

Nickel sulfide formation by a sulfate-reducing consortium originating from heavy metal polluted creek soil

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Uranium-mining activities in the area of Ronneburg (Thuringia, Germany) led to the contamination of aquifers with sulfate, heavy metals and radionuclides. Sulfidogenesis may act to decrease contaminant inputs to adjacent ecosystems. The objectives of this study were to investigate the influence of sulfate-reducing bacteria on metal attenuation in (1) field and (2) laboratory scale. The water saturated soil horizon with the highest sulfur content (2%) was enriched with e.g. Co and Ni (43 and 229 $\mu\text{g g}^{-1}$, respectively). The metals were mainly bound to Fe-oxides and silicates, while ~20% of Ni and Co ions were found in the bioavailable fraction. Sulfate reduction rates, measured by the $^{35}\text{S-SO}_4^{2-}$ tracer technique, of up to 142 $\text{nmol cm}^{-3} \text{ day}^{-1}$ were determined in the water saturated reduced horizons. When soil samples were incubated under anoxic conditions Ni and Co were immobilized. A nickel-tolerant bacterial consortium was obtained from this site with *Desulfosporosinus* sp. and *Citrobacter* sp. as known sulfate reducers that grew in the presence of 12 mM NiCl_2 . The experimental formation of amorphous and nanocrystalline nickel sulfides was confirmed via high resolution TEM and EDX analysis. Bacterial cell surfaces were highly encrusted by the about 5 nm small precipitates. Surprisingly, the nanocrystals possess the α -NiS structure that is thermodynamically only stable at temperatures higher than 280°C. Altogether the results indicate that biomineralization resulted in *in situ* metal attenuation by formation of metastable metal sulfide.

Quantifying rates of methanogenesis and methanotrophy in Lake Kinneret (Israel) using porewater profiles

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Full seasonal sets of chemical and isotope profiles from the water column and the porewater of Lake Kinneret (Sea of Galilee, Israel) were produced to quantify methanogenesis and methanotrophy processes and the couplings between methane, sulfur and iron. The results suggest that sulfate is depleted within the upper 10 cm of the sediment by bacterial sulfate reduction and is not associated with significant anaerobic methanotrophy. Maximum sulfate reduction rates calculated from sulfate concentration profiles are at the water-sediment interface ($0\text{-}1\text{cm} - 1.4 \times 10^{-12} \pm 0.2 \times 10^{-12} \text{ mol} \cdot \text{cm}^{-3} \cdot \text{sec}^{-1}$). Methane concentrations and the modeling of the stable carbon isotopes of dissolved inorganic carbon ($\delta^{13}\text{C}_{\text{DIC}}$) suggest that methanogenesis has maximum rates of $2.5 \cdot 10^{-13} \pm 1.5 \cdot 10^{-13} \text{ mol} \cdot \text{cm}^{-3} \cdot \text{sec}^{-1}$ at 5-12 cm depth in the sediments, and that it ends around 20cm depth. Methanotrophy occurs in the water column through aerobic oxidation of the methane diffusing upward to the thermocline. However, there is also evidence for anaerobic oxidation of methane in the deep sediments of the lake. The findings from this study contribute to understanding the processes involving methane in lacustrine systems, and also shed light into suggested mechanisms in marine sediments that are difficult to track due to analytical challenges in measuring under high pressures.