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Elevated and heterogeneous oxygen fugacity in global hotspot lavas

LORI N WILLHITE[1], RICARDO AREVALO JR.[1], PHILIP M PICCOLI[1], DEVIN S RAND[2], MAREK LOCMELIS[3], ROBERT WILLIAM NICKLAS[4], MATTHEW G. JACKSON[2], PROF. JAMES M.D. DAY[5], JOHN C. LASSITER[6], THOMAS IRELAND[7], IGOR S PUCHTEL[8] AND VALERIE FINLAYSON[1]

[1]University of Maryland
[2]University of California, Santa Barbara
[3]Missouri University of Science and Technology
[4]University of California, San Diego
[5]Scripps Institution of Oceanography
[6]The University of Texas at Austin
[7]Boston University
[8]Department of Geology, University of Maryland

Presenting Author: lorinwillhite@gmail.com

Plumes sample material from variable depths of the mantle, enabling glimpses into the composition and oxygen fugacity (fO_2) of Earth's interior. This study provides a global, systematic assessment of fO_2 and He-Sr-Nd-Pb-W-Os isotopic compositions of plume-derived lavas from ten hotspot locations: Macdonald (Mangaia and Austral islands, both part of the Macdonald hotspot, are shown separately in the figure below), Canary Islands, Samoa, Réunion, Azores, Hawaii, Pitcairn, St. Helena, and Baffin Island (associated with the early Icelandic hotspot). Ocean island basalts (OIB) have fO_2 values that are heterogeneous both within and among hotspots (Figure 1), suggesting oxygen fugacity heterogeneity within mantle plumes. Generally, global OIB have elevated fO_2 (median = +1.2 ΔFMQ) relative to global mid-ocean ridge basalts (median = -0.4 ΔFMQ). Geochemical indices of crustal recycling, such as Sr-Nd-Pb-Os isotopic compositions, do not correlate well with fO_2 in OIB. An exception is for Hawaiian lavas with relationships between $^{187}Os/^{188}Os$ and fO_2, indicating recycling may influence mantle oxygen fugacity on local spatial scales (see Figure 2). On the global scale, heterogeneous and elevated fO_2 in global OIB can be explained by decoupling of fO_2 and isotopic compositions during crustal recycling or an alternative mechanism of oxidation, such as preservation of oxidized mantle from early Earth differentiation like core formation.

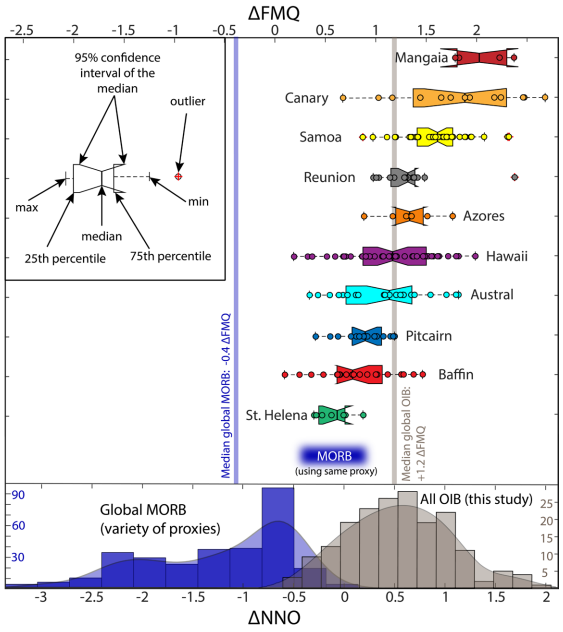

Figure 1

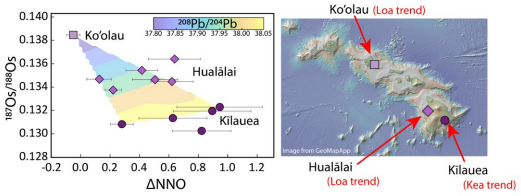

Figure 2