

Biogeochemical processes in Baltic Sea sediments as a recorder of environmental change over the Holocene

LINA PISO¹, NIELS A.G.M. VAN HELMOND², IAN P.G. MARSHALL³ AND CAROLINE P. SLOMP⁴

¹Radboud Institute for Biological and Environmental Sciences

²Radboud University

³Aarhus University

⁴Department of Microbiology, Radboud Institute for Biological and Environmental Sciences, Radboud University

Over the Holocene, the Baltic Sea has experienced significant environmental changes driven by climatic variability, glacio-isostatic rebound and anthropogenic activities. Major variations occurred in, for example, salinity, redox conditions and organic matter loading, which, in turn, are expected to be reflected in changes in biogeochemical processes and the microbial community composition in the sediment. The Integrated Ocean Drilling Program (IODP) Expedition 347, Baltic Sea Paleoenvironment, retrieved well-dated sediment records from three key locations, allowing a reconstruction of environmental conditions in various parts of the Baltic Sea over the Holocene. Here, we summarize what has been learnt about the spatial and temporal variability of bottom water redox conditions and organic matter loading in the Baltic Sea and how it has impacted sedimentary phosphorus burial, methane dynamics, and the microbial community composition.

The IODP records capture the two major past hypoxic intervals in the basin, which are shown to reflect variations in water column stratification and organic matter supply. Phosphorus (P) records are characterized by the widespread occurrence of vivianite [1], an authigenic phosphate mineral, which forms in and below the methanogenic brackish-marine sediments. While methane that diffuses upwards is likely oxidized with sulfate as an electron acceptor, methane that diffuses into the underlying freshwater sediments may be oxidized by Fe oxides [2]. Microbial community analyses reveal shifts in composition that align with the changes in the biogeochemical processes in the sediment, thereby illustrating their close connection [3]. We compare the findings for the IODP records to those for other sites in the Baltic Sea basin, including records for the modern hypoxic period, and discuss the similarities and differences. A key conclusion is that the modern Baltic Sea is characterized by more intense and widespread anoxia and euxinia than in the past, with major implications for the recycling of phosphorus and the dynamics of methane.

[1] Dijkstra, Hagens, Egger & Slomp (2018), *Biogeosciences* 15, 861-883.

[2] Egger, Hagens, Sapart, Dijkstra, van Helmond, Mogollón, Risgaard-Petersen, van der Veen, Kasten, Riedinger, Böttcher, Röckmann, Jørgensen & Slomp (2017), *Geochimica et Cosmochimica Acta* 207, 256-276.