ZVI-Clay Presentation
Hydrology Days

In-Situ Remediation of Chlorinated Solvents via Zero Valent Iron and Stabilization

by Mitch Olson, Tom Sale, Charles Shackelford, and David Castelbaum

Abstract
ZVI-Clay technology is an in-situ approach to chlorinated solvent remediation that involves addition, via deep soil mixing, of a stabilizing agent and zero-valent iron directly into the source zone. The result is two-fold: decreased mobility of contaminants and degradation of chlorinated solvents via reaction with the zero valent iron. ZVI-Clay technology was developed by E.I. DuPont de Nemours and Company (DuPont) and is covered in two patents, dated 1998 and 2002. In September 2003, DuPont donated the ZVI-Clay patents to Colorado State University (CSU).

Chlorinated solvents, which include tetrachloroethene (PCE), trichloroethene (TCE), and carbon tetrachloride (CT), have enjoyed widespread industrial use over the past half-century. However, inadvertent leaks, spills, and improper disposal practices have affected widespread contamination of groundwater. Chlorinated solvents present a unique remediation problem in that they are immiscible, have a density greater than that of water, and are stable under common subsurface conditions. Another concern related to chlorinated solvents is that although their solubility in water is relatively low, it is several orders of magnitude greater than established maximum contaminant levels. Past remediation technologies, such as pump-and-treat, have had limited success in cost-effectively restoring aquifers to typical cleanup levels.

Laboratory research and two field applications provide the bulk of current knowledge on ZVI-Clay technology. In Martinsville, Virginia, ZVI-Clay has been successfully used to address high concentration source areas containing carbon tetrachloride. Within eleven months of completion, degradation of greater than 99% of original contaminants was achieved. At Kinston, Virginia, ZVI-Clay was used to address a chlorinated ethene source area. Preliminary results indicate ~90% removal of these compounds. Research completed to date has primarily included studies of the feasibility of ZVI-Clay, and has generally yielded positive results. CSU is currently conducting research on reaction kinetics, the effects of zero-valent iron particle properties, and evaluating approaches to in-situ mixing. Future research will include detailed studies of the kinetics and mechanisms of the reactions, effects of mass transfer on reaction rates, and use of ZVI-Clay for other forms of contamination, such as pesticides and mining sites.