Characterization of the deep microbial life at different CCS sites

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Deep subsurface formations like subsurface saline aquifers or depleted gas reservoirs are candidate sites for the carbon capture and storage (CCS) technology. Since the Earth subsurface is known to be a major habitat for a high number of different groups of microorganisms, our working group aims at microbial monitoring at different CCS-sites in Germany (a 650m-deep saline aquifer and a 3.5km-deep depleted gas reservoir). Both sites are characterized by high salinity (325 g/l and up to 420 g/l) and relatively high TOC content (up to 150 mg/l and up to 300 mg/l). In order to characterize the microbial life in extreme habitats we aim to localize and identify microbes including their metabolism influencing mineral creation and dissolution. The ability of microorganisms to speed up dissolution and formation of minerals might result in changes of the local permeability and the long-term safety of CO_2 storage. Genetic fingerprinting (PCR SSCP, DGGE), qPCR and FISH are applied for identification and quantification of changes in deep microbial community caused by the injection of supercritical CO_2.

Although saline aquifers could be characterized as an extreme habitat for microorganisms due to high pressure and salinity, a high number of diverse groups of microorganisms were observed with molecular biological methods in downhole samples from the injection and observation wells at a depth of about 650m depth. Of great importance was the identification of the sulfate reducing bacteria, which are known to be involved in corrosion processes. Microbial monitoring during CO_2 injection has shown that both quantity and diversity of microbial communities were strongly influenced by the CO_2 injection.

First results of the sequence analyses from a 3,5km-deep, 120-130°C hot reservoir indicate the presence of several H_2-oxidizing bacteria, thiosulfate-oxidizing bacteria and biocorrosive thermophilic microorganisms. Due to the hypersaline and hyperthermophilic reservoir conditions, and therefore low cell numbers, the quantification of those microorganisms was not yet possible.

Crystal-chemical analyses of soil and drilled rock in Gale crater, Mars

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The CheMin instrument on the Mars Science Laboratory Rover *Curiosity* performed X-ray diffraction analyses in Gale crater on both martian soil at Rocknest [1] and drilled rock at John Klein. Crystalline phases were identified and their abundances and unit-cell parameters were refined with the Rietveld method [2]. Crystal-chemical systematics, using data from the literature, were developed for the observed phases and were used to estimate the chemical compositions of the martian minerals.

Estimated Rocknest soil mineral compositions:

olivine: $(Mg_{0.63(3)}Fe_{0.37})_2SiO_4$

plagioclase: $(Ca_{0.57(13)}Na_{0.43})(Al_{1.57}Si_{2.43})O_8$

augite: $[Mg_{0.87(10)}Fe_{0.40}Ca_{0.73(4)}]Si_2O_6$

pigeonite: $[Mg_{1.13(9)}Fe_{0.70(10)}Ca_{0.17}]Si_2O_6$

In addition to the crystalline component, there is also an amorphous component. Subtracting the weighted chemistry of the crystalline component from the bulk composition, determined by APXS [3], provides an estimate of the amount and chemical composition of the amorphous component.

Currently, the analysis of the John Klein drilled rock sample continues. Preliminary data indicate the presence of smectite(s), sulfates, and igneous minerals similar to those found in Rocknest soil, representing the mineralogy of a potentially habitable environment. These data facilitate determination of comparable crystal–chemical systematics and comparisons with Rocknest soil.

[1] Blake *et al*. (2013) *LPS XLIV*, Abstract. [2] Bish *et al*. (2013) *LPS XLIV*, Abstract. [3] Yen *et al*. (2013) *LPS XLIV*, Abstract.

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