

Elemental fluxes and reactions during sediment transit: concepts of local and 3-D system diagenesis

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Sediment-water solute fluxes associated with subaqueous deltaic and continental shelf deposits are major components of global elemental cycling. Estimates of these fluxes are most commonly made using local measures of early diagenetic reactions, for example, from incubations of overlying water and sediment using *in situ* chambers, retrieved cores, or transport-reaction models of vertical changes in compositions (e.g., pore water solute gradients). Although rapid alteration of continentally derived material in estuarine systems at fresh water – salinity fronts (e.g., ion exchange) is sometimes taken into account in elemental budgets (e.g., Ra^{2+}), it is common to ignore progressive changes in sediment composition that can occur along sediment transit paths across- or long- shelf. As sediment migrates laterally, reactive biogenic debris is typically entrained and remineralized, degraded, or altered, and net changes in sediment composition can occur along the transit path. These changes in composition are in addition to those that occur with depth in deposits locally. In physically mobile or biologically reworked shallow water deposits, it is also often difficult to discern or accurately model down-core changes. Thus, total flux estimates from diagenetic processes along continental margins are typically underestimated. In particular, although long-shelf transport in major deltaic systems is well documented, sediment migration rates are generally poorly constrained. In the case of the Amazon – Guianas dispersal system, it is possible to estimate long-shelf mud migration and to model major progressive diagenetic changes laterally, including loss of “refractory” terrestrial organic C with a net rate constant of $\sim 0.006 \text{ yr}^{-1}$ and conversion of entrained biogenic silica to authigenic clay at $\sim 5 \mu\text{mol g}^{-1} \text{ yr}^{-1}$ (long-shelf $\sim 0.3 \text{ Tmol Si yr}^{-1}$; total system $\sim 1 \text{ Tmol Si yr}^{-1}$), that would otherwise be missed. Accurate estimates of biogeochemical fluxes and dispersal system diagenesis require inclusion of net reactions along sediment transit paths.