Bioremediation and Sustainable Environmental Technologies—2017. Fourth International Symposium on Bioremediation and Sustainable Environmental Technologies (Miami, FL; May 2017). ©2017 Battelle Memorial Institute, Columbus, OH, www.battelle.org/biosymp. A. Barton and S. Rosansky (Chairs)

Treatment of Chlorinated Volatile Organic Compounds and 1,4-Dioxane by Cometabolic Biodegradation

Christa Bucior, Sophia Dore, Donald Pope, Ryan Thomas and ***Alan Weston***
(alan.weston@ghd.com)
(GHD, Niagara Falls, NY, USA)

Background/Objectives. 1,4-Dioxane has been associated with chlorinated solvents in groundwater plumes at many sites around the United States. 1,4-Dioxane is a stabilizer for storage and transport of chlorinated solvents, in particular 1,1,1-TCA. It has a high water solubility and travels further in the groundwater than the chlorinated solvents. Increasing regulatory attention to 1,4-dioxane has prompted the evaluation of 1,4-dioxane at many chlorinated solvents sites around the counry.

Chlorinated volatile organic compounds (CVOC) and 1,4-dioxane were present in the soil and groundwater at a site in California. The CVOC were primarily tetrachloroethylene (PCE), trichloroethylene (TCE), 1,1,1-trichloroethane (1,1,1-TCA), and 1,1-dichloroethane (1,1-DCA).

Approach/Activities. A laboratory treatability study was performed to assess the effectiveness of enhanced in situ biodegradation (EISB) for treatment of CVOC and 1,4-dioxane in soil and groundwater from the site under sequential anaerobic/aerobic conditions and under aerobic conditions using a cometabolic pathway.

EISB is a treatment process whereby the compounds of concern are metabolized into nonhazardous compounds by naturally occurring microorganisms. EISB is a passive, low impact treatment strategy that can achieve clean up goals within a relatively short time in a cost effective manner. Anaerobic biodegradation technology has been demonstrated to be an effective r treatment for PCE and TCE in groundwater at many sites. The addition of EVO enhances the growth of facultative microorganisms, which leads to the establishment of strict anaerobic conditions. The anaerobic conditions stimulate the growth, and activities of the reductive dechlorination microorganisms to convert toxic chlorinated solvents into non-toxic ethane and ethene.

Once the chlorinated compounds are treated under anaerobic conditions, the conditions can be made aerobic to allow treatment of 1,4-dioxane. In situ biosparging involves injection of pressurized gases into the subsurface at very low flow rates to enhance biodegrdataion. Oxygen or air is injected to enhance aerobic biodegradation.

Alternatively, 1,4-dioxane and chlorinated hydrocarbons can be degraded together under aerobic conditions by a co-metabolic pathyway. In order for co-metabolism to occur, a carbon source in addition to the 1,4-dioxane must be present or must be added to the subsurface. In this study, dextrose was tested as a co-substrate. Microogranisms possessing the enzymes to perform this pathway are not present at all sites. The addition of a microbial inoculum may be necessary and was tested.

Results/Lessons Learned. The results of this study showed that CVOC can be removed under anaerobic conditions. Some treatment occurred without the addition of a microbial inoculum; however, the data showed that the addition of a microbial inoculum was required in order for complete reductive dechlorination to occur. CVOC were also removed under aerobic, co-metabolic conditions; greater treatment was observed under anaerobic conditions.

Up to 26 percent treatment of 1,4-dioxane was observed under aerobic cometabolic conditions while up to 41 percent treatment of 1,4-dioxane was observed under sequential anaerobic/aerobic conditions. Since greater treatment of both 1,4-dioxane and CVOC were observed with the sequential anaerobic-aerobic treatment, this treatment was recommended for a field study.