

Hydrogen isotope fraction in lipids of syntrophically associated sulfate-reducing bacteria

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The microbially mediated anaerobic oxidation of methane (AOM) is carried out by methanotrophic archaea (ANME) in syntrophic association with sulfate-reducing bacteria (SRB). This energetically limited metabolism is made thermodynamically feasible by the exchange of hydrogen, electrons, fixed nitrogen and potentially other unknown chemical species between the archaeal and bacterial partners. Understanding the metabolic interplay between the ANME and SRB in consortia is made difficult by the lack of cultured representatives. However, methanogenic archaea, closely related to their AOM counterparts, and SRB also form syntrophic consortia in both the environment and in laboratory grown co-cultures.

Zhang *et al.* [1] demonstrated that the central metabolic pathway is reflected in the hydrogen isotopic fractionation between bacterial fatty acids and growth water. Here we examine the metabolic role of the sulfate reducing bacterial partner through hydrogen isotopic fractionation of bacterial fatty acids from both cocultures of *Desulfococcus multivorans* and *Methanosarcina acetivorans* and sediment cores associated with a variety of active methane seep settings in Hydrate Ridge (offshore Oregon, USA).

[1] Zhang, X, Gillespie, A.L., Sessions, A.L. (2009) *PNAS*, **106**:31, 12580-12586.

Stalagmite trace-element reconstruction of terrestrial hydrology: Results from cave-analogue studies

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We report trace-element data from a series of carbonate growth experiments in cave-analogue conditions with the goal of better understanding environmental controls on trace-element incorporation in stalagmites. The experimental setup closely mimics natural processes (e.g. precipitation driven by CO_2 -degassing, low ionic strength solution, thin solution film) but with a tight control on growth conditions (temperature, pCO_2 , drip rate, calcite saturation index and the composition of the initial solution). Calcite is dissolved in deionized water in a 20,000 ppmV pCO_2 environment, with trace-elements (Li, Na, Mg, Co, Sr, Cd, Ba, U) at appropriate concentrations to mimic natural cave drip-waters. This solution is dripped onto glass plates (coated with seed-calcite) for controlled stalagmite growth [1].

Over a wide range of temperatures (7, 15, 25, 35°C), drip rates (2, 6 and 10 drips per minute) and solution calcite saturation indices ($SI_{\text{calcite}} = 0.1, 0.2, 0.3, 0.4, 0.5, 0.6$ at 15°C), $D(\text{Sr})$ was shown to be statistically invariant. $D(\text{Mg})$ has a relationship with temperature defined by $D(\text{Mg}) = 0.01e^{0.02[40.006]T}$, but temperature is not expected to be the dominant control on Mg/Ca in cave calcite due to the larger impact of calcite precipitation on Mg/Ca. Over short timescales, in conditions where temperature is well buffered in most caves, the fraction of calcium remaining in solution (f) is likely to be the dominant control on Mg/Ca and other trace-element ratios. Cd/Ca is shown to be highly-sensitive to variation in the amount of calcite precipitated from solution, with high $Cd/Ca_{\text{stalagmite}}$ particularly indicative of a low amount of prior calcite precipitation (PCP). Overall, the varied response of trace-elements to temperature and to hydrological factors (e.g. PCP and drip rate) ensure that their combined use, together with other proxies, is well suited for reconstructing terrestrial hydrological conditions.

[1] Day, C.C., & Henderson, G.M. 2011. Oxygen isotopes in calcite grown under cave-analogue conditions. *Geochimica et Cosmochimica Acta*, **75**, 3956–3972.