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Demonstrating Contaminant Biodegradation in Conjunction with Colloidal Activated Carbon Remediation Technologies

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Background/Objectives. Colloidal activated carbon technology is an innovative approach to rapidly reduce dissolved VOC concentrations and quickly mitigate migration and risk to sensitive receptors. In addition, colloidal activated carbon can provide a long-term means of addressing back-diffusion of contaminants from less permeable subsurface strata. To be a long-term solution however, the technology should permit and if possible promote biodegradation to achieve not just containment but effective contaminant destruction. In the following studies, QuantArray analysis was performed to investigate the impact of PlumeStop® injections on key halorespiring bacteria at two chlorinated solvent sites.

Approach/Activities. At the first study site, groundwater was impacted by tetrachloroethene (PCE) at a concentration of 550 mg/L with no evidence of daughter product formation over 14 years of monitoring at this site. The second study was conducted within a dilute plume. During the baseline sampling event, trichloroethene (TCE) and cis-dichloroethene (DCE) were present at concentrations less than 15 mg/L. The remediation strategy at both sites included PlumeStop® injection in conjunction with electron donor addition (HRC®) and bioaugmentation (BDI-Plus). In addition to the baseline event, groundwater samples were collected for chemical and geochemical analyses approximately two weeks, one month, two months, three months and then quarterly for a period of up to two years. Throughout the performance monitoring period, groundwater samples were also submitted for QuantArray® quantification of organohalide-respiring bacteria (e.g., *Dehalococcoides*, *Dehalobacter*, *Dehalogenimonas*) and functional genes (e.g., vinyl chloride reductases) to determine if VOC adsorption to the colloidal activated carbon would impact biodegradation.

Results/Lessons Learned. At the first study site, the PCE concentration was below the detection limit less than 2 weeks after injections and was not detected at concentrations greater than 1 mg/L during any subsequent sampling event. For a period of nine months following biostimulation and bioaugmentation, *Dehalococcoides* were detected at concentrations at or near the 10^4 cells/mL threshold recommended for generally effective rates of reductive dechlorination even with removal of chlorinated hydrocarbons from the dissolved phase. After this period, available electron donor concentrations as indicated by total organic carbon began to decrease. By 15 months, TOC had decreased to less than 10 mg/L, *Dehalococcoides* populations decreased by approximately an order of magnitude and vinyl chloride reductase genes were only on the order of 10^1 gene copies/mL. During subsequent sampling events (18 to 24 months) vinyl chloride was detected at low concentrations (<5 mg/L). While suggesting a decrease in reductive dechlorination rates concurrent with the depletion of electron donor, the detection of vinyl chloride provided strong additional evidence of active biological reductive dechlorination despite effective adsorption of chlorinated hydrocarbons by the colloidal activated carbon. Preliminary results for the dilute plume are similar. High concentrations of *Dehalococcoides* and other organohalide-respiring bacteria have been maintained for over 10 months following injections. Overall the results indicate that colloidal carbon technologies not only have no adverse impact on halorespiring bacteria but particularly for dilute plumes may effectively promote biodegradation by serving as a reservoir for chlorinated hydrocarbons to be used as electron acceptors.