Impact of submarine groundwater discharge on biogeochemical processes and benthic fluxes in coastal sands

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Submarine groundwater discharge (SGD) may have important implications for the cycling of matter in coastal ecosystems. Nutrients and reduced species supplied to sediments and coastal waters via SGD may alter productivity and mineralization and hence the energy flow between benthic and pelagic zones. Furthermore, SGD may contribute to the development of hypoxic conditions in the bottom waters. However, permeable sediments, that are widespread in coastal regions of Europe, have been largely overlooked with respect to SGD-related element sources and associated biogeochemical transformations.

This study evaluates the effect of SGD on mineralization pathways in sandy sediments of the southern Baltic Sea (Hel bight, Poland) and interfacial fluxes of dissolved carbon, nutrients, and metals. *In situ* fluxes are quantified with stirred benthic chambers that are coupled with seepage meters and combined to vertical pore water profiles with emphasis on both solutes of non-conservative and reactive behaviour.

When compared to bottom waters and to a non-impacted reference site, the site impacted by groundwater seepage was found to be enriched in DIC, Mn(II), PO_4^{3-}, SiO_4^{3-}, CH_4 and HS^-, and depleted in salinity, Ca^{2+} and SO_4^{2-}. Measured seepage rates of 85±16 L m^{-2} d^{-1} agree with previous studies indicating that SGD is a persistent feature of this site. Benthic flux measurements and vertical porewater profiles at the seep and reference site show similar remineralization rates. Aerobic oxidation of organic matter represents the main mineralization pathway at both sites while microbial reduction of SO_4, Mn, and Fe play a subordinate role. Surprisingly, rates of net benthic primary production turned out to be similar at both sites, irrespective of the nutrients supplied by SGD. The main difference between biogeochemical processes at the two sites is driven by the supply of CH_4, H_2S, DOC, DIC, and metals by the seeping groundwater.