Goldschmidt 2026 Abstract
https://doi.org/10.46427/gold2026.35596

# Variable magmatic flux of Northwest Hawaiian Ridge shield volcanoes controlled by temporal changes in the upwelling of a depleted plume component

**REED B. MERSHON**[1], AARON J. PIETRUSZKA[1], ARRON STEINER[2], MICHAEL J VOLLINGER[3], JOHN MICHAEL RHODES[3], BRIAN JICHA[4], MICHAEL O. GARCIA[1] AND PENG JIANG[5]

[1]University of Hawai‘i at Mānoa
[2]Washington State University
[3]University of Massachusetts - Amherst
[4]University of Wisconsin-Madison
[5]University of Hawai’i at Mānoa

Hawaiian-Emperor Chain volcanoes display large differences in volume (factor of ~100), which are thought to be related to temporal variations in magmatic flux (Wessel, 2016). The larger volcanoes over the last ~47 Ma have been explained by higher mantle potential temperatures (Garcia et al., 2020) or increased participation of the fertile Loa component in the Hawaiian plume (Harrison et al., 2017). Here we examine the origin of magmatic flux variations using the trace element signatures of lavas from the Northwest Hawaiian Ridge (NWHR; ~47-6.5 Ma). NHWR shield-stage tholeiitic basalts display a large range in Nb/Th (9.6 – 18.5). This alteration-resistant trace element ratio was postulated to be relatively constant in Hawaiian shield lavas (15.2 ± 1.7; Hofmann, 1986; Frey et al., 2016) and is not affected by changes in the degree of partial melting or magmatic differentiation. Instead, Nb/Th may record a change in the fertility of the mantle source. This ratio correlates broadly with the magmatic flux of NWHR volcanoes. Trace element-based mantle melting models indicate that NWHR mantle sources contain ~8-18% recycled oceanic crust (MORB ± gabbro) that was variably dehydrated in an ancient subduction zone. This range and the calculated degrees of mantle partial melting overlap with the modeled range for Hawaiian volcanoes (Mershon et al., 2025). The Nb/Th variations can be explained if the NWHR mantle sources contain variable amounts of recycled mantle lithosphere (RML) – the most depleted, least dense, and likely most buoyant component in the Hawaiian plume (Béguelin et al., 2025). Thus, the larger NWHR seamounts with more RML-dominated sources may have experienced higher buoyancy fluxes, which would have produced a larger amount of melt for a given amount of time. This suggests that changes in the upwelling of ancient recycled depleted materials from the deep mantle were the main control on the variable magmatic flux along the NWHR. The exceptionally high magmatic flux during the formation of the Hawaiian Islands, and the invariant Nb/Th ratios of Hawaiian shield lavas, may result from a recent upwelling of a large heterogeneous blob (e.g., Zhang et al., 2023) with a relatively constant amount of RML.