

## Impacts of geothermal energy storage on the microbial community composition and activity in shallow systems

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To investigate the effects of temperature change due to geothermal energy storage on the microbial communities and the fluid geochemistry, soil column experiments using aquifer sediment and acetate added water were performed at 10, 25, 40 and 70°C. Genetic fingerprinting revealed a change in microbial community composition and activities due to elevated temperatures. The highest DNA amount and sulphate reducing bacteria (SRB) specific gene copy number were observed in fluids of the 40°C column. Correspondingly, the highest sulphate reduction rate was detected at 40°C. Thus probably the highest number of SRB was present in this column. Due to the formation of different redox zones in the 10°C column, zones of microbial colonization were observed. In the entrance nitrate and iron reducers were identified, whereas at the outlet fermentative bacteria dominated. At 70°C sulphate reducing conditions predominated and no zoning of microbial colonization was detected. Genetic fingerprinting revealed the dominance of SRB and fermentative bacteria. Methane production was found at 25°C, only. Accordingly, quantification with quantitative polymerase chain reaction (qPCR) proved the highest number of the dominant methanogen *Methanosaeta concilii*.

## Reduced C-O-H Volatiles Dissolved in Lunar Picritic Glasses

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The Moon had long been considered dry, until recently, when Saal *et al.* [1,2] used SIMS to measure H<sub>2</sub>O dissolved in the lunar picritic glasses. Before this discovery, carbon was considered the primary volatile. The formation of a CO-rich gas phase by graphite oxidation was thought to drive fire fountain eruptions on the Moon producing the glass beads [3]. The natural lunar glasses contain too little dissolved C (below detection limits) to be detected by FTIR spectroscopy. We used the Apollo 15 green glass composition to experimentally determine the solubility and speciation of C in H-bearing graphite-saturated melts. Our experiments show C dissolves in reduced lunar melts ( $f_{O_2} < IW-0.55$ ) as mainly Fe(CO)<sub>5</sub> and to a lesser extent CH<sub>4</sub>. Under more oxidizing conditions ( $f_{O_2} > IW-0.55$ ), we find C is dissolved as carbonate in lunar picritic melts. We also determine that twice as much C can be dissolved in oxidized melts compared to the reduced melts.

NanoSIMS measurements [1] of natural glasses suggest that hydrogen is dissolved in large enough quantities (up to ~40 ppm) to be detectable by FTIR spectroscopy. We used Raman and FTIR spectroscopy to study the speciation of H in the natural orange, yellow, and green lunar glasses. We also calculated the absorption coefficients for each glass composition based on our experiments. The synthetic sample spectra were also used as a guide to baseline correct and locate the weak O-H stretching peak in the natural samples. With this work, we are able to determine the abundance and speciation of dissolved volatiles in lunar and other reduced high FeO melts and the effect of planetary degassing on the evolution of an early atmosphere.

[1] Saal A.E. *et al.* (2008) *Nature*, 454, p.192-95. [2] Saal A.E. *et al.* (2009) *Goldschmidt Conf.*, Abst. #A1139. [3] Sato M. (1976) *PLSC 7th*, p.1323-25.