Arc Magmatism: Insights from Iron Isotopes.

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To examine oxidation of arc magmas, we determined iron isotopes on 130 mafic lavas from 13 arcs. These mainly oceanic arcs are from the circum-Pacific, the Indonesian Sunda-Banda arc and the Lesser Antilles. Their mean δ^{57}Fe value is +0.075 ± 0.05, lighter than MORB (+0.15 ± 0.03). Western Pacific arcs extend to very light δ^{57}Fe (Kamchatka ~ -0.11). This is contrary to expectation, because Fe isotope fractionation factors and the incompatibility of ferric versus ferrous iron during mantle melting, predicts that melts of more oxidized sources will be enriched in heavy Fe isotopes. Subducted hydrous flux may correlate with subducted oxidation capacity and a correlation between each arc's thermal parameter (ϕ) and δ^{57}Fe is predicted. However arcs mostly define a negative array with the ϕ value. High ϕ western Pacific arcs have lighter δ^{57}Fe values than the low ϕ eastern Pacific arcs.

There are two types of covariation between δ^{57}Fe and radiogenic isotopes. Arcs with MORB-like Sr-, Nd- and Pb-isotopes show δ^{57}Fe variation from heavy MORB-like (Scotia or the Cascades) values to light values (Kamchatka, Tonga). This trend to light iron isotopes (high ϕ arcs) results from repeated hydrous flux-driven, oxidised, fO_2-buffered, melt extraction from the mantle wedge. Data from developing intra-arc to back-arc rifts in the western Pacific show that these characteristic arc signatures are rapidly dispersed by DMM or OIB mantle influx when rifting occurs. Hence characteristic light arc signatures form lodged under arcs where sub-arc mantle corner flow is a trapped vortex. The second trend is of enrichment in heavy Fe isotopes positively correlated with increasing Pb- and Sr-isotope ratios and decreasing Nd ratios. This results when subducted sediment melting transfers ferric iron to the wedge and is pre-eminent in sediment-rich arcs such as eastern Indonesia.