Microbial electricity over long distances in the seafloor: How does it work?

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Recently, a novel "electrogenic" type of sulfur oxidation has been documented in marine sediments, whereby long filamentous cable bacteria are generating electrical currents over centimeter-scale distances, which is a 1000 times further than previously known. This long-distance microbial electricity turns the seafloor electro-active and has a strong impact on the geochemical cycling within marine sediments. The actual mechanism of long-distance transport however remains elusive. Here we propose a new model that is capable of quantitatively simulating the solute depth profiles and biogeochemical transformations in electro-active marine sediments. The model is based on a conventional reactive transport description of marine sediments, which is extended with a new model formulation for the long-distance electron transport induced by the metabolism of cable bacteria. The mechanism of electron hopping is implemented to describe the electron transport along the longitudinal axis of the microbial filaments. We demonstrate that this model is capable of reproducing the observed porewater profiles and geochemical tarnsformations in electro-active sediments. Our simulation results also suggest that the cable bacteria must have a high affinity for both oxygen and sulfide, and that intensive cryptic sulfur cycling takes place. A sensitivity analysis shows how long-distance microbial electricity strongly impacts the biogeochemical cycling of sulfur, iron, carbon and calcium in marine sediments.