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Revisiting Barium isotope systematics at the Tongan subduction zone: implications for deep mantle recycling

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Subduction zones are characterized by the highest mass fluxes between crust and mantle and have a direct influence on Earth's mantle heterogeneity. Barium isotopes ($\delta^{138/134}$Ba) have emerged as a novel tracer to investigate the subduction recycling of crustal material into the mantle wedge as well as the deep mantle. Ba plays a key role in tracing subduction recycling as generally more than 90% of the Ba in arc lavas is derived from the subducted slab. Significant stable Ba isotope fractionation occurs during Earth's surface processes leading to distinct Ba concentrations and Ba isotopic ratios in different marine lithologies that eventually subduct. Characterizing the Ba-isotope composition of subducted marine sediments, altered oceanic crust (AOC), and their complementary subduction output (i.e. arc lavas) is therefore a necessary step towards applying this novel isotope system for the investigation of crust-mantle evolution.

Here we report Ba isotope data from input to output at the Tongan subduction zone: pelagic sediment and AOC samples from the DSDP site 595/596 on the subducting SW-Pacific plate, complemented by Tongan arc lavas. Our data show variable and higher $\delta^{138/134}$Ba of subducting deep-sea pelagic sediments than previously assumed [1]. Downhole trends in the sedimentary pile likely reflect a mixture of an isotopically heavy authigenic vs. an isotopically light lithogenic component. This authigenic Ba endmember, which is potentially mobilized in aqueous fluids during the early stages of subduction in the forearc, can account for isotopically heavy Ba reported for Tongan arc lavas. However, Tongan arc samples that are thought to be influenced by hydrous melts show lighter isotope signatures close to that of the lithogenic Ba endmember. This implies that the nature of host minerals and their stabilities during prograde subduction metamorphism has an effect on the recycled Ba signature of the subducted slab material that eventually enters the deep mantle.

[1] Wu, Turner, Schaefer (2020), *Geology* **48**, 1053–1057.