A Study of Autunite Dissolution in the Presence of *Shewanella Oneidensis MR1* and Different Bicarbonate Concentrations

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Background

Remediation of uranium at Hanford Site 300 area via tripolyphosphate injections could sequester uranium (VI) in an insoluble form, creating different types of uranium phosphate minerals like autunite. The factors that influence the dissolution of such minerals come into question. Bacteria can play a significant role in the dissolution of minerals and the formation of secondary minerals.

Formed autunite, as a phosphorus-containing mineral, can attract bacteria to liberate phosphorus, meeting their nutrient requirements and causing uranium release back into the environment.

Previous studies have been conducted under aerobic conditions. This research was extended to investigate the stability of the autunite mineral under anaerobic conditions pertaining to the Hanford Site, and to study the effect of facultative anaerobic bacteria on the uranium (VI) release from autunite.

Objectives

- Evaluate bacterial interactions with uranium (VI) by focusing on facultative anaerobic bacteria, *Shewanella Oneidensis MR1*.
- Study the effect of bacteria on the dissolution of the uranyl phosphate solid phases created as a result of sodium tripolyphosphate injections into the subsurface at the Hanford 300 Area.
- Evaluate the role of anaerobic bacteria as one of the factors affecting the outcome of environmental remediation.

Experimental Approach

- 16 crimp-sealed bottles (Figure 1) were prepared with 50 ml of media solution and 90 mg (4.4 mM of uranium VI) Ca-autunite mineral obtained from Hanford site. Bottles were inoculated with *Shewanella Oneidensis MR1* strains when autunite was equilibrated with the media solutions. Bacteria was obtained from Pacific Northwestern National Laboratory (PNNL).
- Solution media preparation: 20mM NaHepes buffer: pH=7, 10mM Lactate plus bicarbonate in four concentrations (0, 3, 5 and 10 of $KHCO_3$) and a bacteria-free control. Samples were taken from the supernatant solutions of the experimental and control bottles. Wet and dry digestion was performed until a white solid residue was acquired. Dilution was made on solid samples for KPA anlysis to determine concentration of U (VI) as function of time.

Figure 1. Experimental bottles for Ca-autunite dissolution.

Preliminary Results

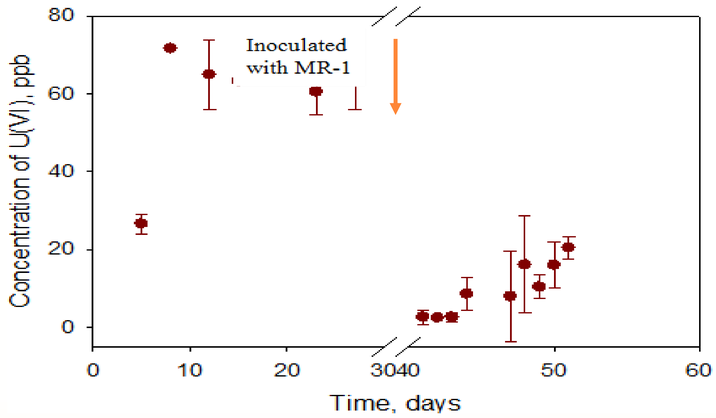

Figure 2. Uranium (VI) concentration released in the aqueous phase as a function of time without any presence of bicarbonates.

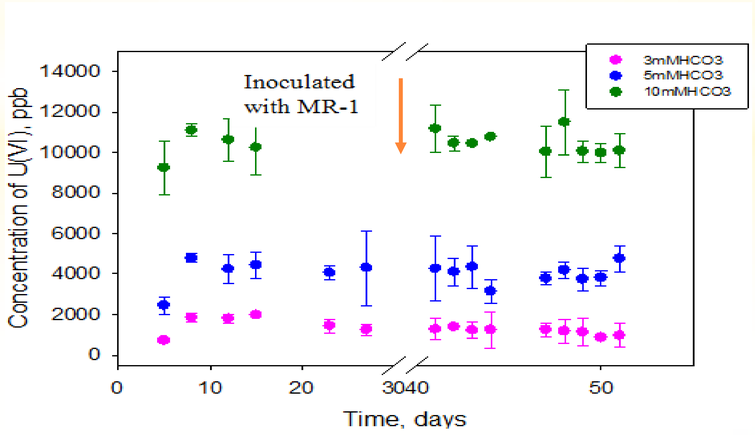

Figure 3. Uranium (VI) concentration released in the aqueous phase as function of time under three different bicarbonate concentrations: 3,5 and 10 mM.

Discussion

- The results suggests that in the absence of HCO_3^- (Figure 2) there was a decrease in the of uranium (VI) concentration due to metal reducing bacteria *Shewanella Oneidensis MR1*, but for higher concentrations of HCO_3^-, there is no significant difference in uranium (VI) reduction before and after inoculation with bacteria (Figure 3).
- Although bottles were sealed, there is an hypothesis that it was oxygen restricted but not strictly performed under anaerobic conditions. For that matter there is a reason to repeat the experiment using the glove box to understand the uranium (VI) reduction mechanism and behavior of bacteria with oxic/anoxic interfaces.

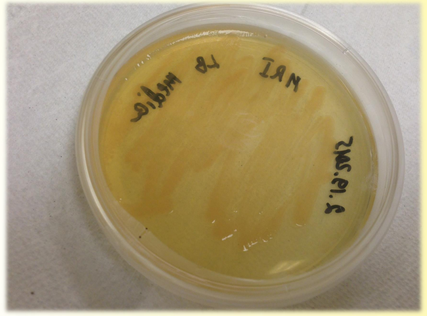

Figure 4. *Shewanella Oneidensis MR1 growth on LB media.*

Conclusions

- Higher bicarbonate concentrations might interfere with uranium (VI) reduction by anaerobic bacteria.
- It is necessary to reduce time of sampling before the inoculation and prolong sampling time after inoculation.
- It might be necessary to increase concentration of lactate.

Future Work

- Conduct experiment in strictly anaerobic conditions by using the glove box and evaluate if further reduction of uranium (VI) is obtained in the presence of carbonates (HCO_3^-).
- Finalize analysis of calcium and phosphorous via ICP instrument.

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