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Tidal Forcing on biogeochemical element cycling in intertidal salt marsh sediments, Skidaway Island, Georgia

S. Neuhuber (1), G. Bistrow (2), M. Taillefert (2)

(1) Department of Geodynamics and Sedimentology, University of Vienna, (2) School of Earth and Atmospheric Sciences, Georgia Institute of Technology (mtaillef@eas.gatech.edu)

Saltmarshes are characterized by high remineralzation rates of natural organic matter. This requires a high spatial resolution to characterize processes of organic matter degradation. In addition, these systems are influenced by tidal forcing that affects the processes involved in carbon oxidation.

We use in situ voltammetric techniques to determine the role of tidal forcing on early diagenetic processes in intertidal salt marsh sediments and compare in situ time series collected at several depths in the sediment during a tidal cycle at two distinct areas. Further, head measurements in monitoring wells are used to study the influence of tidal forcing on biogeochemical processes in the first 15 cm of intertidal salt marsh sediments. The high spatial and temporal resolution data demonstrate that tidal forcing mostly influences the first tens of centimeters of these sediments and has different impact on creek bank and mud flat sediments.

In creek bank sediments, dissolved sulfide advects from depth at rising tide and partly reduces iron and manganese oxides and precipitates FeS on its way to the surface of the sediment. Fe^{2+} is found in excess of dissolved sulfide in creek bank porewaters. At ebb tide, dissolved oxygen must penetrate the sediment, as reduced chemical species are rapidly removed from the porewaters and replaced by soluble organic-Fe(III) complexes. This hydrologic regime favours the recycling of iron oxides and the prevalence of microbial iron reduction detected by other studies in these environments.

In contrast, mud flat sediments from the low marsh are less affected by tidal fluctuation because they are further away from the open water which results in less hydrostatic pressure. We observed the penetration of water through the first 15 cm of sediment from the top. As a result, the porewater chemical composition is less variable during tides and sulfate reduction is much more prevalent during most of the year.

Our results indicate that the tides coupled to the salt marsh morphology drastically influences the distribution of redox geochemical species and may be responsible for local differences noted year-round in the same sediments. Advection, rather than bioturbation, is the likely most important physical parameter affecting the biogeochemical cycling of redox sensitive elements in salt marsh sediments. Nevertheless, bioturbation passively facilitates the redox cycling by the increase the permeability of the sediments and increase of surface area exposed to dissolved oxygen from the overlying waters. The flushing and burrowing activity of macroorganisms does probably not influence the biogeochemical cycling of elements significantly. Iron reduction can be sustained in intertidal marine sediments by a combination of physical forcing and chemical oxidation.