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Silicate weathering in marine sediments: A prominent role of deltas

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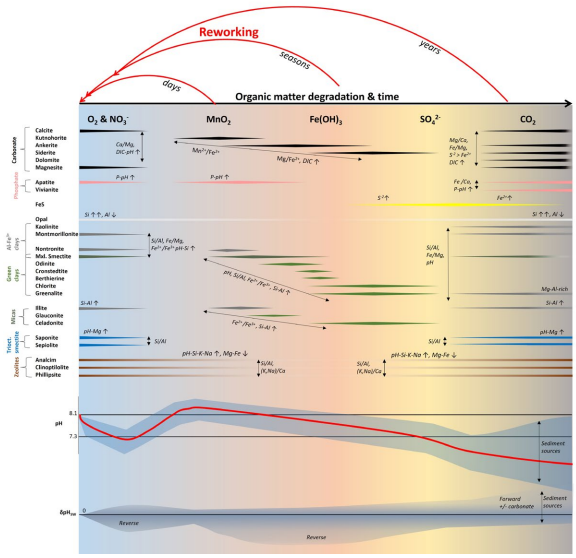
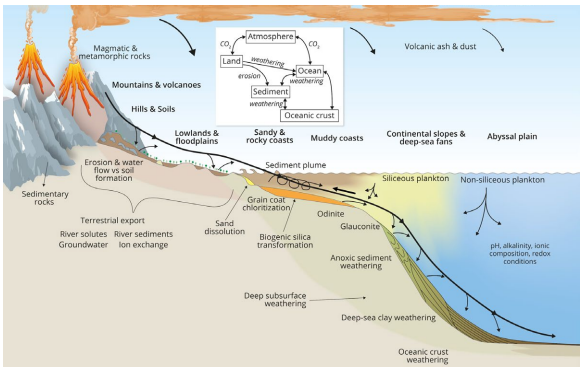
Silicate weathering globally redistributes major elements and nutrients, affecting ocean chemistry, carbon cycling and climate. Weathering transforms crustal and sedimentary materials with a spectrum of reaction balances and fluxes ranging from alkalinity and cation consumption (‘reverse’ weathering) to alkalinity and cation release (‘forward’ weathering). In marine sediments, reaction balances vary across depositional environments and with depth/time at individual locations. Thus, diagenetic forward and reverse weathering are endmembers of a reaction continuum moderated by sedimentation dynamics and reactant mixtures [1]: Terrigenous and marine-biogenic inputs determine the reaction *potential*, while environmental boundary conditions govern reaction *expression* (Figure 1).

Using diagenetic models, we predict rapid clay authigenesis and reverse weathering in episodically reworked, low-latitude deltaic muds, where green clays form from intensely pre-weathered river sediments and biogenic silica (bSi) under sustained suboxic conditions. Rapid precipitation, protracted (~ 10 – 1000 years), seasonal reworking and bSi supply drive large weathering rates and fluxes. In contrast, forward and carbonate-forming weathering are likely at low pre-weathering intensity (high latitudes and active margins), and under sulfidic-methanogenic conditions of steady, organic-rich sediments. Internal recycling during diffusive transport in such redox-stratified deposits limits their influence on the overlying water. In permeable, sandy and rocky sediments, prominent in proximal mid- and high-latitude deltas, strong and continuous advection should suppress precipitation, promote dissolution and efficiently export mobilized elements [2]. Global flux estimates must consider the relative contributions of environments with fundamentally different reaction balances, shifts of which may have dramatic consequences for seawater chemistry and Earth’s weathering feedback ([1], Figure 2). Deltas appear as modern hotspots of marine sediment weathering with a prominent role in multiple global biogeochemical cycles.





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