In-Situ Enhancement of Anaerobic Microbial Dechlorination of Polychlorinated Dibenzo-p-dioxins and Dibenzofurans in Marine and Estuarine Sediments

Background:
Microbiologically-mediated reductive dechlorination of organohalides is well established, and there is recent evidence for microbial reductive dechlorination of polychlorinated dibenzo-p-dioxins and dibenzofurans (PCDD/Fs) in marine and estuarine sediments. However, fundamental information about the organisms that carry out this process and how they may best be stimulated is not available. This lack of information is a major impediment to the application of in-situ bioremediation to marine and estuarine sediments. A fundamental understanding of the microbial processes is essential for the design of site-specific solutions for bioremediation of PCDD/F-contaminated sediments.

Objective:
The overall objectives of the project are to identify environmental conditions and amendments that enhance and accelerate dechlorination of PCDD/Fs by native microbial populations and to identify the organisms responsible for the dechlorination using microbiological and biomolecular methods.

Summary of Process/Technology:
We will characterize the PCDD/F-dechlorinating capability of native dehalogenating bacteria in estuarine and marine sediments from both contaminated and pristine sites. Specific amendments that prime and/or accelerate the dechlorination of PCDD/Fs by dehalorespiring or cometabolizing bacteria will be identified using an existing PCDD/F-dechlorinating culture and new enrichments. The effect of different competitive terminal electron accepting processes (e.g. sulfate reduction, iron reduction, and methanogenesis) on the dechlorination and further transformation of PCDD/Fs will be determined. Complementary molecular techniques including cellular phospholipid fatty acid profiling, terminal restriction fragment length polymorphism (TRFLP), and cloning and sequencing 16S rRNA genes associated with the TRFLP peaks along with traditional cultural approaches will be used to characterize and identify specific PCDD/F-dechlorinating bacteria. The enrichment results and community structure analysis will be combined to produce site conceptual models and bioprocess models to describe the effects of different amendment strategies on the dehalogenating populations.

Benefit:
The immediate and direct benefit resulting from this project will be a fundamental understanding of dehalogenating bacterial communities that dechlorinate PCDD/Fs in marine and estuarine sediments and how these communities may be stimulated by the addition of primers and amendments. The development of conceptual and biological process models to describe and predict the effect of different enhancement methods on the microbial populations will enable assessment of the potential for PCDD/F dechlorination at specific sites. The long-term potential benefit of this research will be the eventual application of the developed in-situ amendment strategies in pilot or small field-scale experiments.

Accomplishments:
This is an FY01 New Start project.

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