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Innovative Approach to Determine the Rate of Abiotic Degradation of TCE in a Large Diffuse Plume

James Mills and David L. Freedman (Clemson University, Clemson, SC, USA)
Todd H. Wiedemeier (Wiedemeier and Associates, Denver, CO, USA)
Diana Cutt and Lorenzo Thantu (U.S. Environmental Protection Agency, New York, NY, USA)
Brian Looney (Savannah River National Laboratory, Aiken, SC, USA)
Barbara Wilson and ***John T. Wilson*** (john@scissortailenv.com) (Scissortail Environmental Solutions, LLC, Ada, OK, USA)

Background/Objectives. The Hopewell Precision NPL site is located in Hopewell Junction, New York. A large and diffuse plume of groundwater contamination extends about 1.5 miles from the source. The aquifer sediment has an appreciable magnetic susceptibility, and abiotic degradation of TCE on magnetite is plausible. Over time, the concentrations of TCE in groundwater have attenuated. In February 2003, the highest concentration of TCE at the site was 250 µg/L. In March 2013, the highest concentration was 42 µg/L. Because attenuation of TCE over time in any particular well at this site is a combination of decay of the source and degradation of TCE along the flow path, it is difficult to use a computer model to extract an unambiguous estimate of the rate constant for degradation in the groundwater. The goal of the study was to attain an independent estimate of the rate of abiotic degradation of TCE in the aquifer sediment.

Approach/Activities. The volume magnetic susceptibility of the aquifer sediment was determined by inserting a sonde into five monitoring wells. A reading was recorded for every 0.1 feet of penetration. The volume susceptibility was converted to mass magnetic susceptibility by dividing by an assumed bulk density of 1,700 kg m^{-3} for aquifer material. An average was taken for the all the readings extending from the water table to the bottom of each well. Then a grand average was taken for the five wells. That value was 2.7E-07 m^3kg^{-1}.

The REMChlor computer application was used to construct a model of the TCE plume at the site. The predictions of the model were compared to concentrations of TCE in the 12 monitoring wells. To match the observed distribution of TCE in groundwater at the site, the first order rate constant for degradation of TCE would need to be 0.0625 yr^{-1}. This rate constant for degradation normalized by the magnetic susceptibility is 2.3E+05 kg m^{-3} yr^{-1}.

Four core samples from three locations along the plume were analyzed for mass magnetic susceptibility, and then assayed for the rate constant for abiotic degradation of TCE on the sediment (Mills et al., 2017). Sediment was suspended in groundwater from the site, then ^{14}C labelled TCE was added and the rate of production on non-volatile degradation products was determined. The normalized rate constants for abiotic degradation of TCE varied from 1.8E+05 to 1.2E+06 kg m^{-3} yr^{-1} with a mean of 1.3E+06 kg m^{-3} yr^{-1}.

Results/Lessons Learned. At an average field-scale magnetic susceptibility of 2.7E-07 m^3/kg, the mean of the normalized rate constant in the ^{14}C assay corresponds to a rate constant of 0.34 yr^{-1}. This is roughly five times the rate constant extracted using the REMChlor model (0.0625 yr^{-1}). Abiotic degradation of TCE on magnetite in the aquifer sediment is a plausible explanation for the observed rate of natural attenuation of TCE in the groundwater, and provides a second line of evidence to support the rate constant that was extracted using the REMChlor model.

This is an abstract of a proposed presentation and does not necessarily reflect EPA policy.