Microscopic Mass Transfer and Its Influence on Microbial Reduction of U(VI)

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Background

In contaminated subaqueous sediments, U(VI) species in both organic-rich active water (ORAW) and intergranular domains (IGRD) move through diffusion. Diffusion-controlled mass transfer (DMR) on the redox interfaces (IGRD/ ORAW) abounds and can yield more mobile properties (U(VI) aq). Integration of U(VI) between non-redox interfaces results in a broad diffusion interface in the micromineral domain. If the DMR interface itself is redox-active, then DMR within U(VI) aq is incomplete. Microscopic and spectroscopic analysis of micromineral-contaminated sediments from the Hanford site was successful in interpreting the diffusive process and the dominant mode of mass transfer. The results indicate that the mass transfer processes can be divided into non-diffusive and mass-transfer limited (DMR) processes.

Characterization of Mass Transfer Process

An NMR-PGSE technique was developed to characterize the microscopic mass transfer process in the grain body and mass transfer reactions (U(VI) aq-diffusion). The NMR approach uses water molecules exchangeable with the redox interface to measure the mass transfer process. The NMR-PGSE approach is based on the diffusion coefficients (D) of water molecules, and (D) was measured on the redox interface to measure the mass transfer process.

Coupling of U(VI) Diffusion, Dissolution, and Microbial Activity

The microbial reduction of U(VI) was developed as a function of dissolved U(VI) (aq) species. The experimental results were well described by the model coupled with the dissolution of uranyl, dissolution/sequestration, and reduced uranyl of dissolved uranyl. Individual models and the free parameters were reduced from six to three. Results indicate that uranyl carbonate is not present.

Objective

- Characterize and develop transient models to describe the microscopic mass-transfer processes in intergranular sediments of different redox states.
- Identify and characterize biogeochemical strategies used in DMR in intergranular sediments at different redox states.
- Evaluate the coupling of dissolution, leaching, and suspended sediments to the overall bioreduction of U(VI) in the system.

Methods

Intragranite mass transfer processes and the influence of intragranite dissolution were evaluated using both sequential coupling of intragranite dissolution and mass transfer. The results for the sequential coupling of dissolution, leaching, and suspended sediments to the bioreduction of intragranite U(VI) aq species were used to develop a microscopic mass-transfer model to describe the coupled intragranite U(VI) dissolution, distribution, and intragranite sediments. The influence of mass transfer on microbial reduction was evaluated using both sequential coupling of intragranite dissolution and intragranite sediments. The results of the sequential coupling of intragranite dissolution and intragranite sediments were used to evaluate the coupling of intragranite dissolution and mass transfer. The results indicate that U(VI) aq species can be coupled with the bioreduction of intragranite U(VI) aq species. The results indicate that the coupling of intragranite dissolution and mass transfer is a key factor in the bioreduction of intragranite U(VI) aq species.

Summary

- An NMR-PGSE technique was developed to describe the microscopic mass transfer in the intergranular domain of U(VI) aq species in the grain body. The technique was used to measure the mass transfer process in the grain body and mass transfer reactions (U(VI) aq-diffusion).
- A new model was developed to describe the microscopic mass transfer in the intergranular domain of U(VI) aq species in the grain body. The model was used to measure the mass transfer process in the grain body and mass transfer reactions (U(VI) aq-diffusion).