Molecular study of microbial S oxidation in sulfidic sediments

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Functional Molecular Tools

An alternative approach to determining the relationship between microbial activity and biogeochemical transformations is to target the 'molecular genetic' functional attributes of microbial populations (Rogers *et al.* 2002). We have developed a new generation of molecular biology techniques based on the direct extraction of nucleic acids from regolith samples to quantify functional gene presence and rates of gene expression.

Results

In brief, DNA and mRNA were extracted from sulfidic sediments in the River Murray floodplain South Eastern Australia.. Oligonucleotide primers successfully amplified (using polymerase chain reaction [PCR] and reverse transcriptase PCR) *sox*B gene sequences in sediment DNA and mRNA extracts. The presence and rates of expression of the *sox*B gene was related to rates of S mineral oxidation reactions. This work forms part of a larger project assessing the impact of River Murray floodplain management on S oxidation/reduction mechanisms and acid sulfate soil formation (Lamontagne *et al.* 2004).

References

Lamontagne, S., Hicks, W.S., Fitzpatrick, R.W. and Rogers S. (2004). *CRC LEME Open File Report 165, Perth WA. 63p.*

Rogers S.L. Colloff M. & Gomez D. (2002). Abstracts. 13th Australian Nitrogen Fixation Conference September 24-27 Adelaide, South Australia.

Investigation of the geochemical relationships governing dissimilatory bacterial reduction of U(VI) from solid uranyl mineral phases

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Hypothesis

U(VI) mineral reactivity may differ systematically as a function of mineral structure and chemical properties in the presence of bacteria. By measuring rates of microbial reductive corrosion for different minerals, and by comparing corrosion rates with quantifiable mineral properties (e.g. solubility, lattice structure, composition), it will be possible to assess the corrosion potential of a variety of U(VI) phases.

Results

Preliminary XAFS results show of a shift in the U L3 edge energy for uranyl sulfate minerals to a reduced U species within the first 24 h and continues over 2 weeks (Fig 1.). *Desulfovibrio desulfuricans* appear *to* enhance U reduction in low nutrient media captalizing on nutrients derived from the mineral surface. Further reduction by *Desulfovibrio desulfuricans* occurs after 145 days characterized by an average U oxidation state of U(IV). Bulk XAFS structure shows the gradual development of uraninite as the principle phase.

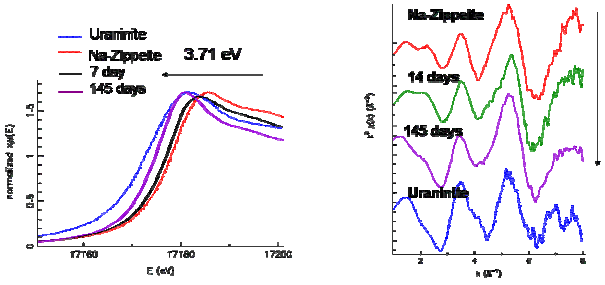

Figure 1 Comparison of U (L3 edges) XANES and XAFS spectra. After a 145 day microbial exposure Na-zippeite contains features observed in uraninite.

Conclusions

Desulfovibrio desulfuricans effect the U(VI)-phase reductive alteration of uranyl sulfate. This leads to changes in compositions and growth habits of the U(VI) protolith and biomineralization of a U(IV) secondary phase (uraninite). The mechanism along with additional solid phase characterization will be discussed.