Improving the Efficiency of Remediation of TCE-Contaminated Groundwater Using Permeable Reactive Barriers

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Background/Objectives. Trichloroethylene (TCE) is a toxic volatile organic compound with several health associated problems such as cancer, liver and kidney damages, and neurological problems. An aquifer in Maryland was contaminated with high levels of TCE. In 2013, a permeable reactive barrier (PRB) was installed across the flow direction between the plume and the nearby wetland. Four years later, the PRB has provided suitable conditions for the indigenous microbial community to dechlorinate TCE. Despite the decrease in TCE levels (600 ppb up gradient to below 1 ppb, down gradient from the wall), not much ethene has been produced and a buildup of TCE degradation products has occurred (vinyl chloride concentration increased from ND up gradient from the PRB to 19 ppb down gradient from the PRB), showing the inefficiency of the PRB.

Approach/Activities. To obtain more information on the microbial community present in the PRB and to identify the bacteria with the potential to degrade VC, DNA extraction, sequencing of the microbial communities were conducted. PCR and qPCR using primers targeting functional genes responsible for dechlorination is also being conducted. A solid material like biochar with high surface area and ability to adsorb the organic pollutant like TCE is able to provide a suitable solid surface for the biofilms to grow on. Biochar biofilm samplers (Bio-charts) were also installed in two wells (one inside the PRB and another up-gradient from the PRB) to compare and evaluate the microbial community present in groundwater over time.

Results/Lessons Learned. Batch reactor experiments comparing different amendments for the PRB, such as organic carbon and consortia of TCE and VC degrading microorganisms, have been initiated to identify a more-efficient treatment for VC degradation. Initial batch reactor experiments with WBC-2 (a consortia of bacteria able to dechlorinate TCE anaerobically to ethene) showed that samples which were amended with WBC-2 were successful in fully dechlorinating TCE to ethene. DNA extraction, PCR and qPCR on the biofilms formed on the biochar particles collected from Bio-charts, have indicated the concentration of bacteria is higher inside the PRB than in the monitoring well. Results will be used to advise engineers and land managers on changes and PRB amendments needed to produce more effective TCE remediation.