When the seafloor turns electric: impact of microbial long-distance electron transport on coastal biogeochemical cycling

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Long-distance electron transport enables a novel type of microbial metabolism, whereby filamentous cable bacteria are transporting electrons over centimeter-scale distances. By establishing such electrical circuitry, these multicellular micro-organisms (referred to as cable bacteria) are able to exploit spatially segregated pools of electron acceptors and donors, equipping them with a competitive advantage.

Recent data reveals that long-distance electron transport occurs naturally in the seafloor in a wide range of marine sediments. When cable bacteria are active, they exert a disproportionately large influence on biogeochemical transformations and fluxes in the seafloor. On the one hand, electrical fields are established, which induce ion migration. On the other hand, the spatial separation of redox half-reactions induces a strong acidification of the pore water, which promotes the dissolution of minerals, such as sulfides and carbonates. This in turn significantly increases the exchange of solutes across the sediment-water interface.

Electro-active sediments hence form a whole new type of geochemical environments. The biogeochemical impact of cable bacteria is however not limited to the sediment, but also extends to the water column. Our data reveal that in seasonal hypoxic coastal basins, long-distance electron transport can exert a dominant control on the overall cycling of iron, manganese, sulfur and phosphorus. Overall, the combination of a widespread occurrence and a strong local geochemical imprint suggests that long-distance electron transport by cable bacteria could be important in the biogeochemical cycling and ecosystem functioning in various natural environments.