

## Sulfate mineral solubilities in Na-Ca-Cl brines

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Geothermal brines produced from deep sedimentary basins show a strong tendency to produce mineral precipitants (scales) during operation of a power plant. Measured  $\text{SO}_4^{2-}$  concentrations (up to 3 mM) in the fluid at the Groß Schönebeck (GrSk) *in situ* geothermal laboratory, Germany suggest that sulfate-bearing minerals may be significant scale forming phases. Of particular concern are the behavior of (1)  $\text{Ba}^{2+}$  and  $\text{Sr}^{2+}$  in the high salinity (up to 5 M Cl<sup>-</sup>) Na-Ca-Cl fluid, and (2) the overall equilibrium concentration of  $\text{SO}_4^{2-}$  that subsequently controls the mass of  $\text{CaSO}_4 \cdot x\text{H}_2\text{O}$  precipitation. In order to predict the estimated amount and nature of these scales, we have both modeled and experimentally determined mineral solubilities in synthetic GrSk brines under proposed plant operating conditions (15 bar, 70°C – 150°C).

Modelling was performed using the PHREEQc Quintessa database, with anhydrite ( $\text{CaSO}_4$ ), barite ( $\text{BaSO}_4$ ), and celestite ( $\text{SrSO}_4$ ) as the equilibrium phases. Experiments were performed using a “flooding method,” in which a deliberately oversaturated concentration of  $\text{SO}_4^{2-}$  was injected into a Na-Ba-Ca-Sr-Cl brine filled pressure vessel. While there is general agreement between the PHREEQc and experimental results, some significant differences do exist. PHREEQc over-estimates the amount of barite precipitation by up to three orders of magnitude and underestimates the amount of celestine precipitation by up to one order of magnitude. In total, both PHREEQc and experimental results predict between  $10^1$  and  $10^4$  grams of total sulfate mineral precipitation per  $\text{m}^3$  of produced fluid, depending on the conditions and total available  $\text{SO}_4^{2-}$ .

## Microbial cycling of sulfur in the aphotic zone a meromictic lake

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Fayetteville Green Lake (FYG) is a meromictic euxinic lake characterized by large differences in the composition of sulfur isotopes of sulfides and sulfates ( $\delta^{34}_{\text{sulfate-sulfide}}$  of 56-57.5‰) [1]. Similar  $\delta^{34}_{\text{sulfate-sulfide}}$  values are commonly thought to involve microbial sulfate reduction (MSR) coupled with microbial disproportionation of sulfur (MSD). Because our recent study suggests that MSR limited by the availability and quality of organic compounds can produce similar  $\delta^{34}_{\text{sulfate-sulfide}}$  in the absence of MSD, here we study molecular, metabolic and physiological diversity of microbes from the sulfidic water column and the bottom sediments of FYG.

Enrichment cultures confirm the presence of S-disproportionating microbes in the sediments and the water column. Preliminary most probable number counts (MPNs) suggest that these organisms may be as abundant in sediments as sulfate reducing microbes. The MPNs also indicate a marked increase with depth of organisms that are able to couple sulfate reduction to the oxidation of acetate. Isolated microbes from the lake bottom sediments include at least two phylogenetically distinct organisms that can disproportionate S.

Preliminary studies suggest that microbes in the bottom sediments of FGL can metabolize recalcitrant organic substrates, reduce sulfate and disproportionate S. Further physiological, metabolic and isotopic analyses of enrichment cultures and isolates, as well as molecular comparisons of the diversity of dissimilatory sulfate reductase genes (*dsrAB*) and 16s rDNA genes in the water column and the sediments are in progress.

[1] Deevey, Nakai, Stuiver (1963) *Science* **139**, 407-408.