AN INTEGRATED ASSESSMENT OF GEOCHEMICAL AND COMMUNITY STRUCTURE DETERMINANTS OF METAL REDUCTION RATES IN SUBSURFACE SEDIMENTS

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The objective of our research is to examine the importance of microbial community structure in influencing uranium reduction rates in subsurface sediments. If the redox state alone is the key to metal reduction, then any organisms that can utilize the oxygen and nitrate in the subsurface can change the geochemical conditions so metal reduction becomes an energetically favored reaction. Thus, community structure would not be critical in determining rates of metal reduction unless community structure influenced the rate of change in redox. Alternatively, some microbes may directly catalyze metal reduction (e.g., specifically reduce U). In this case the composition of the community may be more important and specific types of electron donors may promote the production of communities that are more adept at U reduction. Our results will help determine if the type of electron donor or the preexisting community is important in the bioremediation of metal-contaminated environments subjected to biostimulation.

In sediments collected from the FRC in Oak Ridge, we have seen significant and consistent differences in rates of U reduction that are associated with different electron donors. We have found that nitrate and sulfate reduction were stimulated in all experiments with all electron donors utilized. In contrast, uranium reduction was significantly influenced by the type of electron donor. Rapid U reduction was observed in ethanol and glucose amended sediments. However, methanol promoted nitrate but not uranium reduction in all but one experiment. We did observe one unique result with methanol where there was U reduction. We are currently running experiments to determine if differences in the experimental set up or the initial community were responsible for the variability in results. We are also examining the effects of adding humic material on the rates of U, iron and sulfate reduction. In experiments to date, the addition of humics did not increase rates of uranium reduction in treatments where uranium reduction was already rapid (e.g., with addition of ethanol).

Preliminary characterization of the microbial community using a variety of methods (PLFA, TRFLP, PCR) indicated that there were substantial differences in the community structure related to the type of electron donor added. Further analyses using these techniques and profiling of the community using a functional gene array are planned. Community composition will be related to uranium reduction rates by non-linear data analysis techniques. We also plan to test resource ratio theory to determine if changes in carbon/phosphate ratio can significantly impact the community and U reduction.

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