

Across-arc variations in Rb isotopes in cold subduction zones

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To what extent partial melting of subducting slabs contributes to arc magmatism in cold subduction zones is highly controversial. Although traditional views hold that altered oceanic crusts (AOC) merely dehydrate and subducted sediments partially melt, increasing studies have suggested that partial melting of AOC is also necessary to account for arc elemental fluxes, particularly Sr. Rubidium (Rb) isotopes can be used as a novel tool for tracing the recycling of subducted materials. This study reports Rb isotope data ($\delta^{87}\text{Rb}$) for arc basalts, back-arc basalts, and intraplate basalts associated with the cold subduction zone of the Paleo-Pacific (Izanagi) plate in Eastern China. The $\delta^{87}\text{Rb}$ of the basalts shows apparent variation across the subduction zone, which increases from the arc basalts ($-0.31 \pm 0.45\text{‰}$) over the back-arc basalts ($-0.19 \pm 0.07\text{‰}$) to the intraplate basalts ($0.03 \pm 0.22\text{‰}$). These values are lower, similar to, and higher than those of MORB ($-0.12 \pm 0.08\text{‰}$), respectively, reflecting the variation in Rb isotope composition across different tectonic settings.

These variations indicate that while partial melting of subducted sediments occurs across the sub-arc, back-arc, and intraplate regions, partial melting of AOC is only evident in the back-arc and intraplate regions, not beneath the sub-arc region. Moreover, the correlations between $\delta^{87}\text{Rb}$ or Sr-Nd-Pb isotopes and Sr or Sr/Y compositions of the arc basalts strongly suggest that their high Sr contents (385-913 $\mu\text{g/g}$) result from the subduction input from sediments, rather than from the AOC as has recently been proposed. Globally, similar findings are observed in arc lavas from other cold subduction zones, which typically exhibit a negative correlation between Sr/Y and $^{143}\text{Nd}/^{144}\text{Nd}$ or Nb/U ratios. Our results imply that arc lava geochemistry in cold subduction zones does not necessarily reflect the partial melting of AOC in sub-arc regions. Instead, partial melts of metasomatic pyroxenites formed via the metasomatism of the sub-arc DMM by sediment melts can carry a significant budget of trace elements for arc magmas.