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Fractionation of trace elements under the lowest grade conditions of subduction zone metamorphism: some insights from the Mariana forearc

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The Mariana forearc affords unique opportunities to examine materials from a subduction channel assemblage at 0.4-0.7 GPa and ≈70° to ≤ 350°C, P-T° conditions that range lower than the lowest metamorphic grades reported for the Catalina Schist [1,2]. Serpentinite muds with entrained ultramafic, mafic and sedimentary clasts and geochemically anomalous pore fluids have been recovered from over a dozen active serpentinite mud volcanoes from the outermost forearc. Five of these were drilled during ODP Legs 125 and 195 and IODP Expedition 366 to examine geochemical changes as a function of slab depth, as well as changes related to convergence geometry and the subduction of volcanic Pacific plate seamount chains.

The serpentinites and pore fluids show geochemical evidence for epidote formation at the expense of lawsonite in the subducting ocean crust under lower blueschist facies conditions, as Sr and Ca decline sharply, while Na increases in both the fluids and serpentinites at greater distances from the trench (Asut Tesoru: depth to slab≈18 km; T°≥250°C [3,4]). Sr and Ca enrichments and Na depletion in seamounts closest to the trench (Yinazao: slab depth≈13 km; T°≈70°C) appear to reflect the decomposition of calcic feldspars and early lawsonite growth. While the heavy alkalies and boron all are markedly enriched in pore fluids from the deeper-slab seamounts (e.g., B = 0.2 µM/kg at Yinazao vs. >1000 µM/kg at Asut Tesoru) consistent with clay decomposition on the slab, the serpentinites show more gradual increases in concentration, suggesting that changes in serpentinite/porefluid partitioning with increasing T° may buffer the enriching effects of slab mineral breakdowns. While Ba, As, Sb, and U all become higher in the serpentinites with increased slab depth, the abundances of Li, Mo, and Pb are more uniform, though all the fluid-mobile elements in the Mariana serpentinites are enriched compared to depleted mantle [5].

[1] Bebout et al (1999) *EPSL*, 177, 69-83; [2] Fryer et al (2020), *Phil Trans Roy Soc A*, 378:2165; [3]Menzies et al (2022) *GCA* 319*,* 118-124; [4] Mottl et al, (2023) *GCA* 340, 1-20; [5] Salters and Stracke (2004) *GCubed* 5, doi:10.1029/2003GC000597