Post Bioremediation Chemical Reduction to Achieve Treatment Standards for Carbon Tetrachloride/Chloroform at an Industrial Site in Brazil

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Background/Objectives. Both in situ bioremediation and in situ chemical reduction (ISCR) have been successful remediation technologies in Brazil. Exceptionally warm groundwater temperatures lead to diverse and robust microbial populations that foster rapid biodegradation kinetics that drive subsurface conditions deeply reducing. While TCE and 1,1,1 TCA are common target compounds in Brazil, carbon tetrachloride and its daughter product, chloroform, have occasionally been the focus of remediation.

At an adhesives manufacturing site in São Paulo, carbon tetrachloride is used as a raw material. Two source areas were identified and the groundwater plume has migrated off-site to neighboring properties and under a minor highway. A cometabolic bioremediation system using butane was previously implemented and had success reducing carbon tetrachloride concentrations, but chloroform accumulation resulted. To address remaining carbon tetrachloride and chloroform mass, an in situ chemical reduction approach was implemented.

Approach/Activities. To demonstrate the efficacy of in situ chemical reduction, a pilot test was undertaken using a hybrid amendment consisting of a carbon source and microscale zero valent iron that was applied to low permeability silts/clays using pneumatic fracturing, trenching, direct push, and soil mixing techniques (depending on the varied lithology in the area). Significant reductions of carbon tetrachloride and chloroform were quickly observed, with changes in field parameters and geochemistry. A microbial profile was also obtained using molecular biological tools. Information on injection spacing was also developed. A description of the approach and data from the pilot test will be summarized for this presentation.

Over the last six years, a full-scale application of the hybrid amendment was completed at 30 locations across three properties using a combination of techniques for different site scenarios and post-injection were data collected. Data were entered into a database that was used for preparation of 3-D visualizations of the plumes and ongoing tracking of mass and concentration changes.

Results/Lessons Learned. Significant reductions of parent/daughter compounds have been documented with corresponding changes in field parameters and geochemistry. Changes in mass, concentration and plume geometry will be presented over the course of remediation. Remediation is in its final stages and much of the site has met commercial treatment standards with residential standards within reach. Observations from the life cycle of remediation will be presented and the final path forward described.