Goldschmidt 2023 Abstract
https://doi.org/10.7185/gold2023.17683

Barium isotopes trace perturbations to critical zone nutrient inventories in the Mekong River catchment due to dam construction

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Human activities and climate change are perturbing critical zone nutrient inventories. For example, the construction of dams has reduced sediment fluxes from upland regions, which are a key source of nutrients to the downstream floodplains. Quantifying these perturbations requires tracking the balance between critical zone nutrient inputs (chemical weathering reactions and sediment deposition) and outputs (leaching and erosion). Here will build on recent research (Bridgestock et al., 2022), to demonstrate the utility of barium (Ba) isotopes to place mass balance constraints on the nutrient stock imbalances resulting from dam construction.

This new tracer application relies on the partitioning of chemical weathering Ba fluxes between the dissolved and exchange pools, which is accompanied by an isotope fractionation. These isotopically distinct pools trace the main outputs of critical zone nutrient inventories (leaching and erosion). Isotopic differences between these riverine output fluxes, relative to chemical weathering inputs, can be used to constrain imbalances between these critical zone nutrient sources and sinks. This tool is applied to samples from the Mekong River, which has been significantly impacted by the construction of a cascade of large dams in the upper reaches of the catchment. The samples span a 3500 km transect from just below the dam cascade to the delta in September 2017.

The Ba isotopic composition of the combined dissolved-exchange pool riverine exports are offset to higher $\delta^{138/134}$Ba values (0.09 to 0.16 ‰) compared to estimates of chemical weathering inputs ($\delta^{138/134}$Ba = –0.01 ± 0.05 ‰, 2SE, n =7). This imbalance is interpreted to reflect the trapping of suspended sediment in the upstream dams, associated with exchange pool Ba featuring isotopically light Ba. In turn, this traces a decrease in the supply of bioavailable nutrients to the downstream floodplain via suspended sediment loads. These results complement previous findings from the Irrawaddy and Salween river catchments (Bridgestock et al., 2022), and together highlight the unique utility of Ba isotopes for constraining human impacts on critical zone nutrient inventories.

References

Bridgestock et al., 2022, Tracing transients in exchangeable cation storage using Ba isotopes, *Goldschmidt Conference*