Electrogenic sulfur oxidation drives biogeochemical cycling of As and Co in the coastal seafloor

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Abstract

Electrogenic sulfur oxidation (e-SOx) is a newly discovered pathway of microbial sulfide oxidation, mediated by so-called cable bacteria (Nielsen et al., 2010; Pfeffer et al., 2012). The reduction of oxygen near the sediment-water interface is coupled by long-distance electron transport to the oxidation of sulfide in deeper sediment, and in this way, electrical currents are induced within the seafloor that range over centimeter scale distances. Previously, electrogenic sulfur oxidation has been shown to generate extreme pH excursions in the pore water, and as a result, the process strongly amplifies the cycling of various pH-sensitive minerals, such sulfide minerals and carbonates (Risgaard-Petersen et al., 2012).

Here we show that e-SOx also strongly influences the early diagenesis of trace metals in coastal sediments. For this, field observations at a shallow subtidal site in the North Sea were combined with dedicated laboratory incubations of repacked sediments. High resolution microsensor profiling (pH, H2S and O2) confirmed the typical geochemical signature of e-SOx both in situ as in the laboratory experiments. Pore water analysis revealed a strong mobilization of both arsenic and cobalt within the electro-active sediment zone. The dissolution of iron sulfides, resulting from the acidification of the pore water by e-SOx, appears to be the main driver for the observed release of cobalt and arsenic.

Overall, electrogenic sulfur oxidation has a major impact on the cycling of arsenic and cobalt in coastal sediments, and may substantially increase the effluxes of these trace metals to the coastal ocean.

Keywords: cable bacteria, electrogenic sulfur oxidation, arsenic, cobalt, early diagenesis

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