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Dominance of benthic process in continental shelf rare earth element (REE) cycling and implications for the oceanic REE budget

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The rare earth elements (REE), as a series of particle-reactive elements, show non-conservative behaviour during transport from continental source to oceanic sink. As such, REE are powerful tools to track oceanic biogeochemical processes including boundary exchange and internal cycling. However, our understanding of REE sources is incomplete, leading to controversial interpretations regarding their oceanic cycling. Continental margin sediments have recently been assumed to be a major source, but the sediment pore-water data required to understand the processes controlling that potential source are scarce.

Here we measure and compile pore-water and estuarine REE data from the Changjiang (Yangtze) estuary-East China Sea shelf, which is one of the largest land-ocean interfaces in Asia. We show that release of REE, from shallow pore-water into the overlying seawater, is coupled to Mn reduction. On the other hand, REE are removed in deep pore-water, perhaps due to the formation of an authigenic REE-bearing phase. The sedimentary source can potentially explain REE addition in the estuary at mid-high salinity, in contrast to REE removal by scavenging at low salinity. Regarding the neodymium (Nd; a light REE) budget on the East China Sea shelf, our calculations suggest that the benthic flux is a much larger source than the riverine input.

Globally, however, we suggest that, despite a higher benthic Nd flux on the continental shelf dominated by advection processes, the much more extensive deep ocean still dominates the total area-integrated benthic flux to the water column. Our results call for a much more extensive investigation of benthic processes and the magnitude of the benthic flux of REE to the oceans.