

**Arsenic dissolution from Japanese paddy soil by a dissimilatory arsenate-reducing bacterium *Geobacter* sp. OR-1**

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Dissimilatory As(V) (arsenate)-reducing bacteria may play an important role in arsenic release from anoxic sediments in the form of As(III) (arsenite). Although respiratory arsenate reductase genes (*arrA*) closely related with *Geobacter* species have been frequently detected in arsenic-rich sediments, it is still unclear whether they directly participate in arsenic release, mainly due to lack of pure cultures capable of arsenate reduction. In this study, we isolated a novel dissimilatory arsenate-reducing bacterium, strain OR-1, from Japanese paddy soil, and found that it was phylogenetically closely related with *Geobacter pelophilus*. OR-1 also utilized soluble Fe(III), ferrihydrite, nitrate, and fumarate as electron acceptors. OR-1 catalyzed dissolution of arsenic from arsenate-adsorbed ferrihydrite, while *Geobacter metallireducens* GS-15 did not. Furthermore, inoculation of washed cells of OR-1 into sterilized paddy soil successfully restored arsenic release. Arsenic K-edge X-ray absorption near-edge structure (XANES) analysis revealed that strain OR-1 reduced arsenate directly on the soil solid phase. Analysis of putative ArrA sequences from paddy soils suggested that *Geobacter*-related bacteria, including those closely related to OR-1, play an important role in arsenic release from paddy soils. Our results provide direct evidence for arsenic dissolution by *Geobacter* species, and support the hypothesis that *Geobacter* species play a significant role in reduction and mobilization of arsenic in flooded soils and anoxic sediments.

**The lost city hydrothermal field: A geochemical analog for Nili Fossae, Mars**

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Nili Fossae, Mars contains a mineralogical suite similar to that found at the Lost City Hydrothermal Field (LC) off the mid-Atlantic ridge. The LC is a zone of active serpentinization where the interaction of seawater with the underlying mafic and ultramafic bedrock drives geochemical reactions producing serpentine, brucite, magnetite, and the release of high pH fluids enriched in H<sub>2</sub> and CH<sub>4</sub> [1]. Dense microbial communities subsequently use the abiotically produced H<sub>2</sub> and CH<sub>4</sub> as an energy source to drive metabolisms such as methanogenesis [e.g. 1].

We have acquired fifteen variably altered gabbros, serpentinites, talc-rich fault rocks and carbonates from the LC and characterized their mineralogical variability and spectroscopic characteristics in the thermal infrared and visible/near-infrared (VNIR). These results have been placed into geochemical and astrobiological context with respect to the mineralogically similar units found in Nili Fossae, Mars.

The mineralogy of LC rock samples were determined by measuring their thermal emission spectra. VNIR reflectance measurements were made to determine the spectral characteristics of mineral phases present in order to compare with similar data collected for Mars.

Data from the CRISM VNIR imaging spectrometer orbiting Mars has shown the presence of serpentine, Mg-carbonates, talc and/or saponite within an olivine-rich basaltic unit in Nili Fossae [2-5]. The comparison of VNIR spectral characteristics of the LC samples to the surfaces found in Nili Fossae has shown that the two field sites have similar mineralogical suites.

Mineralogy provides an indication of the geochemical conditions present during the time of mineral formation, and prior studies at LC have shown that the geochemical conditions associated with serpentinization-associated reactions are amenable to the growth of microbial communities. Given that the mineralogy at Nili Fossae, Mars is similar to that at LC, it is possible that similar geochemical conditions, and therefore energy sources for microbial metabolisms, may have been present in Nili Fossae early in Mars' history.

[1] Kelley *et al* (2001) *Nature*, **42**, 145-149. [2] Ehlmann *et al* (2010) *GRL*, **37**, L06201. [3] Brown *et al* (2010) *EPSL*, **297**, 1-2, 174-182. [4] Viviano *et al* (2012) *LPSC XXXIII*, Abs. 2682. [5] Hamilton & Christensen (2005) *Geology*, **94**, 433-436.