Subsurface sulfur cycling in Loki's Castle hydrothermal barite field: insights from sulfate reduction rates

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Sulfur isotope studies have identified hydrothermal barite deposits as habitats for sulfate-reducing micro-organisms, from the Archean eon to the modern seafloor [1,2]. However, little is known about the distribution of sulfate reducers and the magnitudes of geochemical fluxes associated with this metabolic pathway in these environments.

Here, we present microbial sulfate reduction rates and pore fluid geochemistry from four different locations in the low-temperature (~20°C), diffuse-venting Loki's Castle hydrothermal barite field on the ultra-slow spreading Arctic mid-ocean ridge [3]. Metabolic rates were measured by addition of $^{35}SO_4^{2-}$ to sediments and crushed barite slurries, followed by incubation at *in situ* temperatures of 4-20°C.

Measured sulfate reduction rates range from 120 mmol S m^{-3} d^{-1} in the organic-rich (6.6% TOC) surface sediments of the barite field (0-15 cm depth), to 30 mmol S m^{-3} d^{-1} in an active barite chimney (1.5% TOC) and 0.1 mmol S m^{-3} d^{-1} in deeper sediments from the barite field down to 120 cm depth (1.1-0.3% TOC). No microbial sulfate reduction was detected in sediments at 120-200 cm depth or in the surface (0-20 cm depth) of an inactive sulfide mound adjacent to the barite field, possibly due to substrate limitation. These rates are relatively low compared to other sediment-hosted hydrothermal vent sites (Middle Valley, Guaymas Basin), and are insufficient to explain the enrichment in HS^- (2.55 mM) and depletion in SO_4^{2-} (21.5 mM) in pore fluids compared to concentrations calculated from simple mixing of high-temperature hydrothermal fluids [4] and seawater (0.74 mM and 24.1 mM, respectively). This argues for additional microbial sulfur cycling in the deep subsurface of the Loki's Castle barite field.

[1] Shen et al. (2001), *Nature* 410:77-81; [2] Eickmann et al. (2014), *Geobiology* 12:308-321; [3] Pedersen et al. 2010, *Nat. Commun.* 1:126; [4] Baumberger et al. 2016, *Geochim. Cosmochim. Act.* 187:156-178