Goldschmidt 2024 Abstract
https://doi.org/10.46247/gold2024.23131

Particulate polysaccharides drive sediment stability and carbon-remineralization in coastal sediments

FABIAN LANGE[1], SOEREN AHMERKAMP[1], GAUTE LAVIK[1], AMAN AKEERATH MUNDANATT[2], FAROOQ JALALUDDIN[1], GESA SCHULZ[3,4], CHRISTIAN WINTER[5], TIMOTHY FERDELMAN[1], HANNAH K. MARCHANT[2], JAN-HENDRIK HEHEMANN[2], MORITZ HOLTAPPELS[2,6] AND MARCEL KUYPERS[1]

[1]Max-Planck-Institute for Marine Microbiology
[2]Marum - Center for marine environmental sciences
[3]Institute of Geology, Center for Earth System Research and Sustainability (CEN), University Hamburg
[4]Helmholtz-Zentrum Hereon
[5]Kiel University
[6]Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research

Presenting Author: flange@mpi-bremen.de

The sediments underlying the highly productive waters of the continental shelves are largely comprised of permeable sands. These sands are host to highly active heterotrophic microbial communities, which drive remineralization and nitrogen loss, counteracting eutrophication. The activity of these microorganisms is supported by advective porewater flow, which enhances the supply of organic matter and electron acceptors compared to diffusion. Porewater flow results from pressure gradients associated with bedform structures on the seafloor and intensifies as bottom water velocities increase. However, when currents reach a critical velocity, the bedforms start to migrate, potentially reducing remineralization, releasing organic substrates and reducing porewater exchange. Consequently, bedform stability is hypothesized to be a key factor controlling remineralization and nitrogen loss in permeable sediments. Recent laboratory studies have shown that extracellular polymeric substances (EPS) can increase bedform stability. A major proportion of EPS are polysaccharides, which are suggested to be produced in-situ by benthic photosynthetic algae. We investigated the relationship between EPS concentrations, primary production, remineralization rates and bedform migration in subtidal sediments in the German North Sea at depths between 10 and 37m. Seafloor topography scans carried out over time revealed that bedform migration was 78% lower during summer than in early spring and substantially reduced compared to model predictions based on grain size and current velocity. Polysaccharide extraction revealed polysaccharide concentrations in pore water ranged from 2–52 mmol C l^{-1}. Yet, stable isotope incubations showed that benthic primary production rates were not nearly sufficient to explain the polysaccharide accumulation and the high respiration rates (5-15 mmol C m^{-2} d^{-1}) in the upper sediment layers. This was supported by irradiation spectra showing that almost no light of the photosynthetic usable radiation (range of chlorophyll *a* absorption) reached the sediment surface. Instead, hyperspectral scans of the seafloor showed that substantial amounts of fresh (chlorophyll *a* containing) biomass that originated from the water column accumulates in the bedform troughs. Our observations indicate that contrary to previous suggestions, the EPS which stabilizes bedforms in sandy sediments is derived from water column, rather than benthic primary production.