ENVIRONMENTAL MICROBIOLOGY

Electricity blankets the seabed

bacteria in marine sediments use electrical currents to couple biogeochemical processes that are spatially separated

Our understanding of how certain types of bacteria generate electrical currents in microbial fuel cells has progressed rapidly in recent years. These so-called exoelectrogenic bacteria are thought to use outer-membrane cytochromes, soluble electron shuttles and conductive nanowires to mediate the extracellular transport of electrons to facilitate cell-to-cell communication and energy transfer. However, the physiological relevance of such systems in the natural environment has remained unclear. Writing in *Nature*, Lars Peter Nielsen and colleagues now describe how bacteria in marine sediments use electrical currents to couple biogeochemical processes that are spatially separated on a millimetre scale.

Bacteria in marine sediments consume oxygen as it diffuses down from the overlying water, leading to the formation of a series of sedimentary layers that contain decreasing amounts of oxygen the further

they are from the surface. Nielsen and colleagues incubated sulphidic marine sediments in the presence of oxic (oxygenated) seawater and observed that the hydrogen sulphide gradually disappeared from the surface sediment layers. After 1 month, the oxic surface layer and the underlying sulphidic layer were separated by a 12- to 19-millimetre-deep suboxic zone that lacked both oxygen and hydrogen sulphide. Replacing the oxic seawater with anoxic seawater starved the surface layer of oxygen and led to a surprisingly rapid decrease in the depth of the suboxic zone as the levels of hydrogen sulphide in the lower sediment layers started to increase owing to decreased microbial consumption. When oxic seawater was reintroduced, the pattern reversed and hydrogen sulphide levels began to decrease equally rapidly. The speed with which hydrogen sulphide levels changed was too fast to be explained

by diffusion of any known compound, leading the authors to propose that a natural electrical circuit exists in which electrons generated by the oxidation of hydrogen sulphide deep within the anaerobic sediment layers are conducted to the aerobic surface layers by the electron shuttles and nanowires that are produced by exoelectrogenic bacteria.

These data suggest that sediment communities may use electrical circuits to spatially separate metabolic functions, such that organisms with access to oxygen at the sediment surface carry out all oxygen reduction processes, whereas organisms with access to electron donors in the lower sediment layers carry out all oxidation processes.

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ORIGINAL RESEARCH PAPER Nielsen, L. P. et al. Electric currents couple spatially separated biogeochemical processes in marine sediments. *Nature* **463**, 1071–1074 (2010)