Testing the slab connection in volcanic arcs: a global perspective

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The flux of material from the subducted slab drives arc volcanism and controls arc-trench connectivity, yet the overall impact of slab flux remains difficult to assess as it mixes variably with the depleted and enriched mantle wedge prior to re-emergence in arcs. I provide a new perspective on the influence of the slab flux on arc magma composition through a evaluation of radiogenic isotope tracers in global arc magmas. A compilation of Sr-Pb-Nd-Hf isotope ratios from n= 5419 arc volcanic rocks from 31 arc segments reveals large-scale variations in Sr-Pb-Nd isotope ratios. Circum-Pacific arcs delineate a region of Pacific-type MORB Δ8/4 values that is bordered by regions where arc magmas exhibit enriched, Indian-type MORB Δ8/4: the Pacific Northwest (Kuriles-Honshu-Izu Bonin-Ryuku-Luzon-Indonesia) and the Pacific Southeast (southern South America-South Sandwich), respectively. However, $^{87}Sr/^{86}Sr$ and $^{143}Nd/^{144}Nd$ only partly follow the enriched vs. depleted pattern of the Pb isotopes, and show significant deviations along the east Pacific rim (Cascades to Andes NVZ) and the Izu Bonin-Mariana arcs.

These large-scale arc patterns can be reconciled with a strong impact of the slab flux on the arcs' mantle sources. A high Pb flux from the subducted altered oceanic crust (AOC) can control the Pacific- vs. Indian-type MORB signatures of arcs. The AOC flux would also strongly influence the arc $^{87}Sr/^{86}Sr$ together with unradiogenic Sr from the mantle wegde. In contrast, arc $^{143}Nd/^{144}Nd$ seems to be mostly sourced from the mantle wedge, excepting those arcs systems where either copious amounts of terrigenous sediment and/or eroded forearc crust enter the subduction channel (e.g. Mexico), or where oceanic ridges and plateaus collide with the arc (e.g. central America, Izu Bonin-Mariana). Remarkably, the isotope data do not provide evidence for any significant crustal contamination, which supports the concept of rapid material turnover from slab through mantle and crust to surface, and of strong arc trench connections that can be sensitive to changes of the ocean-atmosphere system.