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Design and assessment of electrochemical zones for remediation of chlorinated solvents in natural groundwater aquifer settings

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Background/objectives. Widespread contamination of chlorinated solvents threatens the quality of groundwater based on extensive use in the past for e.g. dry-cleaning and metal processing. The chlorinated solvents and their chlorinated degradation products are acute toxic and carcinogenic. Furthermore, the compound's properties challenge the current treatment systems. Pump-and-treat (P&T) systems are commonly used to keep plumes from reaching water supply wells. However, these are long-term solutions with substantial operation and maintenance costs. Thus, optimized means of protecting the groundwater from this group of contaminants is important. We propose, as an alternative to P&T, establishment of an electrochemical zone for *in situ* degradation of chlorinated solvents and degradation products.

Approach/Activities. It is known, that i) fast electrochemical reduction of chlorinated solvents near the electrodes can be obtained and ii) reactants can be generated and subsequently reduce or oxidize the chlorinated solvents, i.e. no need for addition of e.g. substrates. Furthermore, no waste products like spent activated carbon are generated. Studies have so far mainly focused on the influence from electrode materials and configurations, and the influence of system parameters such as current density, flow rate etc. in spiked, synthetic liquid phases only. The focus of this study is on intelligent use and combination of the different electrochemical processes to optimize the electrochemical zone for complete degradation of the chlorinated solvents in natural groundwater settings. Testing in natural groundwater settings is vital for proving the methods applicability. However, so far no studies on electrochemical remediation of chlorinated solvents have been performed under constant current with field extracted contaminated groundwater and unrefined sand as aquifer material.

This study has taken these challenges and developed systems for assessment and optimization of electrochemical zones in 1D and 2D experimental set-ups targeting plume control in field realistic designs. The 2D-box set-up allows for assessment of the influence of single parameters, e.g. current density, flow and electrode material as well as power consumption, lateral dispersion of generated reactants, electrode configuration and spacing. The set-up replicates site conditions through flow-through of natural groundwater with an aged contamination of PCE in a sandy aquifer material at common groundwater flow rates.

Results/Lessons Learned. Initial 1D-column tests revealed a high electrical resistance in the sandy geology, which inhibited the current distribution. Despite the low current level applied, contaminant degradation was observed. The 2D-box set-up has been further developed to overcome the challenges experienced in the column tests. Data expected to be available includes fate of the contaminants and induced changes in geochemistry during the bench scale electrochemical remediation in near natural settings.