Optimizing Bioremediation at Mixed Contaminant Sites

Corey Scales (cscales@siremlab.com), Jeff Roberts, and Phil Dennis (SiREM, Guelph, ON, Canada)

Background/Objectives. Bioremediation of chlorinated solvents, petroleum hydrocarbons and 1,4-dioxane is a proven remedial approach at many sites, however, there are still sites that present challenges to implement bioremediation especially when multiple contaminants are present. Over the last two decades advancements have been made in our understanding of bioremediation processes to allow the technology to be used for a growing number of compounds and mixed contaminant scenarios. In the early 2000s bioremediation was primarily used for chlorinated ethene sites and *Dehalococcodies* bacteria and associated functional genes are well understood. We also learned that some chlorinated compounds inhibited the degradation of others and that it is important to understand inhibition and sequencing of degradation reactions under complex mixture scenarios. Also, some non-chlorinated compounds (i.e., BTEX,1,4-dioxane) present at complex sites may also interfere with degradation pathways and/or affect the sequencing of remedial approaches. Successful bioremediation may be possible under these challenging conditions and tools are available that can help to mitigate these factors.

Approach/Activities. Complex contaminant mixtures may include novel or emerging contaminants that interfere with known degradation pathways of common chlorinated solvents such as PCE, TCE and 1,1,1-TCA. Understanding the appropriate electron acceptor and electron donor required for contaminant degradation is critical, as well as what redox conditions may be suited for bioremediation approaches. Impacts of known microbial inhibitors (high concentrations, pH extremes, chloroform, CFCs) that may be present concurrently can make remediation extremely challenging. Under these mixed contaminant, complex scenarios, treatability testing is often a critical first step to evaluate potential remedial approaches, to understand inhibition effects and how to overcome them and achieve realistic remedial outcomes. Numerous laboratory treatability studies have been conducted by SIREM under a wide range of complex conditions. The advancement of blending zero valent iron (ZVI) with common electron donors often helps promote degradation and reduce inhibition in mixed contaminant plumes. Also, sequencing of aerobic/anaerobic approaches may be required when chlorinated and non-chlorinated compounds are commingled (i.e., 1,4-dioxane).

Results/Lessons Learned. Examples of successful bioremediation at mixed contaminant sites will be presented with a focus on degradation half-lives, degradation pathways and remediation outcomes. One site with a mixture of chlorinated solvents including chlorinated ethenes, ethanes and methanes indicated higher rates and more complete dechlorination when ZVI was used along with electron donor and bioaugmentation. Another Site required anaerobic conditions to degrade the chlorinated solvents and aerobic conditions to degrade 1,4-dioxane and benzene. This presentation will discuss the approaches used for these different complex sites and lessons learned that can be applied to other similar sites for planning field implementation strategies.