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Tracing transients in exchangeable cation storage using barium isotopes

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The storage and release of cations adsorbed to mineral surfaces (known as the 'exchange pool') within the critical zone is hypothesized to buffer riverine chemical export fluxes [1]. The size of this storage reservoir is sensitive to perturbations to regolith production versus erosion. Here we demonstrate the utility of barium (Ba) isotopes to trace transient changes in exchange pool storage in two of the world's largest river systems in terms of sediment transport; the Irrawaddy and Salween.

Barium partitions strongly into the exchange pool, accounting for between 4 and 94% of total mobile (dissolved + exchangeable) riverine Ba export fluxes, associated with an isotope fractionation of $\delta^{138/134}Ba_{diss\text{-}ex}$ = 0.24 ± 0.11 ‰. Concentrations of suspended particulate material (SPM) are the primary control on this flux partitioning. The $\delta^{138/134}Ba$ values of total mobile Ba export fluxes vary between 0 and 0.21 ‰, also as a function of SPM concentrations (Fig. 1). At high SPM concentrations, total mobile $\delta^{138/134}Ba$ values balance those of the weathering lithologies (represented by residue fractions of bedload sediment). At lower SPM concentrations total mobile $\delta^{138/134}Ba$ values are offset to higher values relative to the weathering lithologies.

These systematics are consistent with transient changes in the size of the exchange pool storage reservoir within these catchments. Isotopic imbalances between total mobile Ba exports and weathering lithologies largely correspond to samples from dammed sub-catchments or during seasonal minima in SPM export. Such imbalances are interpreted to reflect the growth of exchange pool cation storage, associated with the preferential accumulation of lighter Ba isotopes in the regolith. Overall these results demonstrate the utility of barium isotopes to study how climate change and human activities (e.g. dam construction and land-use changes) perturb exchange pool storage and riverine chemical fluxes.

[1] Chow and Mast, 2010, *Chemical Geology*, 269, 40-51, 10.1016/j.chemgeo.2009.09.014

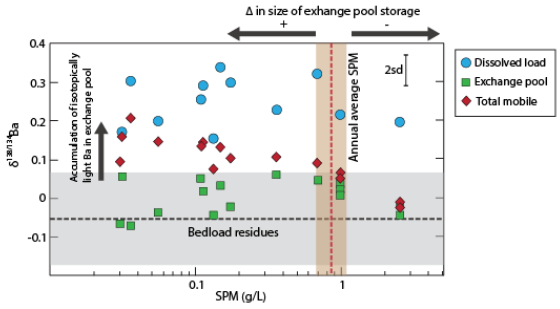

Fig 1, Barium isotope results for the Irrawaddy River catchment as a function of suspended particulate material (SPM) concentrations. Annually average SPM concentrations are from Baronas at al, 2020, *JGR Earth Surface*, doi:10.1029/2020JF005554