microbialinsights

ISMs

Cost Effective Remedy Selection at a TCE Impacted Site

PROJECT SUMMARY

- An *In Situ* Microcosm (ISM) study was conducted to evaluate MNA, biostimulation, and bioaugmentation as potential remediation strategies at a TCE-impacted site.
- Increases in *Dehalococcoides* and vinyl chloride reductase genes concentrations in the biostimulation (BioStim) unit relative to the MNA unit, along with enhanced vinyl chloride and ethene production indicated that electron donor addition alone would stimulate reduction dechlorination.
- Although *Dehalococcoides* concentrations were highest in the bioaugmentation (BioAug) unit, multiple lines of evidence indicated that bioaugmentation was not necessary.

PROJECT CHALLENGE

A shallow groundwater aquifer at a former industrial facility was impacted by trichloroethene (TCE). During historical groundwater monitoring, cis-1,2-dichloroethene (cis-DCE) had been detected at notable concentrations. However, vinyl chloride concentrations were low and ethene was typically near or below detection limits suggesting that cis-DCE may continue to accumulate under existing site conditions (DCE stall). Site managers wanted a cost effective way to evaluate monitored natural attenuation (MNA), biostimulation, and bioaugmentation as potential remediation strategies going forward.

IN SITU MICROCOSMS AND ANALYSIS

An *In Situ* Microcosm (ISM) assembly is a group of individual microcosm units, each representing a different treatment strategy. Each individual microcosm contains passive diffusive samples for organics and geochemistry, a Bio-Trap® for microbial sampling (or providing a bioaugmentation culture), and a source of amendment (here an electron donor) where appropriate. Thus chemical, geochemical, and microbial data needed for conclusive yet cost effective evaluation of multiple remediation options can be obtained under aquifer conditions. Following in-well deployment, the

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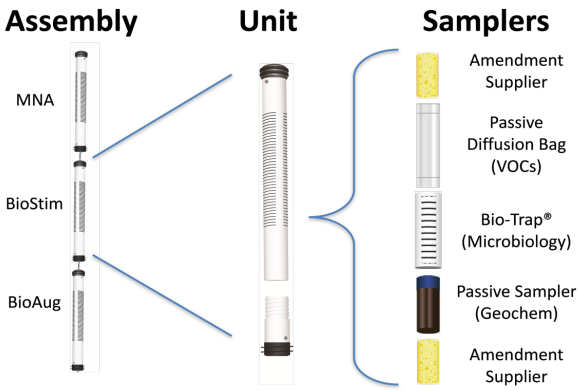
IN SITU MICROCOSMS AND ANALYSIS (CONT.)

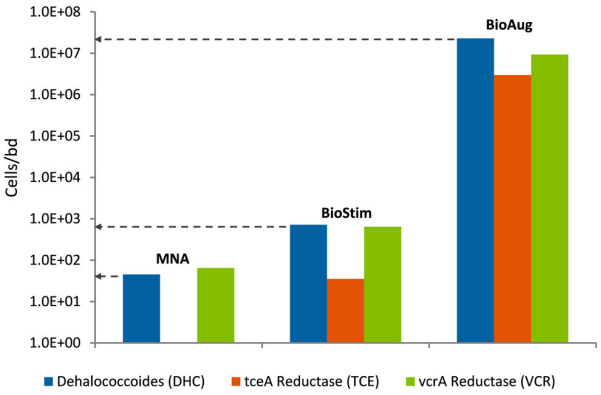
ISM units and passive samplers are retrieved and shipped to Microbial Insights for analysis to determine the impact of each treatment option on contaminant concentrations, daughter product formation, geochemistry, and concentrations of *Dehalococcoides* and functional genes.



For this study site, the ISM was composed of an unamended MNA unit, a BioStim unit amended with an electron donor, and a BioAug unit pre-inoculated with a commercial *Dehalococcoides*-containing culture and also amended with an electron donor. The ISM assembly was deployed in an existing monitoring well at the site for approximately 60 days.

ISM RESULTS

Microbiology: Results of CENSUS qPCR quantification of *Dehalococcoides* (DHC) and vinyl chloride reductase genes (VCR) are shown in the figure below.



- While detected in the MNA unit, *Dehalococcoides* concentrations were low indicating limited potential for complete reductive dechlorination of TCE to ethene under existing site conditions
- In the BioStim unit, concentrations of *Dehalococcoides* and vinyl chloride reductase genes (VCR) were over an order of magnitude greater than detected in the MNA unit – a substantial increase especially considering the short ISM deployment compared to the life of a full-scale electron donor injection.
- For the BioAug unit, the pre-deployment concentrations and the post-deployment *Dehalococcoides* concentrations were comparable indicating survival of the bioaugmentation culture in the field.

Overall, *Dehalococcoides* concentrations were highest in the pre-inoculated BioAug unit. However, CENSUS qPCR results for the MNA and BioStim units indicated that *Dehalococcoides* were present at low concentrations under existing conditions and that addition of an electron donor would stimulate growth of this key group of halorespiring bacteria.

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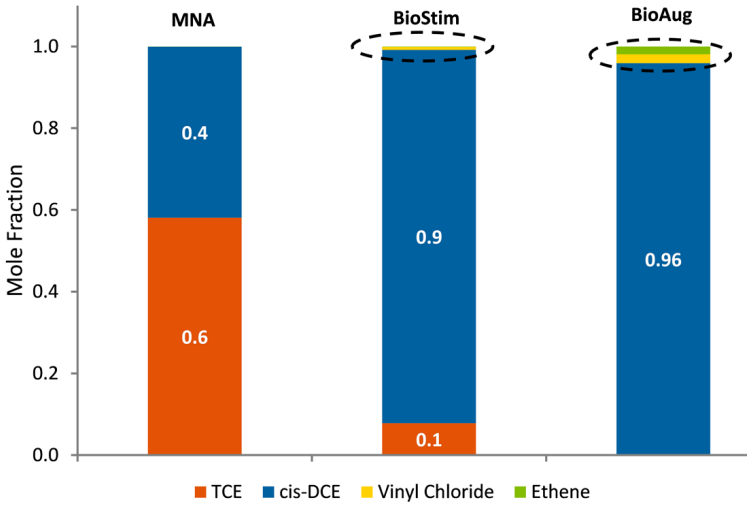
ISM RESULTS (CONT.)

Chemistry: Following in-well deployment, VOCs and dissolved gases were analyzed from passive samplers in each ISM unit. The mole fractions of TCE and daughter products are shown in the figure below.



- In the MNA unit, TCE was predominant with the remainder being *cis*-DCE.
- In the BioStim unit, the mole fraction of TCE had been reduced to < 0.1, cis-DCE was predominant, and vinyl chloride and ethene were detected consistent with the observed growth of *Dehalococcoides* in response to the electron donor.
- In the BioAug unit, all of the TCE was gone and *cis*-DCE was the predominant daughter product. Vinyl chloride and ethene were detected but in low proportions only slightly greater than those seen in the BioStim unit.

Decision: Based on the ISM results, site managers decided that bioaugmentation was not necessary and selected biostimulation as the treatment strategy. The increase in *Dehalococcoides* concentrations in the BioStim unit along with enhanced production of daughter products cis-DCE, vinyl chloride, and ethene indicated that electron donor addition alone would stimulate reduction dechlorination.

KEY BENEFITS

- **Conclusive:** Multiple lines of evidence indicated biostimulation should be effective.
- **Saved Money:** Showed that bioaugmentation was not needed.
- **Cost Effective:** Simultaneous evaluation of multiple remediation options at a fraction of the cost of a lab bench treatability study or pilot scale study.
- ***In Situ:*** Performed in existing monitoring under field conditions.