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Pulsing plume or mantle mixing? Tracking the appearance and absence of ^{182}W anomalies in the Hawaiian mantle plume.

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Variations in $\mu^{182}W$ (μ is the parts-per-million deviation from the terrestrial standard) in modern ocean island basalts (OIB) can be used to study metal-silicate and silicate-silicate differentiation that occurred within the first ~60 Myr of Earth's history, as well as grainy late accretion, and core-mantle interactions. Ocean island basalts have $\mu^{182}W$ similar to the modern bulk silicate Earth (~0 ± 3.5), with a subset of OIB having negative $\mu^{182}W$ anomalies spanning to approximately -25. It is not clear what processes and materials control the appearance and magnitude of $\mu^{182}W$ expressed in these lavas at Earth's surface. Variation in $\mu^{182}W$ within a single mantle plume, such as the Hawaiian plume, may be related to plume structure (e.g., spatial heterogeneity), dynamics (e.g., entrainment, ascension, and melting), and interaction with additional components in the plume (e.g., mixing with recycled materials), which are not mutually exclusive processes. The Hawaiian mantle plume is well characterized with respect to chemical and isotopic variations, as well as magmatic flux. Paired with chemical and Sr-Nd-Hf-Os-Pb isotopic compositions, new $\mu^{182}W$ analyses from fourteen Hawaiian volcanic centers, spanning ~5 Myr and 500 km, are used to demonstrate that the Hawaiian plume likely experienced pulses of anomalous material participating in melting. The largest $\mu^{182}W$ deficits (~ -25) in the archipelago occur in Kauaʻi at ~5 Ma and in the Kamaʻehuakanaloa Seamout at <1 Ma. Available data suggest the component that hosts negative $\mu^{182}W$ was either absent, or did not contribute to melt production, in the mantle source of some Hawaiian volcanic centers such as Waiʻanae, West Maui, and Haleakalā. Mixing between components with anomalous and normal $\mu^{182}W$ is observed within individual volcanic centers, resulting in a range of $\mu^{182}W$ compositions where anomalies are observed. Attenuation of $\mu^{182}W$ by recycled W-rich materials with normal $\mu^{182}W$ remains a viable mechanism to explain smaller magnitude and absent $\mu^{182}W$ anomalies observed in relatively geochemically enriched lavas in Hawaiʻi at West Kaʻena Ridge, Koʻolau (Makapuʻu), and possibly Lānaʻi.