Variation in interactions between iron reducers, sulfate reducers, and methanogens with electron donor supply in semi-continous bioreactor experiments

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Microbial activity can significantly impact the quality of water resources. In turn, water chemistry is an important control on microbial activity. Understanding these two-way interactions is essential to our ability to predict impacts of environmental change and develop biological strategies to enhance water quality.

In this study, we consider how variation in electron donor concentration influences microbial activity in iron-bearing anoxic environments. We constructed two sets of semi-continuous bioreactors, each inoculated with a microbial community from a freshwater aquifer. One set contained 0.5 mM sulfate whereas the other set was sulfate deficient. Acetate, which served as the electron donor in both sets of bioreactors, ranged in concentration from 0 mM to 0.25 mM.

We sample the reactors and replace with fresh medium weekly, giving a fluid residence time of 35 days. To evaluate rates of microbial reactions, we analyze reactor effluent for ferrous iron, sulfide, alkalinity, and major ion concentrations. We also periodically analyze the methane content of reactor headspace. In addition to chemical analyses, microbial communities will be directly analyzed by using sequencing by synthesis.

Our experiments are ongoing but we expect that variation in electron donor flux will not only affect the overall rate of microbial activity but also the balance between individual groups. Unlike sulfate reduction and methanogenesis, the upper limit of the rate of iron reduction is limited by oxide surface area. Even where iron reducers hold a significant competitive advantage over sulfate reducers and methanogens, therefore, electron donor will be available to those groups if electron donor is supplied more rapidly than iron reducers can consume it. Improving our understanding of these relationships will help us better understand controls on microbial activity in natural settings and improve our ability to design environmentally-relevant laboratory experiments.