Goldschmidt 2025 Abstract
https://doi.org/10.7185/gold2025.27501

Benthic fluxes from sediment explain elevated deep ocean metal abundances

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The oceanic depth profiles of many metals show upper ocean concentration minima and deep maxima. For bioactive metals like Zn and Ni, this observation is mostly explained by uptake into phytoplankton cells in the photic zone and return to the dissolved phase at depth during regeneration, with water mass signatures often set by particularly intense one-dimensional vertical cycling in key parts of the ocean [e.g., 1]. But these processes often cannot explain some important features of metal depth profiles, notably high deep ocean concentrations relative to phosphate. This has led to the suggestion that deep concentrations are boosted by scavenging to the surfaces of biological particles in the upper ocean, providing an additional source to deep water when these regenerate/dissolve [e.g., 2,3]. For non-bio-active elements like Nd, reversible scavenging has become a canonical explanation of oceanic depth profiles [e.g., 4]. However, the tuned scavenging co-efficients required by models that seek to test this idea are orders of magnitude higher than suggested by recent GEOTRACES particle data [e.g., 5]. Instead, these latter data point to efficient and irreversible scavenging by Mn oxide particulates.

Here, we present an alternative means to elevate deep ocean concentrations. We summarise recent sediment-porewater studies that have documented large benthic fluxes back across the sediment-water interface for a number of elements. Beneath productive upwelling ocean margins, these are driven by the continued respiration of organic matter within sediment, releasing intracellular metals to pore water. For the organic-matter-lean sediments of the abyssal ocean, high pore water concentrations result from desorption from Mn oxides. We will also present a model [6] that shows how topographic mixing driven by internal tide dissipation mixes the benthic flux signal upwards through the water column.

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