Assessment of PlumeStop® to Manage Back Diffusion at a Fractured Sandstone Site

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Background/Objectives. In situ remediation options for sites with contrasting adjacent permeability zones are limited by poor forward diffusion of treatment amendments from higher to lower permeability zones. A method to address contaminant back diffusion from low permeability zones is to emplace amendments with extended in situ longevity into mass flux zones. Activated carbon has been demonstrated to be an effective long-term treatment technology at numerous groundwater extraction sites. The recently introduced in situ treatment technology PlumeStop® (Regenesis, San Clemente, California), a sterically stable activated carbon based amendment, is ideally suited for emplacement within thin mass flux zones without significant risk of blocking groundwater flow in these zones and potentially diverting plume flow to unaffected areas. This study aims to assess combined PlumeStop and bioremediation treatment of chlorinated aliphatic hydrocarbon (CAH) in a fractured sandstone aquifer.

Approach/Activities. Characteristics of CAH plume distribution within the sandstone aquifer were well defined using traditional groundwater sampling techniques along with pumping, slug, and tracer tests, borehole geophysical logging, and laboratory analysis of sandstone core samples that included petrographic analysis and XRD, XRF, and SEM microscopy. Amendments consisting of PlumeStop®, fermentable electron donor, buffer, nutrients and an augment consisting of organohalide respiring microbes were injected into the aquifer to both transfer contaminants from the aqueous phase to the solid phase and stimulate biodegradation of the sorbed contaminants. Stimulative effects on degradation pathways were assessed by examining impacts on contaminant concentration and geochemistry in both aqueous and solid phases using sandstone in situ microcosms (ISMs) deployed in monitoring wells before amendment application. Compound Specific Isotope Analysis (CSIA) was employed to confirm the degradation of target compounds and quantitative polymerase chain reaction (qPCR) was used to evaluate the microbial population. The combination of these conventional and advanced diagnostics provided an in-depth evaluation of degradation of contaminants sorbed to the PlumeStop® activated carbon.

Results/Lessons Learned. Contaminant concentrations rapidly decreased in the aqueous phase with total VOC concentrations decreasing by as much as 80 percent one month following the amendment injection and 98 percent 4-months following the injection. Both groundwater and sandstone ISM samples showed generation of sequential degradation daughter products including ethene and ethane. Corresponding isotopic fractionation of parent compounds and moderate to high *Dehalococcoides* abundances were also measured in sandstone ISM samples. Overall, multiple lines of evidence show the combined remedy of Plumestop and bioremediation to be effective in managing back diffusion within the treated area. Future activities will include optimizing PlumeStop dose to extend biostimulant application intervals.