# Remediation of Chlorinated Solvent Source Zones via ZVI-Clay Soil Mixing

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**Abstract**.
Chlorinated solvents in the subsurface are a widespread problem with thousands of impacted sites in the United States. A large body of literature exists that evaluates treatment of chlorinated solvents using granular zero valent iron, which has been shown to treat chlorinated solvents via reductive dechlorination. Much of this literature is conducted within the context of permeable reactive barriers (PRBs), which are designed to treat dissolved phase contaminant plumes. An emerging technology, herein referred to as ZVI-Clay, builds on this approach for treatment of chlorinated solvent source zones. ZVI-Clay uses conventional soil mixing equipment to admix a grout consisting of water, granular iron, and bentonite clay with contaminated soil. Through this process, zones of high contaminant concentrations, including pools of dense non-aqueous phase liquids (DNAPLs), are redistributed and brought into close contact with iron particles. Within the treated soil body, ZVI drives solvent degradation while the clay reduces the hydraulic conductivity. The overall benefit is a permanent reduction in both the mass of chlorinated solvent and the rate of discharge from the treated area into surrounding groundwater. As of February 2008, ZVI-Clay has been employed for treatment of a variety of chlorinated ethenes and ethanes at seven full scale field sites.

This presentation includes a comparison of the well-researched PRB system to the relatively novel ZVI-Clay system. This includes kinetic analysis of data generated from ZVI-Clay field applications and laboratory studies. As an approximation, the ZVI-Clay system can be shown to be pseudo-first order in contaminant concentration. More detailed analysis shows that this is not universally true. In fact, the reaction rate constant declines with higher initial concentration. This is thought to be due to a combination of (1) saturation of reactive sites on the iron surface and (2) rate limited dissolution of NAPL. When compared to published values for PRB systems, typical reaction rates in ZVI-Clay systems are slower. Due to the reduced hydraulic conductivity, however, the effect of reaction rate on overall treatment achieved is greatly diminished. Preliminary study data shows that, due to the extended residence time, ZVI-Clay can potentially treat contaminants that are believed to be too recalcitrant for effective treatment in PRBs. As an example, a recent study showed that 1,2-dichloroethane can be potentially treated via ZVI-Clay.

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