Geophysical Research Abstracts
Vol. 12, EGU2010-15252, 2010
EGU General Assembly 2010

Bacterial sulfate reduction and methanogenesis in brackish, oligotrophic northern Baltic Sea sediments

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Recent sediments of the northernmost Baltic Sea form underneath low-phosphate surface waters with year-round low primary production. Terrestrial organic matter from subarctic peatlands and tundra are important sources of organic matter in these sediments. These conditions make the northern Baltic an attractive Baltic analog of the Arctic shelf, because effects of changes in weathering patterns on land due to climate-related changes in temperature and runoff can be more easily studied in these sediments. Due to low production and salinities below 4 permil of northern Baltic Sea seawater, organic matter mineralization in these sediments has traditionally been thought to be dominated by aerobic respiration and suboxic diagenesis via bacterial denitrification, manganese, and iron reduction. Here we show with porewater water analyses of sulfate and methane as well as direct rate measurements of bacterial sulfate reduction and methanogenesis that these processes are more important for organic matter mineralization in these sediments than previously thought. Methane concentrations in porewaters reach saturation only few decimeters below the sediment surface and attest to the steep concentration profiles of sulfate driven by high rates of bacterial sulfate reduction. Anaerobic carbon mineralization and methane formation, and upward transport of methane to the sediment surface and water column are therefore significant components of Northern Baltic Sea sediment biogeochemistry.