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Modification of a Sparge/Vent Groundwater Remediation System in Fractured Rock for Reductive Dechlorination

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Background/Objectives. Advances in bioremediation provide options for remediation of complex geological conditions that did not exist just a few years ago. An area of mixed chlorinated solvent contaminated groundwater in residuum and fractured bedrock exists at a chemical agent decontamination training area of a former US Army post in the southeastern US. Remediation is complicated by the presence of karst features and strong downward hydraulic gradients. An air sparging and soil vapor extraction (SVE) system was installed with a row of eight deep air injections wells to sweep chlorinated solvents (primarily 1,1,2,2-tetrachloroethane [TeCA] and trichloroethene [TCE]) from rock fractures into the vadose zone where it would be recovered by the eight vacuum well SVE system. The sparge/vent system functioned to remove solvent mass, but once the sparge/vent system reached asymptotic solvent removal, the system was reconfigured to support a bioremediation remedy.

Approach/Activities. The conversion of the sparge/vent system into a bioremediation system involved treatability studies to evaluate potential challenges in converting an aerobic aquifer into an anaerobic aquifer suitable for reductive dechlorination. A series of progressively deeper monitoring wells were installed to monitor the vertical distribution of bioremediation amendments and the performance of the bioremediation process. The SVE wells, which were partially screened below the water table, were converted into injection wells to take advantage of the strong downward gradients with the intent that amendment solutions would follow the vertical and horizontal migration pathways taken by the spilled solvents. The air sparging wells were converted into deep bedrock monitoring wells to evaluate the extent of treatment within the contaminated area.

Results/Lessons Learned. An emulsified vegetable oil (EVO) product, sodium bicarbonate, and KB-1 Plus formulated to treat the mixture of solvents was applied in each SVE well such that the amendments contacted the soil/bedrock interface. Groundwater monitoring indicated a very rapid onset of reductive dechlorination with the formation of ethene and ethane. Within six months almost all the monitoring wells showed geochemical conditions and solvent compositions typical of complete dechlorination. Two small areas failed to respond to treatment. One of the poorly treated areas seemed related to limited distribution of remediation amendments resulting from the constraint of using pre-existing SVE wells that were not optimally placed for injection. Investigation of the other area revealed a small and previously unrecognized solvent source that supplies dissolved solvents into the treatment area at a rate that exceeds the biodegradation rate and results in a persistent plume. After one year of treatment several of the monitoring wells no longer contained detectable levels of chlorinated solvents. Additional characterization of the newly discovered source area and localized treatment is underway.