Bioaugmentation for Remediation of Aerobic Vinyl Chloride Plumes

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Background/Objectives: Generation of persistent vinyl chloride (VC) plumes during anaerobic in situ bioremediation of chlorinated ethene contaminated groundwater has been observed in the field, particularly in cases where electron donor is limiting. Although VC is often further reduced to ethene by further electron donor amendments, there are potential benefits to understanding how VC-oxidizing bacteria could support an overall site remediation strategy, particularly at sites entering a monitored natural attenuation (MNA) phase. One potentially major advantage of aerobic VC degradation would be no absolute requirement for exogenous electron donor addition to the system.

Methane and ethene are typically generated concurrently in a VC plume, originating from both methanogenesis and anaerobic reductive dichlorination. Methanotrophs and etheneotrophs (i.e.; ethene-oxidizing bacteria) are commonly found at chlorinated solvent contaminated sites, even in groundwater considered anaerobic, and have been identified as important VC-oxidizing groups. Site remediation and closure strategies could benefit from the optimal use of these aerobic VC oxidizers. For instance, bioaugmentation with VC-oxidizing etheneotrophs could be beneficial for remediating VC plumes where they may be absent or at low abundance in groundwater.

Approach/Activities: Existing VC-oxidizing enrichment cultures were analyzed for their effectiveness under fully aerobic conditions in the laboratory. Effectiveness was evaluated by determining normalized VC oxidation rates and normalizing to biomass in terms of the epoxyalkane:Coenzyme M transferase gene (*etnE*) abundance. VC-oxidizing cultures will also be evaluated for their performance with environmental variables relevant to bioaugmentation, e.g. low dissolved oxygen conditions. Molecular biological tools (MBTs) will be used to characterize and monitor the key VC-degrading populations at a variety of sites to determine the prevalence of these organisms and to monitor growth and activity of the VC-oxidizing populations after bioaugmentation.

Results/Lessons Learned: Several enrichment cultures capable of aerobic VC degradation have been developed from groundwater obtained from chloroethene-contaminated sites located in Alaska, Hawaii, and California. These cultures exhibit uncorrected rates of VC oxidation between 0.3-17 µmole/day under fully aerobic conditions. Normalized rate experiments are in progress. MBTs to monitor key functional genes involved in aerobic VC degradation (i.e. *etnE*) have been developed and preliminary screening of field sites has commenced to understand how site conditions and VC-oxidizer abundance correlate. Data from further molecular site screening, microcosm studies and culture characterization efforts will be reported to provide useful guidance on what are optimal conditions for aerobic VC oxidation and how cultures are likely to perform under varying field sites conditions. The most promising cultures will be selected for further laboratory bench-scale treatability tests using materials from VC-contaminated sites and a selected culture(s) will be further scaled up for field pilot testing.