Xenolith constraints on "self assimilation" and the origin of low $\delta^{18}O$ values in Mauna Kea basalts

DANNY W ANDERSON[1], JOHN C LASSITER[1*], ED MARSHALL[1]

[1]Jackson School of Geosci., U Texas, Austin, TX; correspondence: lassiter1@jsg.utexas.edu

Numerous post-shield cones from Mauna Kea (MK) volcano contain abundant dunite, gabbro, and pyroxenite xenoliths. These xenoliths provide a window into magma storage, assimilation, and mixing complementary to the record contained in volcanic samples. Sr- and Pb-isotopes in MK xenoliths are positively correlated, with $^{87}Sr/^{86}Sr$ ranging from ~0.70349-0.70357 and $^{206}Pb/^{204}Pb$ from ~18.37-18.52. Comparison of Sr-Pb isotopic signatures with basalts from the HSDP-2 drillcore suggest most xenoliths are magmatic products from the late shield to post-shield transition period.

Clinopyroxene and olivine from the MK xenoliths have $\delta^{18}O$ values ranging from 3.3 to 4.8 ‰, significantly lower than typical mantle olivine values (~5.2 ‰). Mineral $\delta^{18}O$ values are positively correlated with Mg#, which ranges from ~0.73 to 0.90. Oxygen isotopes do not correlate with Sr- or Pb-isotopes. The lack of correlation between oxygen isotopes and other geochemical tracers indicates that assimilation of hydrothermally altered lower Pacific Ocean crust is unilkely to account for the low $\delta^{18}O$ values observed in evolved xenoliths. Instead, the Mg#-$\delta^{18}O$ correlation is consistent with assimilation of hydrothermally-altered ediface material. The lack of Sr-isotope anomalies in the xenoliths with the lowest $\delta^{18}O$ values suggests the absence of a "seawater signature" in the assimilated ediface. Thus, alteration and assimilation likely occurred as magmas were stored in shallow reservoirs in the subaerial portion of MK. These results are consistent with previously reported correlations between olivine Mg# and $\delta^{18}O$ in MK basalts.

Although "self assimilation" has significantly impacted O-isotopes in MK plutonic and volcanic products, the $\delta^{18}O$ values (4.7-4.8 ‰) of the most primitive xenoliths (Mg# ~0.90) are well removed from typical mantle values. Even assuming very light potential assimilants ($\delta^{18}O$ ~0), at least ~10% assimilation would be required to account for the observed low-$\delta^{18}O$ values in the most primitive xenoliths. This level of assimilation should result in cooling and fractionation of the primary magma, which is inconsistent with preservation of primitive Mg#s in these samples. Thus, the low $\delta^{18}O$ signature of the most primitive xenoliths (and MK basalts) likely derives from a low-$\delta^{18}O$ recycled component intrinsic to the Hawaiian plume.