Kinetics of PCB Microbial Dechlorination Explained by Freely Dissolved Concentration in Sediment Microcosms

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Background/Overview. The microbial bioremediation of polychlorinated biphenyl (PCB) contaminated sediments have traditionally struggled to measure and model the microbial kinetics at environmentally relevant concentrations found in contaminated sediments. Advances in low-density polyethylene (PE) sampling have enabled freely dissolved hydrophobic organic contaminates to be more accurately measured at low aqueous concentrations. Recent work has demonstrated how polymer based passive samplers can be utilized in both a passive dosing and passive sampling capacity to determine microbial kinetics of anaerobic dechlorination of PCBs. The objectives of this study were to: 1) Demonstrate the ability to measure the aqueous biological rate of anaerobic dechlorination by *Dehalobium chlorocoercia* (DF-1) using a PE passive sampling/dosing approach in a sediment free system. 2) Predict and measure anaerobic dechlorination kinetics in sediment microcosms based on freely dissolved porewater concentrations.

Approach/Activities. This study utilized PE passive samplers to measure and quantify the biological rate of dechlorination of 2,3,4,5-tetrachlorobiphenyl (PCB 61) to 2,3,4-trichlorobiphenyl (PCB 23) by organohalide respiring bacterium DF-1. The biological rates were first measured over environmentally relevant ranges of 1.5-40 ng/L aqueous concentration in sediment free bench scale microcosm studies. Sediment microcosms were prepared both as well mixed slurries and as static systems to determine the effects of diffusion of PCBs from the sediment. PCB dechlorination rates were determined based on both the aqueous concentration calculated from PE and the extraction of the bulk sediment.

Results/Lessons Learned. The first order rate of dechlorination was determined to be linearly dependent on the initial freely dissolved concentration of PCB 61 both in mixed sediment slurry and sediment free microcosms. Predicted dechlorination rates based on sediment free microcosms were within a factor of 2 of the rates observed in the sediment slurry microcosms. Dechlorination rates in static sediment microcosms were limited by the diffusion rate from the sediment into the porewater. The kinetics were consistent with a two compartment diffusion model for hydrophobic contaminants. The use of passive sampling techniques reported in this study, combined with partitioning characteristics of specific sediments, demonstrate the potential for in-situ measurement and modeling of microbial dechlorination for bioaugmentation or monitored natural attenuation.