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Verification of Analytical and Amendment Approaches for an In Situ Microcosm Device for Testing Enhanced Bioremediation Processes

Philip Dennis (pdennis@siremlab.com), Michael Healy and Peter Dollar (SiREM, Guelph, ON, Canada)
Duane Graves (Geosyntec Consultants, Knoxville, TN, USA)
Hester Groenevelt (Geosyntec Consultants, Guelph, ON, Canada)
Silvia Mancini (Geosyntec Consultants, Toronto, ON, Canada)

Background/Objectives. In situ microcosm (ISM) devices are used to test remediation processes in site groundwater though incubation in monitoring wells and retrieval after which parameters relevant to the remediation processes are tested on the groundwater or solid matrices contained within the ISM. ISM testing suites include quantification of the contaminants (e.g., CVOCs, BTEX) volatile fatty acids, and total organic carbon to assess electron donor longevity, dissolved hydrocarbon gases, anions, molecular genetic tests for biodegradative organisms and functional genes, as well as overall microbial community composition and compound specific isotope analysis (CSIA) to confirm degradation processes. In addition to providing a matrix for bioremediation reactions, ISM need to effectively deliver amendments including electron donors, nutrients, bioaugmentation cultures, zero valent iron or other relevant amendments depending on the remediation scenario being tested.

Approach/Activities. Using a novel ISM design, experiments to determine the feasibility of this ISM approach in simulated groundwater wells were carried out in the lab using 3 feet long glass columns filled with groundwater. Key questions were related to operation of the device were: How well does the device communicate with groundwater? What is the longevity of various electron donor amendments (e.g., lactate, chitin and emulsified vegetable oil)? Is the inclusion of microorganisms for bioaugmentation of the units feasible? In addition, tests for reductive dechlorination were carried out in aerobic and anaerobic groundwater to determine groundwater redox significantly affects the outcome of the study. Furthermore, tests with amended and non-amended devices side by side were performed in order to understand the potential transfer of amendments and break down products between units that could complicate data interpretation. A number of approaches for quantifying the analytical parameters were assessed including the use of different sorbents as well as direct testing of sand and groundwater contained within the device. Finally, how results of the ISM compared to conventional laboratory microcosms performed under similar initial conditions.

Results/Lessons Learned. The ISM device was determined to effectively fill and communicate with ground water within a few hours. The groundwater contaminants were shown to migrate by diffusion or advection into the sand matrix where they were subjected to degradation processes in the ISM unit. A number of sorbent materials were selected for analytical testing with varying degrees of performance for the compounds tested. The ISM device results obtained will be compared to those from standard microcosm studies. The overall goal of the study is to develop verified and robust amendment and analytical regimes for various groundwater contaminant remediation scenarios using ISM testing approaches.