Electrokinetically-Emplaced Amendments for Enhanced Bioremediation of Chlorinated Solvents in Clay: A Pilot Field Test

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Background/Objectives. Bioremediation is an increasingly popular treatment technology for contaminated sites due to the proven success of biostimulation and bioaugmentation. However, bioremediation, along with other in situ remediation technologies, face challenges with amendment delivery in low permeability media. Studies have suggested that electrokinetics (EK) can enhance the delivery of amendments in low permeability soils. A pilot field trial was conducted to evaluate the potential for electrokinetics to support anaerobic dechlorination in clay by improving the transport of lactate and microorganisms. The study presents a field trial performed on the site of a former chlorinated solvent production facility in which contamination is found in low permeability clay zones.

Approach/Activities. Transects were set up in the contaminated clay and different amendments were injected in each transect cell to evaluate various remediation strategies under the influence of EK. Two cells were used as controls, one with EK applied and the other with no EK. This presentation focuses on the cell that applied electrokinetics for lactate emplacement followed by bioremediation (EK-Bio). This cell had an initial single injection of KB-1 bioaugmentation culture (SiREM, Canada) followed by injection of sodium lactate as a biostimulant while direct current was applied. EK can enhance lactate migration by electromigration, while microorganisms have the potential to be influenced by electroosmosis of the bulk fluid or by electrophoresis of the charged bacteria themselves. Weekly aqueous sampling was completed and samples were analyzed for metals, anions, dissolved organic carbon (DOC) and chlorinated volatile organic compound (cVOC) concentrations. Soil samples were also collected prior to the injection of amendments and twice post-injection, 6 months apart.

Results/Lessons Learned. All monitoring well locations in the EK-Bio cell exhibited evidence of successful lactate delivery corresponding to an increase in dissolved organic carbon. Reduction in chlorinated volatile organic compound (cVOC) concentrations, in particular 1,2-dichloroethane (1,2-DCA), were evident in monitoring locations coinciding with significant lactate breakthrough. Through DNA analysis of groundwater samples, the delivery of lactate by EK appears to effectively stimulate microbial activity. This is observed with increases in total bacterial abundance and shifts in bacterial community structure that could support the presence of anaerobic dechlorination. This study provides original insights into the application of electrokinetically-enhanced bioremediation as a treatment strategy for solvent-contaminated, low permeability porous media.