Tracing subduction zone fluids in Izu arc lavas using molybdenum isotopes

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Molybdenum isotope ratios recently emerged as a tracer for mass transfer within subduction zones. Yet in different arcs Mo added to magma sources from subducted slabs appears to be of variable isotope composition. In particular, there is still debate about the processes generating high $\delta^{98/95}$Mo in arc lavas, for which diverse hypotheses have been proposed [1, 2, 3, 4, 5].

Here we present Mo isotope data for basalts and basaltic andesites from the Izu island arc, where slab-derived components are suggested to be dominated by hydrous fluids [e.g. 6, 7]. This makes the Izu arc an ideal setting to study the Mo mobilization from subducted slabs via fluids and potentially associated Mo isotope fractionation.

The lavas have significantly higher ^{98}Mo/^{95}Mo than MORB (i.e. $\delta^{98/95}$Mo > -0.20‰). Relative enrichments in fluid-mobile elements (e.g. Ba/Th, Ce/Pb, ^{238}U/^{230}Th) are associated with high $\delta^{98/95}$Mo, suggesting that the slab-derived fluid has a heavy Mo isotope composition. Positive correlations between $\delta^{98/95}$Mo and ^{143}Nd/^{144}Nd and ^{176}Hf/^{177}Hf ratios exclude fractional crystallisation of hydrous phases as a cause for the observed Mo isotope variations. By identifying a clear link between isotopically heavy Mo and slab-derived fluid addition in arc lavas, our data lend strong support to the hypothesis that Mo isotope fractionation occurs during the transport of fluids through the oceanic crust, which has been attributed to the retention of isotopically light Mo in oxide phases, such as rutile, during fluid fluxing [1, 2]. Through geochemical modelling, we further constrain the causes and magnitudes of these Mo isotope variations and assess the consequences for the Mo cycling in subduction zones.

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