# An Integrated Assessment of Geochemical and Community Structure Determinants of Metal Reduction Rates in Subsurface Sediments

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Fundamental questions still persist concerning the interactive effects of geochemistry and community structure on metal reduction rates in the subsurface. The overall goal of our project is to provide an improved understanding of the relationships between microbial community structure, geochemistry, and metal reduction rates. Many microorganisms can change the subsurface geochemical conditions (e.g., cause a drop in redox) such that metal reduction becomes an energetically favored reaction. Some microbes can directly catalyze the necessary reactions so that metal reduction occurs at a more rapid rate than without microbial activity. Many microorganisms can accomplish the first role but much fewer can accomplish the second. Physical and geochemical factors such as mass transport, oxygen level, and nitrate concentration will likely dominate the rate of microbial change in the redox potential. Thus, it is possible that the importance of community structure at this stage of metal reduction may be minimal. However, the effect of community composition on the rate of metal reduction may be important. We are using controlled laboratory experiments with sediments and groundwater from the NABIR Field Research Center (FRC) to compare the effects of manipulations designed to influence community structure (differences in electron donors) to those designed to influence geochemistry (the presence of humics as electron shuttles) on uranium reduction. Also, the effect of carbon:phosphate ratios on community structure and uranium reduction rates will be examined in the context of resource-ratio theory to help predict the nutrient supply rates and ratios that maximize uranium reduction at the FRC site. This theory predicts that the structure of a biological community depends on the supply rates and ratios of potentially growth-limiting resources. A preliminary scoping experiment is underway using methanol (20 mM), ethanol (10 mM), and glucose (5 mM) as electron donors at equivalent electron transfer potential. The experiment is being run at pH 7.0 with archived site material and a groundwater inoculation. At two weeks, there was evidence of metabolic activity (increased headspace pressure compared to the controls) for all three electron donors. Total U, organic C, pH, and nitrate are being measured. The next experiment will use six electron donors and will be run at several pH levels. These combinations should lead to even greater differences in community structure. This study will help assess the applicability of NABIR research to other sites with diverse community structures.

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