Biostimulation of Trichloroethene Dechlorination by Organohalide-Respiring Bacteria

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Background/Objectives. Most in situ bioremediation of chlorinated ethenes, as well as several other organohalide pollutants, depends on the activity of organohalide respiring bacteria (OHRB). Bioremediation at contaminated sites is often incomplete and has operation limitations, so there is a critical need to find more efficient methods to enhance the dechlorination of these pollutants. Published studies have demonstrated that OHRB grow while dechlorinating naturally-occurring organochlorides, expanding our understanding of organohalide-respiring physiology. By exploiting this physiology, a synthesized mixture of "natural organochlorides" was produced from chloroperoxidase enzyme and tested for their ability to stimulate the degradation of trichloroethene (TCE) under different anaerobic conditions in microcosm studies. The hypothesis of this work is that natural organochlorides can stimulate the complete degradation of TCE in a variety of soils and physicochemical conditions. This work has the potential to develop a novel strategy for the biostimulation of in situ bacterial communities for complete bioremediation of organochlorides, such as TCE.

Approach/Activities. A synthesized organochloride mixture was produced using a chloroperoxidase enzyme reacting on a hydrophilic soil organic matter extract. Synthesized organochlorides were then amended to triplicate slurry microcosms (100 mL total volume) with an anaerobic headspace. A non-reacted organic matter extract was used in control microcosms, and these amendments were compared to controls not amended with any exogenous soil organic matter. Each set of triplicate microcosms was monitored under different independent variables, such as soil inoculums, pH, redox/competitive electron acceptors, and carbon sources. Vitamins, 100 µL of neat methanol, and 0.1 mM of trichloroethene were amended to all microcosms. TCE and degradation products (through ethene) were analyzed using gas chromatography (GC) with a micro-electron capture detector. Lag time and degradation rates under the stimulated and control conditions were determined. Known organohalide degrading bacteria were measured with qPCR assays on selected conditions.

Results/Lessons Learned. After a lag time of 12 days, TCE degraded completely within 9 days in the microcosms amended with synthesized organochlorides. Then a second dosage of TCE was respiked in these microcosms, and was fully depleted with 9 days with no lag time. In the organic matter –amended control, dechlorination occurred after a lag time of over 30 days with complete dechlorination over 60 days. In non-amended controls, the soils could not degrade TCE over a 6 month period. These results indicated that the organic matter amended with chloroperoxidase enzyme made a significant difference on TCE degradation rates and lag time, which means that the enrichment of organic matter with synthesized organochlorides did improve the stimulation of TCE degradation. Microbial analysis of organohalide resipirers is currently underway. The results of TCE degradation after the respike confirmed that the microbial acclimation was well enhanced during the degradation process. And the GC measurement results would help up to better understand the mechanism of TCE degradation process based on the degradation products. The microcosms under different independent variables would expand our understanding of the effect of these conditions on the TCE degradation process, thereby optimize the most suitable conditions for OHRB to degrade TCE.