Tracking Cleanup of Chlorinated Solvents: Development of Benchmark Decay Rates

Kenneth Walker (klwalker@gsi-net.com), Travis McGuire, David Adamson, and Charles Newell (GSI Environmental Inc., Houston, Texas, USA)

Background/Objectives. An in-depth analysis of electronic database records was evaluated as part of an ESTCP research project to evaluate the occurrence of sustained treatment, where the benefits of enhanced bioremediation extend beyond the active treatment period. Evidence for sustained treatment of chlorinated volatile organic compounds (CVOCs) previously was demonstrated at a majority of in situ bioremediation sites with 3 to 12+ years of post-treatment monitoring (McGuire et al., 2015). The objective of this study was to extend prior site-specific studies with a "big data" evaluation of remediation sites and assess: (i) long-term CVOC trends, (ii) the interrelationships among chlorinated solvents and their daughter products (e.g., how is TCE related to cis-1,2-DCE, etc.), and (iii) development of benchmark decay rates for evaluating sustained treatment and monitored natural attenuation (MNA). Similar mining of "big data" datasets for insights has successfully been applied to BTEX and MTBE (McHugh et al., 2012; McHugh et al., 2015), 1,4-dioxane and chlorinated ethenes (Adamson et al., 2014, 2015), and chlorinated solvents (McHugh et al., 2014). This study extends prior work by including a larger database of environmental monitoring data.

Approach/Activities. Analytical data were downloaded from the State of California Geotracker database, which contains over 12,000 sites with electronic concentration data. Sites were selected with electronic data after 2006 and with detected concentrations of PCE/TCE and their degradation products. Preliminary data analyses separated sites based on a presumed parent product of either PCE (e.g., dry cleaners) or TCE (e.g., DOD facilities). Source attenuation rates were computed for each site by evaluating the site-wide maximum concentration of each compound over the monitoring period. Similarly, concentration trends over time (e.g., linear regression and/or Mann-Kendall) were calculated with long-term monitoring data for both presumed source areas and within individual monitoring wells. Trends of total mass of chlorinated solvents were evaluated following an approach consistent with the Monitoring and Remediation Optimization System (MAROS), and trends in plume center of mass were also tracked. Statistical comparisons were made between analytical parameters, and correlations between sampled parameters were evaluated.

Results/Lessons Learned. Preliminary analyses indicate several tantalizing relationships between PCE, TCE, cis-1,2-DCE, and vinyl chloride. For example, at many sites, maximum concentrations of cis-1,2-DCE exceed maximum vinyl chloride concentrations by over an order-of-magnitude, possibly suggesting the stall of cis-1,2-DCE biodegradation to a vinyl chloride daughter or the aerobic degradation of vinyl chloride. In addition, very few sites demonstrate maximum vinyl chloride concentrations greater than 10x maximum cis-1,2-DCE concentrations. Source attenuation rates for TCE at 507 sites indicate a median rate of 0.11 per year, which is equivalent to a half-life of 6.3 years. The development of these source attenuation rates for each analyte can serve as benchmark decay rates for evaluating sustained treatment and MNA of chlorinated solvents and daughter products.