Microbial methane formation from coal and mine timber in abandoned coal mines

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Worldwide, about seven percent of the annual methane emissions originate from coal mining. Due to rising energy prices, this alternative energy source comes into the focus of the power-producing industry. In many coal deposits, stable isotopic analyses have shown a mixed thermogenic and biogenic origin of the mine gas [1]. We have confirmed this by measuring the isotopic composition of methane in gas samples collected underground. Time series experiments with *in situ* flux chambers positioned over hard coal and mine timber showed similar isotopic signatures, pointing towards acetoclastic methanogenesis.

Long-term incubations of coal and mine timber as sole carbon sources showed steady methane production over nine months. The rates rapidly increased upon acetate addition, while hydrogen, trimethylamine and methanol showed less effects. Correspondingly, acetoclastic methanogens were detected by molecular approaches in enrichments and the original samples [2]. The predominance of this physiological group indicated that acetate appears to be a central intermediate of mine-gas production. The initial processes of coal and mine-timber degradation are catalysed by a broad spectrum of fungi and bacteria as shown by microbial community analysis. In summary, the combined geochemical and microbiological observations confirm the presence of methane formation currently being produced by a diverse microbial community in abandoned coal mines.

[1] Thielemann *et al.* (2004) *Organic Geochemistry* **35**, 1537-1549. [2] Krüger *et al.* (2008) *Geomicrobiology Journal* **25**, 315-321.

Influence of groundwater flow on sediment pore-water biogeochemistry

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Lake sediments are a biogeochemically active and hydraulically dynamic interface. Diffusive and advective mixing of the adjacent water bodies influence the avalability of organic substrates and the pore-water pH, and thus redox conditions within sediments. To study such interactions, we determined ground water flow rates and pore-water composition at 19 loactions at the sediment-water interface of an acidic mining lake.

We observed spatially heterogenous rates of ground water – surface water exchange which ranged between up to 7 L m^{-2} d^{-1} for inflow rates and up to 3 L m^{-2} d^{-1} for outflow rates, except for some local hotspots. Along with these differences in flow rates, we recorded differences in the pore-water composition:

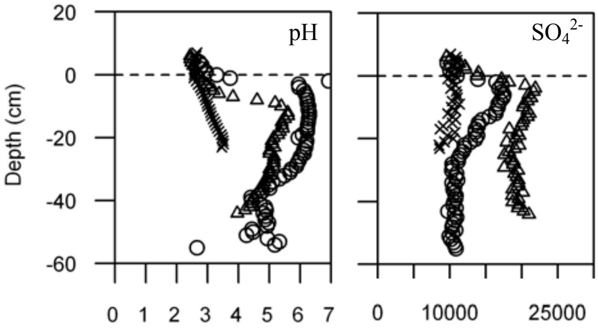

Figure 1: Pore-water pH and sulfate concentrations (µmol L^{-1}) at a site with outflow (crosses), low inflow (circles), and high inflow (triangles).

Under outflow conditions, the pH gradient was less steep and the sediment pore-water more acidic (below pH 3-4) compared to inflow sites (pH up to 6). At the inflow sites, sulfate concentration-depth profiles indicated sulfate release due to mineral transformation of schwertmannite to goethite in the upper part of the profile and sulfate reduction below.

It appears that biogeochemical processes in the sediments are driven by ground water flow and the chemical composition of the percolate. To detect the influence of ground water flow on sulfate reduction rates we conducted further experiments.