Microbially Influenced Mass Transfer from Entrapped Pools of Non-Aqueous Phase Tetrachloroethene: Preliminary Results of Small Flow-Cell Experiments

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Abstract. Groundwater remediation at sites with non-aqueous phase liquid (NAPL) typically is limited by a slow rate of contaminant mass transfer from high-saturation pools of entrapped NAPL. Our research is designed to characterize and model effects of biodegradation on mass transfer from NAPL containing tetrachloroethene (PCE). Specifically, we are investigating effects of microbes that grow by reductive dechlorination of PCE. Four distinct microbe cultures are being evaluated, including pure cultures of obligate and facultative anaerobes, and a mixed culture of acetogenic, methanogenic and dechlorinating bacteria. Batch experiments using aqueous phase and multiple-phase (NAPL, sand and water) systems are being conducted to identify a suitable culture for use in characterizing degradation and mass transfer.

We are conducting mass-transfer experiments in small glass flow cells packed with two well-characterized sands to create a capillary trap for PCE NAPL. Water is pumped under anaerobic conditions through fine-grained sand overlying the NAPL pool at a rate representative of field-scale groundwater movement and PCE concentration breakthrough in effluent water is monitored. Experimental conditions are varied as follows: (1) abiotic conditions (2) abiotic conditions with elevated concentrations of electron donor and other nutrients (3) inoculation with inactive microbes, and (4) inoculation with biologically active microbes. In this manner mass transfer effects can be evaluated for each factor. Results of an initial set of flow cell experiments will be presented. These results will be incorporated into a reactive solute transport model (RT3D) to predict intermediate-scale effects of biodegradation on mass transfer from pools of entrapped NAPL.