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A new geochemical database for ocean island basalts: A highly biased dataset and a potential solution.

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We present a new Sr-Nd-Pb-Hf-Os-He isotope database for 12,828 samples from 48 oceanic hotspots. Data were hand entered from 1273 publications in an attempt to include all high-quality radiogenic isotope data generated on ocean island basalts (OIB) that were published before August 1st, 2023. Where available, major and trace element concentrations and relevant metadata were included in the database. We show that a large number of oceanic hotspots still have not been characterized for $^{187}Os/^{188}Os$ (N=28 hotspots lack robust analyses), $^{3}He/^{4}He$ (N=16), and $^{176}Hf/^{177}Hf$ (N=15). We also show that a small number of oceanic hotspots have been oversampled: ≥75% of the Sr-Nd-Pb-Hf-Os-He isotope data has been obtained from <25% of the hotspots. Just two of the hotspots—Iceland and Hawai'i—account for 35-45% (depending on the isotope system) of the total global OIB isotope dataset. In order to correct for this extreme sampling bias, we reweight the contribution of isotopic data from each hotspot based on a hotspot's fractional contribution to the global oceanic hotspot buoyancy flux. This way, in the reweighted dataset, the number of geochemical analyses at a hotspot is in direct proportion to the mass of material upwelling in the plume. After reweighting, we make several observations. First, just 7% of all OIB with Nd isotopes analyzed are geochemically enriched ($^{143}Nd/^{144}Nd < 0.51263$), while the vast majority (93%) of OIB are depleted in the reweighted database. Among the samples with Pb isotopes analyzed, OIB with HIMU signatures ($^{206}Pb/^{204}Pb > 21$) comprise just 2% of the samples in the reweighted database. Finally, OIB with high $^{3}He/^{4}He$ OIB ($^{3}He/^{4}He > 20\ R_A$) are relatively uncommon, and represent just 9% of OIB samples in the reweighted database. In fact, >50% of OIB—which presumably sample the lower mantle via upwelling plumes—in the reweighted database have MORB-like $^{3}He/^{4}He$ ($8 \pm 2\ R_A$). These observations highlight the importance of understanding why OIB are overwhelmingly dominated by geochemically depleted material, the origin of HIMU mantle by oceanic crust subduction, and the possibility that MORB-like $^{3}He/^{4}He$ dominates the lower mantle.