Source Zone Removal followed by Enhanced Bioremediation in Chlorinated Ethene-Impacted Fractured Sandstone

Jonathan P. Waddell (jwaddell@gesonline.com), J. Rusty Field, and Montgomery S. Bennett
(Groundwater & Environmental Services, Inc., Richmond, VA)

The purpose of this abstract is to describe the effects of Enhanced Bioremediation as a polishing step within fractured sandstone following the excavation of chlorinated ethene source zone impacts within an overlying glacial till. Contaminants of concern at the 31-acre industrial site consist primarily of chlorinated ethenes including tetrachloroethene, trichloroethene, *cis* 1,2-dichloroethene, and vinyl chloride. The site is directly underlain by around 10-feet of glacial till, which overlies 50-foot deep U-shaped Berea Sandstone channels surrounded by Bedford Shale ridges.

Two (2) source zone removal events have been conducted at the site as part of an on-going corrective action process conducted under the auspices of the Ohio EPA-Voluntary Action Program (VAP). In Winter 2007, around 8,500-tons of chlorinated ethene-impacted till were removed. In Fall/Winter 2008, nearly 24,000 tons were excavated. Source zone excavation and removal, coupled with historical and current Enhanced Bioremediation efforts, has had a significant effect with respect to decreasing contaminant mass flux and increasing the extent of anaerobic reductive dechlorination (i.e., chlororespiration) at the site.

Prior to source zone removal in Winter 2007, Enhanced Bioremediation was utilized to prepare the sandstone underlying the source zone for perturbances resulting from excavation of source zone materials, enhance degradation rates of chlorinated ethene impacts prior to and immediately following source zone excavation, and to promote complete reductive dechlorination of chlorinated ethenes via indigenous *Dehalococcoides* species to innocuous product ethene. Approximately 650 gallons of quick-release electron donor HRC-Primer® were packer-injected directly into the sandstone. Following Biostimulation, molar decreases in parent chlorinated ethenes within the limits of excavation were observed. However, molar increases in daughter products and total chlorinated ethenes were observed within the limits of excavation, which were expected as a result of perturbing the contaminated media. On a larger-scale, significant source zone mass was removed and was evident in molar decreases of parent and daughter chlorinated ethenes and increases in daughter product formation (including ethene) down-gradient.

In order to maintain elevated chlororespiration within the sandstone prior to, during, and following the second source zone removal event; Enhanced Bioremediation was conducted in Fall 2008 prior to commencement of soil removal activities. Nearly 900 gallons of commercially-available electron donor 3-D MicroEmulsion (3DMe)™ were straddle-packer injected directly into the sandstone at approximate 10-foot intervals. 3DMe was selected in order to provide a combination of quick-release (i.e., free lactate) and slow-release (i.e., polylactate esters and fatty acids) electron donors. Subsequently, groundwater monitoring will be conducted in order to evaluate the total effectiveness of the two (2) source zone removal events coupled with the use of Enhanced Bioremediation as a polishing step.