Electrical cooperation by cable bacteria has large impact on coastal sediments

van de Velde Sebastiaan[1], Yue Gao[1], and Filip Meysman[1,2]

[1] Analytical, environmental and geochemistry, Vrije Universiteit Brussel, Pleinlaan 2, B-1050 Brussel, Belgium
E-mail: sevdevel@vub.ac.Be

[2] Ecosystem studies, Royal Netherlands Institute for Sea Research, Korringaweg 7, 4401 NT Yerseke, the Netherlands

Recently, it has been discovered that long filamentous bacteria can transport electrons over centimetre scale distances (Nielsen *et al.*, 2010; Pfeffer *et al.,* 2012). These so-called cable bacteria have a unique metabolic lifestyle; while in other bacteria, each cell supplies its own energy, the cells in the multi-cellular cable bacteria cooperate for their energy supply. To date, this metabolism has not been observed elsewhere in biological systems. Cable bacteria transport electrons from the deeper layers in marine sediments, where sulphide is abundant, to the sediment water interface, where oxygen is present. This metabolism creates a characteristic geochemical signature in the pore water; (i) the oxygen and sulphide are widely separated, creating a suboxic zone of several millimetres thickness, (ii) a distinct pH peak is formed below the surface, while a pH minimum is generated in the deeper sediment, due to proton release due to oxidation of sulphide to sulphate. This geochemical fingerprint can be recorded as a set of micro-electrode depth profiles (O_2, pH and H_2S).

Originally discovered in laboratory incubations, the natural occurrence of cable bacteria and their metabolic activity was documented for the first time in several sites in the North Sea (Malkin *et al.*, 2014). As part of my FWO PhD project, we have started a yearlong campaign in the Belgian coastal zone (Station 130) to document the presence and metabolic activity of cable bacteria, and to characterize their effect on the geochemistry of coastal sediments. We approach this topic by combining (i) micro-electrode profiling of the sediment with (ii) standard geochemical porewater and solid phase analysis and (iii) reactive transport sediment-models. Preliminary results show that cable bacteria are regularly present and have a strong impact on sediment geochemistry and trace metal cycling (and especially iron and manganese). This has strong implications for the bioavailability of these trace elements, and so, cable bacteria have the potential to radically change our views of metal cycling in coastal environments.

References

Malkin S.Y., A. Rao, D. Seitaj, D. Vasquez-Cardenas, E.M. Zetsche, S. Hidalgo-Martinez, H.T. Boschker, and F.J.R. Meysman. 2014. Natural occurrence of microbial sulphur oxidation by long-range electron transport in the seafloor. The ISME Journal. doi:10.1038/ismej.2014.41. http://www.nature.com/doifinder/10.1038/ismej.2014.41

Nielsen L.P., N. Risgaard-Petersen, H. Fossing, P.B. Bondo Christensen, and M. Sayama. 2010. Electric currents couple spatially separated biogeochemical processes in marine sediment. Nature 463:1071-1074.

Pfeffer C., S. Larsen, J. Song, M. Dong, F. Besenbacher, K.U. Kjeldsen, L. Schreiber, Y.A. Gorby, M.Y. El-Naggar, K.M. Leung, A. Schramm, N. Risgaard-Petersen, and L.P. Nielsen. 2012. Filamentous bacteria transport electrons over centimetre distances. Electric currents couple spatially separated biogeochemical processes in marine sediment. Nature 491:218-221.