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Iron and manganese dynamics in coastal seas and response to eutrophication

CAROLINE P. SLOMP[1], WYTZE K. LENSTRA[1] AND MARTIJN HERMANS[1,2]

[1]Utrecht University
[2]University of Helsinki

Presenting Author: c.p.slomp@uu.nl

Iron (Fe) and manganese (Mn) are micronutrients for phytoplankton, tracers of redox processes and carriers of a range of trace elements in the ocean. Shelf sediments are a major source of Fe and Mn to overlying waters. The processes leading to benthic release, lateral transport of Fe and Mn ("shuttling") and transformation on continental shelves and the ultimate fate of the Fe and Mn are still incompletely understood.

In my presentation, I will summarize our recent findings on Fe and Mn dynamics in the Black Sea and Baltic Sea. Both seas are characterized by relatively shallow shelves and adjacent euxinic deep waters. In both seas, Mn is released from shelf sediments more easily than Fe, likely because of slower oxidation kinetics of Mn(II) and ligand-bound-Mn(III) when compared to Fe(II). Macrofaunal activity plays a key role in driving high Fe and Mn release from coastal Black Sea sediments. On the open Black Sea shelf, benthic release of Fe and Mn is limited because of insufficient organic matter input to mobilize the metals. In the highly eutrophic Baltic Sea, in contrast, benthic Fe and Mn release are regulated by various factors, including bottom water oxygen, Fe-sulfur interactions and the input of Fe and Mn oxides. In both seas, water column Fe is dominated by particulate forms, such as poorly crystalline Fe oxides and clay-bound Fe. In contrast, Mn is present mostly in dissolved form, with particulate Mn (Mn oxides) playing a role only in specific areas. Sediment records of Fe and Mn for the euxinic Baltic Sea basins, capturing the past two centuries, highlight strong temporal and spatial changes in Fe and Mn input and sequestration linked to anthropogenic eutrophication and variations in bottom water oxygen. The implications for the use of sediment Fe and Mn as redox proxies will be discussed. Benthic release fluxes of Fe and Mn in the Baltic and Black Sea are at the high end of the range typical for marine environments, emphasizing that continued eutrophication and deoxygenation of continental margins may have a larger impact on Fe and Mn release to the ocean than previously thought.