Spatial and seasonal variations of biogeochemical transformations in coastal sands under the impact of SGD in the southern Baltic Sea

Westphal J[1]., Moore, W.S. [2], Scholten, J.[3], Schmiedinger I.[1], Hsu, F.-H.[3] & Böttcher, M.E.[1]
1- Geochemistry & Isotope Biogeochemistry, Leibniz Institute for Baltic Sea Research (IOW), D-18119 Warnemünde, FRG (julia.westphal@io-warnemuende.de; michael.boettcher@io-warnemuende.de)
2- University of South Carolina, Department of Earth and Ocean Sciences, Columbia, USA-SC 29208
3- Institute of Geosciences, Kiel University, D-24118 Kiel, FRG

ABSTRACT

Submarine groundwater discharge (SGD) is an important pathway of dissolved element transport from the terrestrial to the marine environment. Beside fresh groundwater, SGD also consist of a considerable proportion of brackish groundwater.

Little is known about the controls of this transport from landside to the Baltic Sea and vice versa, and the associated biogeochemical reactions at the seawater/ freshwater interfacial zone. Spatial and seasonal variations of SGD especially in deeper sediments have remind widely unknown.
In the present study we followed the water and element exchange and associated biogeochemical transformation processes along a 2.5 km long costal stretch in front of a rewetted peatland, the Hütelmoor area at the southern Baltic Sea. The compartments under consideration include the coastal water column and pore waters coastal sediments.

Vertical pore water profiles were retrieved via 1.5 m push-pull pore water lances and 4.5 m long permanent pore water samplers in the shallow water area on a seasonal base. Water samples were obtained during several ship-based cruises. A focus was set on the investigation of concentration gradients of major and redox-sensitive trace elements, nutrients and the stable isotope composition (H, C, O) of water and dissolved inorganic carbon (DIC) to understand the mixing processes and superimposing biogeochemical transformation reactions. Ra isotope investigations in the water column and in the pore water complemented these measurements and are used for the detection of benthic-pelagic coupling via exchange of solutions.

The study area displays a spatial and temporal patchiness in pore water compositions due to a complex lithology with permeable sediments subdivided by impermeable peat layers of variable thickness and depth distribution. The results of the hydro geochemical and isotope investigations show SGD contributions via subterrestrial freshening along the coastline of the study area. Salinities of near-surface pore water with permeable substrate show an intense exchange with overlaying seawater, low DIC values (2.6 mM). Dissolved sulfide accumulates in deeper depths below 80 cmbsf, whereas dissolved manganese is found in depths of 15 cmbsf. Pore water with an overlaying peat layer show lower salinities with DIC values up to 20 mM derived from the oxidation of organic matter of marine origin. Dissolved sulfide and manganese accumulates already in very shallow sediments (below 10 cmbsf) due to high rates of sulphate reduction and/or pore water fluxes. However, whereas salinities vary in the upper 1.5 m they remain constant down to depths of 4.5 m. Nutrient

concentrations up to 1.2 mM for dissolved phosphate and 0 and 7.2 mM for ammonia where found. Ra isotope measurements show nearshore water with high ^{223}Ra signal indicating the contribution from SGD with high seasonal dynamics.

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