Sedimentary cycling and fluxes of bio-essential trace metals in the Peruvian oxygen minimum zone

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Trace metals can (co-)limit primary productivity in the ocean and affect the efficiency of the biological pump. Water column studies suggest that marine sediments represent an important source or sink of trace metals to the ocean. However, the mechanisms leading to trace metal release from the sediment or fixation and burial are poorly understood. Declining oxygen concentrations in the oceans will likely modify trace metal fluxes across the sediment-water interface, as the mobility of many trace metals is sensitive to redox conditions.

To investigate environmental controls on sedimentary trace metal fluxes, we present solid phase and pore-water data of Mn, Co, Ni, Zn and Cd along a zonal transect in the Peruvian oxygen minimum zone. Sediments within the permanent oxygen minimum zone are enriched in Ni, Zn and Cd but depleted in Mn and Co compared to the lithogenic background. Pore-water profiles indicate upward-directed diffusive fluxes of Mn, Co and Ni into the bottom water, whereas diffusive Zn and Cd fluxes are directed into the sediment. An apparent mismatch between total Zn and Cd accumulation rate and the amount of Zn and Cd delivered by diffusion, lithogenic and organic material is attributed to metal sulfide precipitation in the water column. The sedimentary depletion of Mn and Co compared to the lithogenic background matches the diffusive efflux of the elements within the core of the oxygen minimum zone (> 150 m water depth). By contrast, on the upper shelf Mn and Co depletion and diffusive fluxes are decoupled. The sedimentary Ni concentrations are closely correlated with organic carbon content. Recycling of Ni from organic matter within the sediment seems to be an important source of Ni to bottom waters.

Our results suggest that ongoing ocean deoxygenation may increase the benthic source fluxes of Mn, Co and Ni to the water column, whereas the sediments will represent a sink for Cd and Zn and their benthic release will likely diminish. These trends could affect the trace metal stoichiometry in upwelling water masses with potential consequences for marine ecosystems in the surface ocean.