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The influence of subducted components on the Ti isotopic composition of arc magmas

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The Ti stable isotope composition ($\delta^{49/47}$Ti) of arc magmas is widely thought to reflect that of their mantle source. However, the $\delta^{49/47}$Ti of subducted slab components, and how these are modified during the prograde and retrograde metamorphism that takes place in subduction-zone environments, remain unknown. To address this and evaluate the effects that subduction-related metamorphism and metasomatism may have on arc magmas $\delta^{49/47}$Ti values, we conducted an extensive Ti isotope study of metabasites (n = 37), metasomatites (n = 7), serpentinites (n = 2), and calcschist (n = 1). The samples were collected from six different exhumed subduction complexes (Tavşanlı (Turkey), Alpine Corsica (France), Diahot (New Caledonia), Franciscan (USA), Port Macquarie (Australia), S. Motagua (Guatemala)), and two continental subduction zones (Western Gneiss Region (Norway), and D'Entrecasteaux islands (Papua New Guinea)). This global study allows us to constrain the typical $\delta^{49/47}$Ti ranges of major subducted components (e.g., altered oceanic crust, subducted sediment, hydrated lithospheric mantle), which coupled with bulk major and trace element contents enables interrogation of the extent to which these can influence the $\delta^{49/47}$Ti of volcanic arcs.

Our results show that subducted components are characterized by a wide range of $\delta^{49/47}$Ti values, which correlate with the extent of sediment influence via mechanical and/or chemical mixing. Increases in $\delta^{49/47}$Ti coincide with an overall bulk enrichment in Th, U, Mo, and light rare earth elements (LREE) compared to Mg and transition metals (e.g., Cr, Ni, Co). Using these data, the potential contributions of two major subducted slab components (i.e., metabasite, (meta)sediment) to the $\delta^{49/47}$Ti of volcanic arcs were evaluated relative to mantle-derived partial melts, using mass balance constraints on their bulk Ti concentrations and isotopic values. Results of Monte Carlo simulations show a marked increase in the relative contributions of both metabasite and (meta)sediment to arc magmas as the mantle source becomes progressively depleted in Ti. Our comprehensive Ti isotope study across various subduction complexes sheds light on the $\delta^{49/47}$Ti values of major subducted components, revealing not only significant changes during subduction and/or exhumation but also their potential contributions to the $\delta^{49/47}$Ti of volcanic arcs.