The Spatial Distribution of fO_2 in the Mantle: Insights from V Partitioning Behavior in Ocean Island Basalts

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Redox conditions affect the partitioning behavior of elements among phases within the Earth system, and exert a strong control on the chemical speciation of gases released from magmatic systems into the atmosphere. Therefore tracking the redox state of mantle reservoirs has implications for the material exchange among all of Earth's chemical reservoirs through time. It is not yet clear how recycling crust and mantle lithosphere affects the oxidation state of the mantle—Earth's largest chemical reservoir—warranting examination of redox signatures in mantle-derived rocks. Ocean island basalts (OIB) represent melts from a diverse suite of mantle domains thought to contain variably depleted and enriched recycled materials; these lavas allow for investigation of the oxidation states of their spatially and chemically distinct mantle sources.

First row transition elements (FRTE) are used as redox indicators because select FRTE can take on multiple valence states during basalt genesis. Here, we use the partitioning of V between olivine and the matrix ($D_V^{ol/matrix}$) to evaluate the oxygen fugacity (fO_2; a major control on the mantle redox state) of OIB from nine localities (Hawaii, Samoa, Pitcairn, Canary, St. Helena, Cook-Austral, Mangaia, Reunion, Azores) and one continental flood basalt (CFB, Baffin Island). Preliminary results indicate that the fO_2 of different localities overlap, but some localities are statistically distinct from others (e.g., Baffin Island fO_2 [median = 0.4 ΔNNO] is lower than Mangaia [median = 1.5 ΔNNO], Samoa [median = 1.3 ΔNNO], and Reunion [median = 1.3 ΔNNO]). The samples in this study appear to have overlapping, but typically higher, fO_2 than previous estimates of MORB fO_2 (~ -1 to 0.5 ΔNNO; using XANES, bulk rock V/Sc, etc.), indicating OIB and CFB mantle sources may contain components that are more oxidizing than MORB mantle.