Copper isotope constraints on Cu enrichment in subduction zones

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Copper ore formation is largely linked to arc magmatism. Yet, whether Cu enrichment in arc magmas is caused by slab contributions or magma evolution under oxidised conditions is disputed [1,2]. Copper isotope ratios (reported as δ^{65}Cu, the permil variation in ^{65}Cu/^{63}Cu relative to NIST976) are a potential tracer for the Cu enrichment but have not been explored in detail in subduction zones. To explore this potential we measured Cu isotope ratios in magmas from the Izu volcanic arc in the Western Pacific ocean.

The Izu arc is a global end-member where slab contributions to the magma sources are dominated by hydrous fluids whereas melts of subducted sediments are minimal. This allows a close examination of the potential for Cu mobilisation from the slab via fluids. The Izu arc Cu isotope ratios are mostly within the range previously reported for arc magmas from Kamchatka [3], the Tonga rear-arc [4], and the suggested composition of the depleted mantle [3]. Yet, Cu isotope ratios vary significantly between individual islands along the arc. The variations do not correlate with tracers for enrichment via slab components.

Copper is incompatible during differentiation of arc magmas until the onset of magnetite crystallization and concurrent sulfide fractionation [2]. The Izu arc lavas sample this compositional interval but do not show coherent trends with degree of differentiation. These observations indicate that the Cu isotope variation in the Izu arc lavas is not caused by slab enrichment or fractional crystallization. Instead, it could be either related to heterogeneity of the mantle source or to Cu isotope fractionation during partial melting of the mantle in the presence of residual sulfides. Our data therefore support models in which the arc magma Cu budget is dominantly mantle-derived.

References:

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