Distribution of metabolic activity and current production along conductive cable bacteria

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Centimetre long bacterial filaments belonging to the Desulfobulbaceae family mediate electric coupling of oxygen reduction and sulfide oxidation in spatially separated regions of marine sediments [1,2]. Their cell numbers are equal throughout the few millimetres of oxic and the underlying 2-3 cm of anoxic sediment. Thus, only about 10% of the cells are responsible for the reduction of oxygen for the entire filament, using the electrons produced by sulfide oxidation of all connected cells below. As a consequence, a much higher electron turnover per cell must be assumed for those cells with access to oxygen.

In this study, we evaluated whether the higher metabolic rate in the oxic zone coincides with increased energy conservation. Our experimental approaches involved comparison of carbon and ammonia incorporation rates in different filament sections by using stable isotope labelling and nanoSIMS. Moreover, we estimated the vertical distribution of current production by microprofiling electric fields and conductivities in artificial sediment systems.

Our preliminary data suggests that the highest metabolic activity is indeed exhibited by cells in the oxic zone, where excess energy seems to be conserved in storage components rather than used for cell growth. Futhermore, we found that current production, and thus sulphide oxidation, takes place throughout the top 2-3 cm of the anoxic sediment zone, which includes a zone where no free sulphide is detectable.

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[2] Pfeffer *et al* (2012), *Nature* 491, 218–221.

High-precision tantalum isotope measurements by MC-ICPMS

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Tantalum-180(m) is the rarest observationally stable nuclide in the solar system and has a relative abundance of 0.01201 ± 8% [1]. Furthermore, ^{180m}Ta is the only nuclide that is stable in an excited state, whereas in ground state it undergoes decay to ^{180}Hf and ^{180}W with a half-life of 8.1h. Therefore, the nucleosynthetic origin of solar system ^{180m}Ta and the relative contributions from s-process branching at ^{179}Hf and from neutrino process in core-collapse supernovae are uncertain [2]. Isotope analyses on natural materials may provide a clue to the source of this nuclide. However, the extremely low ^{180m}Ta/^{181}Ta ratio challenges sufficiently precise measurements. Here we present a high precision method as well as first data on extraterrestrial material.

Tantalum from two basalts (La Palma, Canary Islands) and one L6 chondrite (Wagon Mound) was separated by anion exchange chromatography modified after [3,4]. Measurements were conducted with a Neptune MC-ICPMS using $10^{12}\Omega$ amplifiers on masses 180 (Ta, Hf, W) and ^{178}Hf for monitoring the large isobaric interference by ^{180}Hf (rel. ab. 30.64%). ^{183}W was monitored for correction of the minor ^{180}W interference (rel. ab. 0.12%). ^{181}Ta was tuned to 40-45V to achieve optimum precision. Instrumental mass bias was corrected for externally by doped Yb, using different ratios between masses 171 to 176 and the exponential law. This protocol enables more precise measurements than using doped Re [4], and the external reproducibility (2σ) was typically better than ±7 ε-units for ca. 80ng of sample

We found that our anion exchange chromatography procedure can efficiently separate interfering Hf and W from Ta. Measured solutions had both Hf/Ta and W/Ta of less than 0.00002, sufficiently low to measure ^{180m}Ta/^{181}Ta ratios accurately. First results for the L6 chondrite and the La Palma basalts are indistinguishable from the terrestrial isotopic value defined by the Alfa Aesar™ standard solution.

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