

Microbial partnerships and methane-oxidation in the deep sea

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The ability to decipher the metabolic roles of microorganisms within living microbial ecosystems and to connect microbial metabolism with biosignatures preserved in the rock record represents some of the grand challenges in the field of Microbial Geobiology. The combination of molecular methods with stable isotope analysis (both natural abundance and as tracers) in modern environments represents a multidisciplinary approach that has been used successfully to characterize links between specific microorganisms and their ecophysiology in situ. In particular, the introduction of micron-scale isotopic analyses by secondary ion mass spectrometry (SIMS and nanoSIMS) [1] to the study of microorganisms has enabled an unprecedented level of inquiry into the inner workings of microbial ecosystems. Integrating SIMS-based stable isotope analysis with microscopy and culture-independent metagenomics techniques, we have been investigating carbon and nutrient utilization by deep-sea microorganisms and symbiotic microbial consortia fuelled by methane in sediments and associated authigenic carbonates. Single cell characterization of methane-cycling archaea and sulphate-reducing bacteria have revealed significant inter and intra-group heterogeneity in both stable carbon isotopic signatures and nitrogen utilization, including differences in nitrogen fixation [2] and assimilatory nitrate reduction. These cell-specific analyses have yielded new information regarding the isotopic variability, metabolic potential and interactions between individual microorganisms and the greater biological community in methane-based ecosystems.

[1] Orphan, V.J. and House, C.H. (2009) Geobiological investigations using secondary ion mass spectrometry (SIMS): microanalysis of extant and paleo-microbial processes. *Geobiology*, **7**, 360-372 [2] Dekas, A.D. *et al.* (2009) Deep-sea archaea fix and share nitrogen in methane-consuming microbial consortia. *Science*, **326**, 422-426

Combining electrochemical and spectroscopic methods to obtain speciation of quinones

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In anoxic aquifers, the presence of goethite-Fe(II) systems plays a major role in electron transfer processes, such as degradation of organic pollutants [1]. To investigate the role of organic matter as potential electron shuttles commonly model quinones such as AQDS, juglone and lawsone were used [2, 3]. To address this question we studied interactions with iron minerals and the speciation of model quinones.

Defined redox and acid-base species of the model quinones were obtained by electrochemical methods, varying systematically the reduction potential, pH and ionic strength. The UV-visible spectra of these species were used as reference to obtain the redox speciation of quinones in goethite-Fe(II) systems. From these data information on electron transfer processes, redox potential and equilibrium states of the redox sensitive quinone and iron species can be derived.

[1] Tratnyek *et al.* (2001) *Water Res.* **35**, 4435-4443.
[2] Aeschbacher *et al.* (2010) *Environ. Sci. Technol.* **44**, 87-93. [3] Doong *et al.* (2005) *Environ. Sci. Technol.* **39**, 7460-7468.