Sediment microbiology and biogeochemistry of the iron cycle in a young acidic mining lake

Katrin Wendt-Potthoff, Constanze Langner

UFZ Centre for Environmental Research Leipzig-Halle Ltd., Brückstr. 3a, D-39114 Magdeburg

In the closed lignite mine Goitsche in Mid-Germany a small acidic lake (pH 3) has developed. Its sediment consists predominantly of floc-like ferric oxyhydroxides. Before flooding of the mine with river Mulde water in 1999, the microbiology and geochemistry of the present lake sediment was investigated with special emphasis on the iron cycle. In laboratory experiments with intact sediment cores, we simulated the effects of settling organic detritus and Fe precipitation during flooding by adding river plankton and P-enriched synthetic Fe(III) oxyhydroxide to the sediment surface. We also simulated the increasing influence of overflowing neutral water on the sediment. Sediment cores were incubated for 24 weeks. With this approach we intended to predict the biogeochemical development of the lake sediment after flooding with river water.

Sediment was obtained with a gravity corer and sectioned under anoxic conditions. Pore water was obtained by centrifugation. Eh, pH, DOC, sulfate, nutrients and Fe(II) in pore waters were determined. Subsamples of wet sediment material were used to determine Most Probable Numbers of iron- and sulfide oxidizing bacteria, Fe(III)-reducing bacteria and sulfate-reducing bacteria. Potential iron-reducing and -oxidizing activities were analyzed by sediment incubations. Phospholipid-P content of the sediment was used as an estimate of total microbial biomass. We found two zones of high microbial iron reduction activity which were confirmed by the Fe(II) fluxes calculated from porewater profiles and partly by abundance of Fe(III)-reducing and sulfate reducing bacteria. DOC- and phospholipid-P profiles also indicated elevated microbial activity. Fe(II)-oxidizing bacteria were present in 10^6fold higher numbers in upper layers, but a lag phase in Fe(II) oxidation experiments indicated that this did probably not reflect high iron oxidation activity in situ. However, this potential was high down to 14 cm depth, indicating a possibility for further acidification if sediments would become oxygenated. During incubation of sediment cores with river plankton and P-enriched Fe(III) oxyhydroxide, a reductive zone formed near the surface where alkalinity was

generated. Total microbial biomass also increased in this layer. Alkalinity profiles of reactive iron, production is supposed to be due to subsequent Fe(III) reduction and sulfate reduction. This hypothesis was suported by Fe(III) reduction assays and a succession of Fe(III)-reducing and sulfate-reducing bacterial populations. Below the reductive zone, the Fe(II) oxidation potential remained constant for 24 weeks. However, rapid reoxidation of sediment material is unlikely under in situ conditions, even if inflowing water would cause some erosion of the surface. Major changes in sediment biogeochemistry were produced by addition of carbon and phosphorus, whereas overflowing neutral water had only minor effects on the sediment.

Geochemische und mikrobiologische Vorgänge in Sedimenten und an der Sediment-Wasser-Grenzschicht in Restseen von Bergbaufolgelandschaften

Workshop

23. bis 25. Februar 2000
im UFZ-Umweltforschungszentrum Leipzig-Halle GmbH
Sektion Gewässerforschung
Magdeburg

Kurt Friese, Kathleen Kirschner, Martin Schultze,
Katrin Wendt-Potthoff (Hrsg.)

UFZ- Umweltforschungszentrum Leipzig-Halle GmbH
Permoserstr. 15, D-04318 Leipzig

Sektion Gewässerforschung
Brückstr. 3a, D-39114 Magdeburg