H_2 fuelled microbial metabolism in Opalinus Clay

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In Switzerland, the Opalinus Clay formation is considered the most likely host rock for a deep geological repository of nuclear waste, with H_2 expected to be the primary gas phase formed from metal corrosion and organic waste degradation. H_2-driven sulfate reduction was demonstrated in a borehole in Opalinus Clay [1]. However, water-rock-microbe interactions were not investigated. Microcosm experiments were performed using Opalinus Clay and porewater from the Mont Terri underground research laboratory to investigate the impact of sulfate reduction on the clay rock. Control microcosms were incubated with sterile porewater to investigate abiotic processes.

Results show an initially high sulfate concentration where clay is present. In the presence of microorganisms, this decreases over time, however there is no evidence of subsequent hydrogen sulfide production in the aqueous phase. There is an increase in aqueous Fe^{2+} concentrations in all experiments where clay is present, with the highest concentrations found in non-inoculated controls. After the incubation period, the microbial community is dominated by the *Desulfobulbaceae* family as found previously [1], suggesting active sulfate reduction is occurring. Sulfur speciation in the Opalinus Clay shows a larger proportion of elemental sulfur when exposed to microbial activity (37% inoculated compared to 10% in non-inoculated) and a lower percentage of pyrite (55% and 88% respectively).

The study suggests that microbially-mediated sulfate reduction can lead to the production of elemental sulfur within the clay rock. This mechanism removes hydrogen sulfide from solution and potentially reduces the corrosion rate of waste-containing canisters.

[1] Bagnoud A., (2016) *Nat. Comm.*, 7, 12770.