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Identification of PCE Degradation Processes in Fractured Rock Aquifer

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Background/Objectives. An evaluation of intrinsic biogeochemical processes was conducted underlying a former dry cleaner property located in the Georgia Piedmont Geological Province. The purpose of the evaluation was to, as part of corrective action alternative evaluation, identify those intrinsic processes supporting tetrachloroethene (PCE) degradation within the underlying fractured rock aquifer consisting of saprolite (residuum) overlying fractured granitic gneiss. The source of PCE within the saprolite, anticipated to be between 10 to 45 years old (timeframe of dry cleaning operations), was remediated in 2013. Identification of the nature and extent of PCE in groundwater was completed in 2015. Statistical trends for PCE are “stable” to “decreasing”, indicating the plume extended to the maximum extent spatially and vertically.

Approach/Activities. The evaluation included an assessment of select biogeochemical parameters indicative of or affecting metabolic, cometabolic, and abiotic pathways of PCE degradation. Groundwater samples were collected from the well network in the Summer of 2015. Samples were analyzed for PCE and degradation products, general water quality parameters, dissolved gasses, terminal electron acceptors and products, total organic carbon, and volatile fatty acids. Select groundwater samples were also evaluated via molecular-based tools (i.e., QuantArray® Chlor) and compound specific isotope analysis (CSIA). Biochlor modeling was used to estimate intrinsic decay rates for PCE based on this data.

Results/Lessons Learned.
Lines of evidence of intrinsic degradation processes were detected in groundwater underlying the site. These included:

- Detection of *Dehalococcoides* (*Dhc*.) species, reductive dehalogenase genes, and other chlororespiring species capable of supporting reductive dechlorination of PCE to ethene
- Detection of ethene and ethane, end products of anaerobic PCE degradation
- Detection of genes capable of promoting cometabolic degradation of PCE
- Low CSIA fractionation values for PCE indicative of slow degradation processes.

These naturally-occurring processes have been instrumental in promoting “stable” to “decreasing” trends for PCE in groundwater, and for promoting a stable plume. However, these processes were heterogeneously distributed across the 12-acre study area, and limited in areas by groundwater conditions in areas. Abiotic degradation pathways for PCE appear insignificant. Biochlor modeling results yielded site-specific decay rates of approximately 0.2 per year. These decay rates support the prospect of long-term PCE degradation over a 30-year period.
The combination of the biogeochemical results, Biochlor modeling results, and PCE trends support that PCE decreases will continue towards regulatory standards over the long-term. Further, current receptors and complete exposure pathways do not exist for groundwater, and future receptors and exposure pathways will be minimized via Streamlined Uniform Environmental Covenants. No unacceptable risks were identified for ecological receptors in the nearby creek, as demonstrated by a screening-level ecological risk assessment (SLERA). Point of demonstration monitoring was proposed to confirm existing trends in groundwater over the long term, with no further active remediation. Georgia Environmental Protection Division approved this proposed remedial option and the SLERA results via letter on August 22, 2016.