Use of Microbial Tools for Evaluating Large Dilute Plumes

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Chlorinated solvents are the most common and most widespread contaminants in soil and groundwater at DOE Environmental Management (EM) sites throughout the U.S. Notable examples include the Savannah River Site in SC, the Paducah Gaseous Diffusion Plant in KY, the Idaho National Laboratory in ID, and the Hanford Reservation in WA. EM faces long-term challenges associated with these plumes, particularly with developing management and end state approaches for clean-up that are protective of the environment, technically based, documentable, and cost effective.

Over the past decade, monitored natural attenuation (MNA) increasingly has become accepted as a remedial alternative for organic contaminants dissolved in groundwater. Environmental Protection Agency guidance states that natural attenuation processes which degrade or destroy contaminants are preferred over non-destructive mechanisms (i.e., dispersion or dilution). However, most large dilute plumes contain dissolved oxygen; thus the primary attenuation mechanisms, e.g. anaerobic degradation, are not effective. Tools to characterize, optimize, and monitor long term remedial approaches for these large, oligotrophic, and low concentration plumes are critical for transitioning active remediation into end state strategies including MNA with long term monitoring. ***Enzyme activity probes, EAP, have the potential to be used as practical tools for quickly and conclusively determining the potential for biologically mediated degradation with the potential for estimating degradation rates in situ.***

A suite of enzyme assays have been developed for oxygenases known to degrade environmental contaminants including chlorinated solvents, petroleum hydrocarbons, and emerging contaminants such as 1,4-dioxane, MTBE (Methyl tertiary butyl ether) and NDMA (N-nitrosodimethylamine). EAPs have been applied at contaminated sites to enable better subsurface microbial characterization, for determining rates of degradation, and to enable long term remedial strategies such as monitored natural attenuation to be implemented and effectively monitored. In addition to the EAPs, molecular techniques such as qPCR and stable carbon isotope analyses have been coupled with EAPs to provide multiple definitive lines of evidence for biological degradation. Collectively, these tools have been applied at over 20 DOE, DoD, and industrial sites (groundwater and soils) successfully.