Field Test Yields Aerobic Abiotic Trichloroethene Degradation Rate, Sorption and Diffusion Coefficients for Low Permeability Fractured Rock

Richelle M. Allen-King (richelle@buffalo.edu), Rebecca Kiekhaefer, and Rory Dishman
(University at Buffalo, State University of New York, Buffalo, NY, USA)

Background/Objectives. The purpose of our project was to develop a novel method to measure site specific fate and transport processes for trichloroethene (TCE) in fractured sedimentary rock aquifers. In particular, we quantified the diffusion and sorption coefficients, and degradation rate coefficients for TCE in a contaminated borehole and adjacent low permeability rock matrix. These data are important because back diffusion of TCE stored within the low permeability matrix provides a difficult to treat secondary source of contamination that maintains contaminant plumes. This presentation emphasizes a test that we posit demonstrated rapid aerobic abiotic TCE degradation. Site specific data on the processes controlling back diffusion has implications for remedy selection

Approach/Activities. We developed a straddle packer system and method capable of simultaneously quantifying the effective diffusion coefficients of TCE and its chlorinated degradation products (DP) in low permeability strata, and the TCE degradation rate coefficient in the borehole groundwater within the test interval. To begin each test, we flushed a historically contaminated test interval with groundwater with the contaminants (TCE and DPs) removed. During the test, the TCE back-diffused out of the matrix into the test interval groundwater and the tracers diffused into the matrix. Water samples from the test interval over time were analyzed. Diffusive exchange between the groundwater and matrix, and degradation reactions in borehole groundwater were modeled to determine diffusion coefficients, degradation rates and form of the degradation reaction. This project is a collaborative effort between the authors and US Geological Survey staff, including: A. Fiore, D. Goode, P. Hsieh, T. Imbrigiotta, M. Lorah, A. Shapiro, and C. Tiedeman.

Results/Lessons Learned. We posted that TCE was degraded by the aerobic abiotic reaction in one field test. In this test, the DCE, vinyl chloride, and reactive tracer trichloroethene (TCFE) concentration patterns over time were consistent with retarded diffusion. TCE that diffused from the rock was rapidly degraded without production of a stoichiometric DCE mass, consistent with aerobic abiotic reaction. The results of supporting laboratory experiments will also be presented. In a contrasting test, TCE was biodegraded to primarily cis-1,2-dichloroethene (DCE) and the temporal concentration patterns were best fit by a model with rapid reductive dechlorination of both TCE and TCFE.