Isotopic study of Mauna Loa's submarine Southwest Rift Mile High Section: Hawaiian mantle plume structure

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A high-precision geochemical/isotopic study of a 1.6 km thick submarine stratigraphic section from the southwest rift zone of the Mauna Loa volcano has been undertaken to investigate the structure of the Hawaiian mantle plume. The Mile High section (MHS) may represent over 400 ka of eruptive activity, 50% of the volcano's total lifetime, and is comparable to the time period sampled by the Hawaiian Scientific Drilling Project (HSPD-2). Sr, Nd, Pb and Hf isotopes in the MHS range typically within literature data for the Mauna Loa volcano with $^{87}Sr/^{86}Sr$ from 0.70368 to 0.70378 and $^{206}Pb/^{204}Pb$ from 18.16 to 18.26 (i.e. somewhat more radiogenic than most of the Mauna Loa prehistoric lavas and clearly different from any basalt from the Mauna Kea trend, with distinctly higher $^{208}Pb^*/^{206}Pb^*$). In the MHS, there is a distinct change in isotopic compositions, also recorded by major and trace element data, at a depth of 1353 m with an increase in Pb and Sr isotopic ratios that continues down to the bottom of the section at 2290 m. High-precision Pb isotopic systematics for Mauna Loa do not show binary trends as previously observed in the upper part of the HSDP-1 pilot hole [1]. This might indicate that the Mauna Loa plume source might be more thoroughly mixed than the Mauna Kea source. Most of the Mauna Loa isotopic compositions cluster at 18.15-18.20 for $^{206}Pb/^{204}Pb$ and ~0.70370 for $^{87}Sr/^{86}Sr$, which could be a ubiquitous component in the Hawaiian mantle plume. Nevertheless, a more radiogenic plume component with higher $^{208}Pb/^{204}Pb$, $^{208}Pb^*/^{206}Pb^*$ is clearly present in the lower part of the MHS and might be comparable to the Kilauea-like component observed in Mauna Kea lavas in HSDP-2 [2, 3]. This implies the persistence of specific chemical domains in the Hawaiian plume through time.

References

[1] Abouchami et al., 2000;
[2] Blichert-Toft et al., 2003;
[3] Abouchami et al., 2005.

Assessing Kilauea volcano's historical parental magma compositional variations

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Two hundred years of magmatic history are preserved by lavas and tephra from Kilauea's historical summit eruptions. New geochemical data are presented here for olivine-hosted, naturally quenched melt inclusions and host lavas. Whole-rock data show large and systematic compositional and isotopic variations during the last two centuries from 1820 to 1924, when the summit suddenly and violently collapsed. Thereafter, a reversed geochemical trend has continued for 80 years, including the ongoing, 22-year-old Puu `O`o eruption [1, 2]. Melt inclusions in relatively primitive olivines (Fo 85-90 [3]) were examined from fire-fountain produced reticulite from the 1820 and 1959 eruptions and water-quenched lava from the Puu `O`o eruption to determine the cause of these trends (e.g, magma mixing or systematic parental magma changes). These rapdily quenched samples show minimal post-entrapment re-equilibation with host olivine. The melt inclusions from a single lava trap a remarkable range in major and trace element compositions, much larger than recorded in the erupted lavas during the last 200 years, although inclusions within individual olivines show a limited range. There is no correlation of olivine composition with major element lava composition. Thus, the range of melt inclusion compositions is not related to equilibration with the host olivine, and in fact represents primary magmatic variation, especially for ratios such as Nb/Y. These results indicate that magma supplying Kilauea changes rapidly and that its source has small-scale mantle heterogeneities. These short-term magma compositional variations are buffered by the summit magma chamber but preserved in melt inclusions. The rapid and overall systematic nature of these temporal geochemical variations indicate that summit eruptions are fed from a single, relatively small reservoir that is being continuously fluxed with new, mantle-derived magma. The rate of compositional variation during the last two hundred years is correlated with magma-supply rate and the estimated degree of melting, which may be controlled by the scale of source heterogeneity within the Hawaiian plume.

References

[1] Pietruszka, A.P., Garcia, M., 1999, J. Petrol. 40, 1321-42.
[2] Garcia, M.O., et al., 2000, J. Petrol. 41, 967-90.
[3] Garcia, M.O., et al., 2003, J. Petrol. 44, 2313-39.