

## **Marine rare earth elements, neodymium isotopes and the benthic reactive layer**

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Particles in the ocean have significant potential to influence distributions of trace elements and their isotopes (TEIs) through processes including adsorption, desorption, dissolution and precipitation. The leverage particles exert over dissolved species arises because the concentrations of particulate-associated TEIs tend to be much higher (often orders of magnitude). Particle-dissolved phase interactions are complex, and made more so by amorphous - authigenic - phases, such as FeMn oxyhydroxides, which often undergo (re)cycling within marine environments. The uppermost marine sediments constitute a layer of intense reactivity, wherein these processes and phases (particulate, amorphous and dissolved) are dynamically interacting. However, because solutes are lost through diffusion, leaving behind a partially enriched sedimentary phase, the uppermost sediments are often viewed simply as a sink term for marine TEIs.

Here, we will present rare earth element (REE) and neodymium (Nd) isotope data in comparison to other chemical species from both the water column and sediments. The REEs and Nd isotopes are considered useful tracers of geochemical processes and TEI sources in the environment. We use these species to suggest that there is a benthic flux of REEs that exerts strong control on their distribution in the deep global oceans. We will discuss observations and our hypothesis that early diagenetic processes govern these fluxes, and we will discuss how these benthic processes might be manifest in the water column. While data is limited, we conclude that early diagenesis in marine sediments is likely to be a quantitatively important process affecting marine REEs and Nd isotopes, and suggest that this may be true for many other TEIs. Moreover, we suggest that these processes are not confined to continental margin areas; if they do occur throughout the ocean basins, they may be the dominant term in TEI budgets, and a primary control of isotopic tracers of deep watermasses. Thus, we suggest that compared to a 'top down' model, a 'bottom up' perspective of marine geochemistry is more appropriate.