Microbial community composition and sulfur-cycling in a sediment with electrogenic sulfur oxidation

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Electro-active sediments form distinct microbial ecosystems, which show intense sulfur cycling that is driven by cable bacteria performing electrogenic sulfur oxidiidation. These centimetre-long filamentous bacteria couple sulfide oxidation in deeper anoxic layers of the sediment to oxygen reduction at the sediment surface via electron transport over the length of the bacterial filament. Being recently discovered, the microbial community composition and metabolic interactions in electro-active sediments are still elusive. Especially intriging is the recent hypothesis that autotrophic respiratory bacteria can use the electron transport capacity of cable bacteria as electron sink.

We investigated a sediment with strong cable bacteria activity in the coastal zone of the North Sea (Belgium). Chemical analysis of solid phase and pore water depth profiles documented the sulfur biogeochemistry of the sediment. In addition, we performed metagenomic shotgun sequencing to characterize the sediment microbial community in distinct sediment horizons (the oxic surface layer, the suboxic zone and the deeper sediment where cable bacteria were not present).

Our chemical analyses indicated high rates of sulfate reduction. Moreover, we observed a net production of sulfate in the suboxic zone, indicative of substantial sulfide oxidation resulting from the dissolution of iron sulfides. Metagenomic analysis showed the presence of several bins of cable bacteria and sulfate-reducing Deltaproteobacteria. Our dataset also revealed a high abundance of Gammaproteobacteria related to currently uncultured clades. Genes coding for key metabolic enzymes showed that members of these clades have metabolic potential for autotrophic growth and sulfur oxidation, implicating them as candidates for direct interaction with cable bacteria. Our study demonstrates active sulfur cycling in situ and documents the microbial metabolic potential for sulfur cycling, which suggests that other bacteria may closely interact with cable bacteria and benefit from the electron transport that they provide.