Hydrobiogeochemical Processes in Permeable Sands at the Land-Sea Transition Zone

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Land-sea transition zones are often characterized by organic-poor permeable sands, whereby the biogeochemical cycles of carbon, sulfur and iron in these sediments are not well studied yet.

To improve our understanding of such sedimental environments, we collected a 10 m core at a dune base of the barrier island Spiekeroog, Northwest Germany. Moreover, bimonthly groundwater sampling was carried out for one year to track seasonal changes of the hydrochemistry. Our methods included the analysis of geochemical (TC, TIC, TOC, Fe_{dith}, Fe_{HCl}, TS, TRIS, δ^{34}S-TRIS) and hydrochemical parameters (field parameters, major ions, DOC, molecular DOM compositions, $\delta^{34}S\text{-}SO_4^{2-}$, $\delta^{34}S\text{-}H_2S$). In addition, the ages of the sediments were determined applying optically stimulated luminescence (OSL) dating.

Results demonstrated that the sediments are very young (<500 a) and were rapidly deposited (up to ~15 cm/a). They are characterized by extremely low contents of OC (<0.1% dw.), reactive Fe (~10 mmol/kg) and pyrite (<3 mmol/kg). Top core sediments were impacted by fresh groundwater under oxygen- to nitrate-reducing conditions, whereas the lower sediments were influenced by brackish groundwater and iron oxide- to sulfate-reducing conditions. Furthermore, we could show that geomorphologic changes, (seasonal) hydrochemical variations and the biogeochemistry are closely coupled to each other. For the deeper brackish sediments, the formation of pyrite was inferred based on the detection of intact pyrite framboids, increasing TRIS contents and matching stable sulfur isotope signatures of H_2S and TRIS. Finally, we concluded that the extremely low OC contents limit pyrite formation in the investigated coastal sands.