Performance of Anaerobic Sediment-Capping Systems: Role of Material Type in Designing Effective Bioactive Caps

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Background/Objectives. Reactive sediment caps act as permeable barriers that reduce contaminant flux through adsorption or chemical transformation. Microbial degradation of contaminants within capping systems may increase their efficacy and reduce the risk of breakthrough. It is not clear the extent to which the presence of capping material affects the biodegradation processes in situ. Biodegradation of naphthalene (a model PAH) was previously studied in model bioactive capping systems over 100 days, and results showed that capping material influences bioactivity under oxic conditions.

The goal of this study is to investigate whether capping materials can affect naphthalene biotransformation in anaerobic model bioactive capping systems, in particular under sulfate reducing conditions. Specifically this work aimed to: i) monitor biodegradation and compare reaction kinetics in the presence and absence of capping materials; ii) examine the extent of complete mineralization due to biological processes; iii) analyze the composition of the microbial community and determine effect of capping material.

Approach/Activities. Microbial communities were enriched from sediments collected from a river adjacent to a former manufactured gas plant for 16 months. These incubations show sulfate reduction and were used as inoculum for microcosms. Microcosms were prepared in anaerobic conditions with common capping materials (activated carbon and sand) and mineral media mimicking a freshwater system. These experiments are expected to conclude in late 2018. Systems are periodically analyzed for total naphthalene, aqueous concentrations of ^{13}C labeled and ^{12}C naphthalene, sulfate and sulfide. Microbial community analysis was conducted at the time of microcosm setup and will be repeated for each capping system when the experiments conclude. These results will allow us to compare variations in microbial community richness and population between the capping material systems. Microcosms experiments with uniformly labeled ^{14}C naphthalene are underway and will confirm mineralization of naphthalene through detection of $^{14}CO_2$.

Results/Lessons Learned. Early data show enrichment of ^{13}C labeled naphthalene and production of sulfide in non-sterile microcosms, suggesting that biotransformation under sulfate reducing conditions is occurring in our model cap-systems. Our previous results demonstrated that capping material type affects microbial community and biodegradation kinetics under aerobic conditions. For instance, community richness and biomarker levels increased in presence of activated carbon, although enrichment of known aerobic naphthalene degraders from the genera *Pseudomonas* was observed in sand systems. These findings may be due to physicochemical characteristics of activated carbon (surface area and functional groups), which may contribute to enrich microbial community diversity. In contrast, the presence of naphthalene as the sole carbon source likely served as a selective pressure in sand systems. In the ongoing experiments we expect to see a similar increase in the microbial diversity in the current sulfate reducing microcosms amended with activated carbon, and selection of species able to degrade

naphthalene in sand systems. Our preliminary results lead to the hypothesis that sediment caps can support a microbial community able of degrading the contaminants, and that the cap composition can be designed to facilitate the development of an active microbial community and can affect the efficiency of the capping design.