Tungsten in Mariana arc basalts: Evidence for mobility and isotopic fractionation during subduction

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Many geochemical characteristics of arc lavas can be reconciled if they represent a mixture of upper mantle melts with variable contributions from two slab derived components; a sediment melt, and an aqueous fluid. Traditionally, these two slab components were distinguished based on characteristic trace element variations. Attention has since shifted to diagnosing these components by novel application of non-traditional stable isotope systems [e.g. 1, 2]. The mechanism for generating these isotopic variations provides insight into the role of residual phase mineralogy in the subducting slab [1, 2].

Specifically, a recent study on stable Mo isotope fractionation in arcs tentatively ascribed a role for rutile in the genesis of heavy Mo isotopic compositions in Mariana arc lavas. As a highly incompatible, fluid mobile element also incorporated into rutile in typical subduction zone conditions [3], tungsten isotopes are promising as both a tracer of subduction zone components [4], and a tool with which to test the role of rutile.

We present double spike derived stable W isotopic compositions and W concentrations for several islands within the central island province of the Mariana arc. Mariana arc lavas are enriched in W relative to Th and form a tightly defined array in Ba/Th versus W/Th, providing additional evidence for the fluid mobility of W in subduction zones. That W/Th also co-varies with previosuly determined Pb/Ce [2] suggests a common source for W and Pb in the aqueous fluid: the subducting mafic oceanic crust. Samples preserving the greatest W enrichment record the heaviest W isotopic compositions, suggesting that the aqueous fluid carries an isotopically heavy W signature.

Our results can be reconciled if isotopically light W is incorporated into rutile, leading to complementary enrichment of isotopically heavy W in fluids that rise to contribute to arc magmas. These findings complement previous Mo data [2], and provide an alternative explanation for heavy W isotopic compositions in arc magmas [4].

[1] Prytulak el al., (2013) *Chem Geol*. 345, 139-149 [2] Freymuth et al., (2015) *EPSL*. 432, 176-186. [3] Bali et al., (2012) *EPSL*. 351-352, 195-207. [4] Kurzweil et al., (2019) *GCA*. 251, 176-191.