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"Reversing" reverse weathering in surface sediments

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Reverse weathering (RW) consumes biogenic silica ($bSiO_2$ – as dissolved silicic acid, $Si(OH)_4$), alkalinity, and cations (e.g. Li) while forming new aluminosilicate material and releasing CO_2. RW plays a major control on whether $bSiO_2$ can efflux back into the water column or is sequestered in the sediments as authigenic material. Much of our knowledge about these processes is based on static measurements, with little understanding of temporal evolution due to seasonality or stochastic events (e.g. tropical cyclones). Stable isotope compositions ($\delta^{30}Si$, $\delta^{7}Li$) in porewater and operational sediment pools, analyzed in coastal sediments (Mississippi River Plume) sampled before and after a major tropical cyclone, paint a dynamic picture. Three months post storm, porewater $Si(OH)_4$ concentrations in the upper 15 cm increased over two-fold, but with only a small decline (<0.4‰) in $\delta^{30}Si(OH)_4$. Post storm, porewater Li concentrations were homogenized (opposed to showing clear drawdown with depth) and $\delta^{7}Li$ was 2-4‰ higher. Among particulates before the storm, there were strong $\delta^{30}Si$ differences (average 0.63‰) between operational pools which do (i.e. Si-Alk) and do not (i.e. tbSi) account for authigenic coatings, a metric for the strength of RW; this offset diminished after the storm (average 0.13‰). Similarly, there was a 2-3‰ decline in $\delta^{7}Li$ associated with authigenic particle phases post storm. $\delta^{30}Si$ for both Si-Alk and tbSi, the source of porewater $Si(OH)_4$ via $bSiO_2$ dissolution, remained lower than the porewater $\delta^{30}Si(OH)_4$. This suggests the post-storm porewater consumption of $Si(OH)_4$, due to RW processes (which enrich ^{30}Si in porewater), sustained the high isotopic composition despite the two-fold increase in concentration from dissolution of an isotopically lighter source ($bSiO_2$). Twelve months after the storm, the $\delta^{30}Si$ differences between operational $bSiO_2$ pools increased to ~0.38‰ (~half the pre-storm offset), and porewater $\delta^{7}Li$ returned to pre-storm levels as did porewater Li profile trends. Our data suggest that while the storm "reversed" the apparent sink of RW, this was temporary, as restratification of the sediments post storm reestablished offsets and vertical structure. Such decoupling and recoupling suggests caution when interpreting down-core trends in surface sediments from single-point snapshots which are prone to variability from seasonality and/or stochastic effects.