Goldschmidt 2026 Abstract
https://doi.org/10.46427/gold2026.34280

Carbon and iron dominate the redox budget of subducted sediments

ALLY PECCIA[1], TERRY PLANK[1], BENJAMIN BOSTICK[2], ALBERTO MALINVERNO[3], SHUO DING[4], ZOLTÁN TARACSÁK[5], PROF. ALESSANDRO AIUPPA[6], SALVATRICE VIZZINI[7], CECELIA TRAMATI[8], DAVID PYLE[9] AND TAMSIN A. MATHER[9]

[1]Lamont-Doherty Earth Observatory, Columbia University
[2]Lamont Doherty Earth Observatory, Columbia University
[3]Lamont-Doherty Earth Observatory
[4]University of Florida
[5]University of Cambridge
[6]University of Palermo, Dipartimento di Scienze della Terra e del Mare
[7]University of Palermo
[8]Università di Palermo
[9]University of Oxford

While arc magmas are more oxidized than mid-ocean ridge basalts, the mechanism of oxidation remains hotly debated. Sediments are often invoked as oxidizing agents, bearing oxidized forms of Fe, C, and S from the surface realm to the sub-arc mantle. However, existing redox budgets are data-limited, making it difficult to identify which oxidant carrier dominates and how oxidized inputs vary globally. Here, we conduct the first multi-trench study of Fe, S, and C species in subducting sediments at four contrasting subduction zones: Central America, Alaska, Tonga, and the Marianas. Our budgets are based on new S concentration and $\delta^{34}S$ measurements, derived from high-resolution XRF core scanning and ICPMS and EA-IRMS analysis of discrete samples. We find that S-rich, pyrite-dominated, and isotopically light S subducts at Central America and Alaska, while low bulk S, sulfate-dominated sediments subduct at the Tonga and Marianas trenches. Fe-XAFS measurements reveal highly oxidized sedimentary Fe inputs (>90% Fe^{3+}/Fe^{T}) to the Central America, Tonga, and Marianas trenches, while turbidites subducting at the Alaska margin contribute substantial reduced Fe (~50% Fe^{3+}/Fe^{T}).

With these new data and recent estimates of subducting carbon[1], relative to a mantle reference state (C^{0}, Fe^{2+}, S^{2-}). We find that RB falls between 1 - 17 mol e^{-}/kg, varying substantially on either side of the 11 mol e^{-}/kg global RB predicted by Evans (2012). RB is dominated by C^{4+} at margins where carbonate is present (e.g., Central America, Marianas) and dominated by Fe^{3+} where carbonate is absent (Tonga, Aleutians). While S is a favored candidate in the transfer of RB from the slab to the sub-arc mantle, sedimentary S input is dominated by S^{-}, and therefore limited in its oxidizing capacity. However, our results show in all investigated cases, there is sufficient Fe^{3+} to oxidize S^{-} to S^{6+} in each sediment package, a requirement of current S isotope recycling models[3,4] with implications for redox transfer in subduction zones and the mantle.

References:

[1]Plank & Malinverno, G-Cubed, *in revision*; [2]Evans, Ear. Sci. Rev., 2012; [3]Peccia et al., Chem. Geol., 2025; [4]Taracsak et al., EPSL, 2023.