Assessment of Native Chain-Elongating Microorganisms in Aquifer Materials from a Superfund Site

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Introduction

Chlorinated ethenes are contaminants harmful to human health due to factors including their carcinogenicity. They threaten quality of life at hundreds of sites around the US. When provided with an ample H_2 source, the microbial process of reductive dechlorination can convert harmful chlorinated ethenes to a non-toxic byproduct, ethene. Microbial chain elongation (MCE) has recently shown viability as a H_2-producing process for H_2-consuming reductive dechlorination.. This project explores the possibility of applying MCE in-situ at a Superfund site contaminated with chlorinated ethenes through the stimulation of microorganisms native to the site.

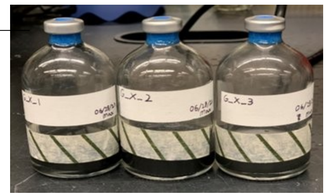
Objective

- Determine whether native chain-elongators are present
- Determine whether biostimulation of native microbes is feasible at the site
- Inform future remedial action at the site

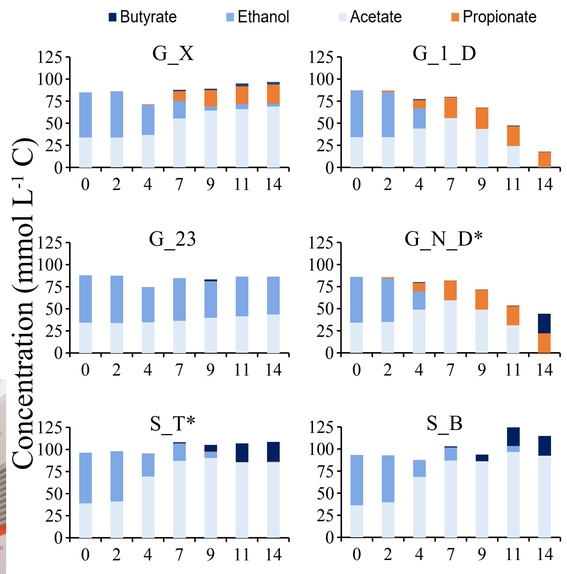
Microcosm Setup

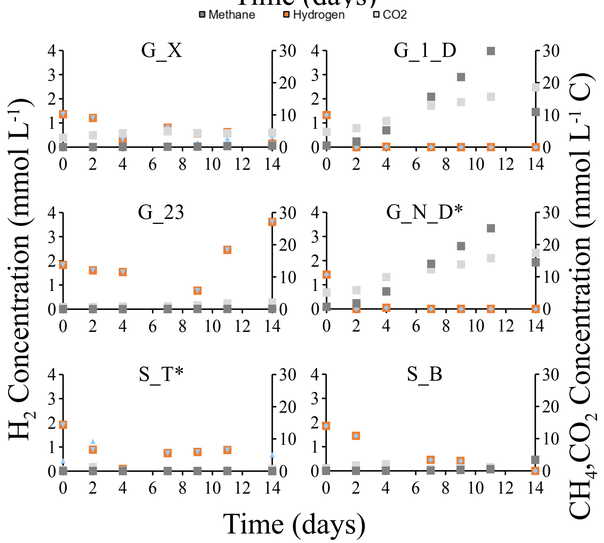
Condition label	Location	Material	Nutrients
G_X_(1-3)	Injection/Extraction well used in prior bioremediation	50 mL[a,b,c]	N
G_I_D_(1-3)	Monitoring well located	50 mL[a,b,c,d]	Y
G_N_D_(1-3)	within source area contamination	50 mL[a,b,c]	N
G_23_(1-3)	Monitoring well outside source area contamination	50 mL[a,b,c]	N
S_T_(1-3)	Soil (0.3m depth) outside source area contamination	25 g[b,c,e]	Y[g]
S_B_(1-3)	Soil (1m depth) outside source area contamination	25 g[b,c,e]	Y[g]

Legend
[a]groundwater ,[b]16.2 mM acetate and 27 mM ethanol,
[c]0.2 mM sulfide and 10 mM phosphate buffer
[d]50 uL trace A, trace B, 500 uL salt stock solution, [e]soil
[g]25 mL anaerobic media containing nutrients, 10 mM phosphate, and 0.2 mM sulfide



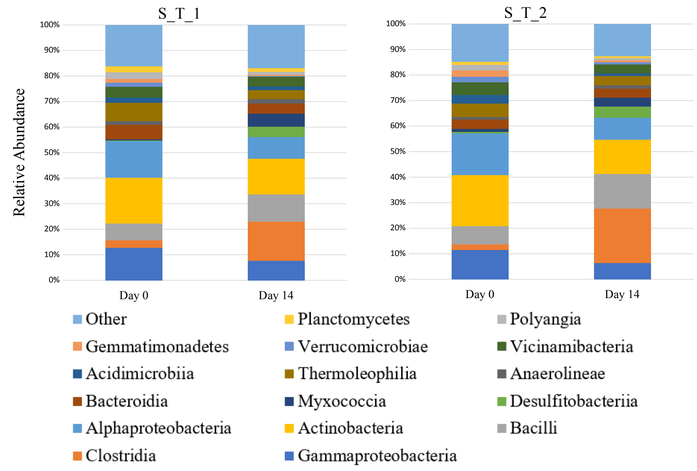
Chemical Analysis





* Indicates a condition was conducted in duplicate. All other conditions are a triplicate.

Microbial Community Analysis



Key Results

- Ethanol was entirely consumed in 5/6 conditions
- Butyrate production (4-carbon) observed in G_N_D, S_T, and S_B conditions
  - Highest concentration: 6 mM (S_T)
- Propionate production (3-carbon) observed in G_X, G_1_D, and G_N_D conditions
  - Highest concentration: 8 mM (G_1_D)
- *Clostridia*, *Bacilli*, *Myxococcia* increased in relative abundance after incubation with acetate and ethanol.

Implications

Overall, the addition of substrates acetate and ethanol stimulated MCE via production of butyrate in soil but not in groundwater. However, when bioaugmentation (the addition of a microbial culture and substrates) with an MCE culture was performed, butyrate was produced (data not shown). This project is part of an ongoing effort to apply MCE as a form of in-situ bioremediation at a Superfund site.

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