Goldschmidt 2022 Abstract
https://doi.org/10.46427/gold2022.12347

Submarine groundwater discharge impacts the biogeochemistry of coastal systems, southern Baltic Sea

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Submarine Groundwater Discharge (SGD) acts as a source of fresh water and dissolved substances for coastal ecosystems, and its fluxes can undergo biogeochemical reactions within the sediments. The present study addresses the impact of SGD on the biogeochemical processes, and further element fluxes across the sediment-water interface in the Puck Bay (PB), southern Baltic Sea. Water column samples were collected on board of research vessels between 2009 and 2021. At the muddy benthic sites, sediment cores were retrieved and porewater samples were extracted. At the sandy sites, porewater was extracted using push point devices. Samples were analyzed for major and trace elements, stable isotopes (H, O, C, S), radium and radon isotopes, nutrients, dissolved inorganic (DIC), and organic carbon. In addition, the data are compared to fresh groundwater from wells on the Hel peninsula and near the main coastline. The stable isotopic signatures of porewater at all the SGD impacted sites decreased with depth, in parallel to salinity. Moreover, at the sand sites discharge from different groundwater systems was observed. At the sandy sites, higher silicate and phosphate concentrations were observed at SGD sites when compared to the reference sites. The concentrations exceed those expected from endmember mixing between groundwater and PB bottom waters indicating the importance of the microbially catalyzed diagenetic processes in the sediments. In agreement, porewater concentrations and $\delta^{13}C_{DIC}$ (-20 and 0 ‰) at the sandy sites show a non-conservative behavior. Possible sources for DIC at these sites are carbon dioxide from the soil zone of the catchment area, sedimentary and aquifer organic matter, and methane. At the muddy sites, the $\delta^{13}C_{DIC}$ reached values up to +10 ‰ and methanogenesis is deduced related to the high organic matter mineralization. The observed benthic diagenetic accumulation of DIC is further enhanced by SGD due to groundwater contribution with overall high fluxes due to the impact of porewater advection superimposing diffusion. Therefore, non-conservative carbon transformations have to be accounted when estimating the impact of benthic-pelagic coupling on the carbon system of overlying coastal waters.

The investigations are supported by DAAD, Assemble+ (EU), BONUS AMBER, COOLSTYLE, IOPAN, and Leibniz IOW.