Cable bacteria & N cycling: direct and indirect electrogenic effects

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Cable bacteria are able to transport electrons over several centimetres in aquatic sediments along the longitudinal axis of their bodies. The metabolism of cable bacteria is termed electrogenic sulfur oxidation, and involves a separation of the oxidative and reductive half-reactions of aerobic sulphide oxidation.

Cathode: $2\ O_2 + 8\ H^+ + 8\ e^- \rightarrow 4\ H_2O$
Anode: $4\ H_2O + H_2S \rightarrow SO_4^{2-} + 10\ H^+ + 8\ e^-$
H_2S oxidation: $2\ O_2 + H_2S \rightarrow SO_4^{2-} + 2\ H^+$

The electrical coupling between the redox half-reactions is mediated by electron transport along the “cables”. In recent years, significant work has been invested into understanding the large impact of long-disatnce electron transport on sediment biogeochemistry. However, the link between cable bacteria metabolism and nitrogen (N) cycling is unclear, and this presentation will address three important questions:

(1) Can N act as the electron donor? We examine if nitrification ($NH_4^+ + 3\ H_2O \rightarrow NO_3^- + 10\ H^+ + 9\ e^-$) is possible either as a direct anodic reaction, or by a third-party microbe using the cable bacteria as an electron sink.
(2) Can N be the electron acceptor? Cathodic denitrification ($2\ NO_3^- + 12\ H^+ + 10\ e^- \rightarrow N_2 + 6\ H_2O$) is investigated as a direct half-reaction by the cable bacteria functioning as an electron source.
(3) Can the geochemical fingerprint of cable bacteria indirectly influence N cycling? Here we focus on the anodic pH minimum, which is known to dissolve iron sulfide minerals. Given that Fe^{2+} can favour dissimilatory nitrate reduction to ammonium (DNRA) over denitrification, sediments dominated by cables may be less efficient at N removal.