but that the two mantle source components are consistently represented to some extent in all lavas, regardless of the specific geographic location of the volcano. Our results suggest that the Hawaiian mantle plume is unlikely to be compositionally concentrically zoned, instead, the observed chemical variation is likely controlled by the thermal structure of the plume.