

Long-Distance Electron Transport by cable bacteria induces strong transient changes in sediment geochemistry

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Traditionally, *in situ* pore water profiles and solid phase data from marine sediments are interpreted as being in steady-state, which allows estimation of benthic fluxes and diagenetic reaction rates. However, a variety of processes that operate on long-term and short-term scales (e.g. resuspension, algae blooms, seasonal anoxia) can induce transient changes, which leads to mismatches between estimated fluxes or rates and their actual values.

Cable bacteria are multicellular filamentous bacteria that couple oxygen reduction near the sediment-water interface (SWI) to sulphide oxidation in the deeper sediment layers via long-distance electron transport (LDET). LDET spatially decouples oxygen reduction and sulphide oxidation, thereby creating a typical pH profile with an alkaline peak near the sediment-water interface and an acidic minimum in the deeper sediment layers. LDET has been shown to have a strong impact on the sedimentary geochemical cycling. The acidic pH at depth stimulates iron sulphide and calcium carbonate dissolution, which releases iron, manganese and calcium in the pore water. Additionally trace metals (e.g. As, Co) that adsorb on iron sulphide are co-released with Fe. The fraction of iron and manganese that diffuses to the sediment-water interface precipitates as iron and manganese oxides, which traps upward diffusing trace metals (e.g. As) and phosphate.

Cable bacteria are believed to have a dynamic and opportunistic life-cycle, where they can develop a sizeable population within days and display intense metabolic activity for a few weeks, after which the population collapses and LDET activity disappears. The combination of the strong impact on elemental cycling and a 'boom-and-bust' life style makes that LDET has the potential to induce strong transient changes in sediment geochemistry.

So far however, this transient geochemistry associated with LDET has not been investigated. Here we document the geochemical changes that follow re-introduction of anoxia after development of cable bacteria. We describe the temporal evolution of the LDET signal in terms of (i) the geochemical signature (O_2 , H_2S and pH), (ii) major ion geochemistry (sulphate, calcium, iron and manganese) and (iii) oxyanion geochemistry (phosphate, arsenic, molybdenum and vanadium). We show that rapid changes occur over the first day, but that it takes three weeks before the pore water sulphur, iron and manganese profiles completely relax to their steady-state in the absence of LDET. In contrast, phosphate, vanadium or arsenic show transient remobilisation for more than 11 weeks after LDET has been halted. We conclude that the metabolic activity of cable bacteria leaves a persistent signal in the sediment biogeochemistry over time scales of weeks.