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Tools for Monitoring Contaminant Biodegradation When Combined with Colloidal Activated Carbon

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Background/Objectives. The combined remedial approach of enhanced bioremediation with injectable activated carbon substrates offers a unique treatment method for quickly reducing contaminant concentrations in groundwater while also destroying the contaminants. Further, this combination provides a sustainable treatment option since the ability to biodegrade contaminants provides a mechanism to regenerate the sorptive capacity of the activated carbon over time. With increasing implementation of this approach, a question arises in how to confirm that the contaminants are actually degrading when they are sorbed to activated carbon and therefore cannot be monitored in a traditional manner. This paper will address this question by reviewing field and laboratory data that can be used to support the biodegradation of sorbed contaminants.

Approach/Activities. A combination of two laboratory studies and a field study will be reviewed in this presentation. A batch microcosm study with PCE was performed in the presence and absence of colloidal activated carbon to support the concept that contaminants sorbed to activated carbon remain bioavailable to microbes for degradation. Over the course of this eight-week study, 10 mg/L of PCE was added into the batch reactors every two weeks to represent a source of flux into the system. Throughout the experiment, the PCE concentration in water was monitored and organic extractions were performed to measure the total PCE mass balance across all phases (water, soil, colloidal activated carbon). In a second laboratory study, dual-soil porosity tanks were used to simulate back diffusion of TCE and evaluate the ability of colloidal activated carbon to treat this long-term problem. Effluent VOC concentrations were monitored throughout the study and microbial analysis was performed at the end of the study. Additionally, field data from a PCE-contaminated site in California that had historically shown no biodegradation will be reviewed and evaluated after colloidal activated carbon was implemented in combination with enhanced bioremediation. Data sets include microbial population analysis over multiple years along with contaminant concentrations and distributions.

Results/Lessons Learned. Results from the groundwater and total mass balance data in the first laboratory study confirmed that for each addition of PCE, the concentration was rapidly reduced via sorption and the PCE was subsequently biodegraded. Key results from this study demonstrated: 1) contaminants remain bioavailable for microbial biodegradation even when they are adsorbed to colloidal activated carbon, and 2) the sorptive capacity of colloidal activated carbon and the ability to biodegrade contaminants are sustained throughout multiple additions of contaminant, supporting a mechanism for long-term treatment. Highlights from the dual-porosity tank study include enhanced removal of total VOCs and multiple orders of magnitude greater microbial populations in the presence of colloidal activated carbon. Finally, results from the field data support multiple lines of evidence for in situ contaminant destruction at sites that received combined remedial treatments of colloidal activated carbon with either electron donor or acceptors. These data include sustained microbial populations over years despite non-detect contaminant levels, evidence of daughter product formation, and isotope changes that correspond with degradation of contaminants.