Influence of Activated Carbon on Biological Oxidation in Sediments: From Surface Chemistry to Microbial Diversity

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Background/Objectives. Media are a critical component of any engineered, biologically active system. It is well known that the media selected for a biological system will influence microbial diversity and oxidation activity. This has been well studied in drinking water systems, and previous works have demonstrated that activated carbon in drinking water filters promotes oxidation of assimilable organic material and enriches microbial diversity, leading to higher quality effluent waters. However, the role and the effect of activated carbon upon biological activity within in situ, environmental applications is not as well understood.

This work will describe recent strides taken to better understand the influence of activated carbon in biologically active sediment systems containing oxidizable contaminants. Specifically, we will discuss the role of activated carbon at two distinct scales: At nanoscale, investigating the role of surface functional groups, and at macroscale, comparing microbial responses to activated carbon and sand amendments.

Approach/Activities. Two series of experiments using activated carbon were conducted.

Surface Treatments. The influence of oxygenated surface functional groups on biodegradation rates was investigated in systems containing *Geobacter sulfurreducens*, which is common to anaerobic environments. Acetate served as a probe substrate; it is readily degraded and does not adsorb. Functional groups were modulated by pre-treating activated carbon with ambient air or acid (simulating weathering) or by altering solution pH (causing protonation or deprotonation). Degradation rates of acetate were calculated for each treatment. DNA extractions were used to quantify and compare the mass of *Geobacter* attached to surfaces of different treatments.

Comparing GAC with Sand. Microbial communities were enriched from contaminated sediments and inoculated into microcosms amended with capping media (sand or activated carbon) and naphthalene (model contaminant). Degradation rates of naphthalene, microbial diversity, and copy numbers of *nahAc*, a biomarker associated with naphthalene degradation, were calculated for each treatment.

Results/Lessons Learned. Both solid-phase amendment type and treatment greatly impacted biological activity. Physicochemical characteristics of activated carbon significantly influenced the rate and extent of acetate oxidation. Oxidation rates increased threefold when activated carbon was significantly weathered and surface functional groups contained the greatest oxygen content. When GAC was present, acetate consumption was most rapid at elevated pH; in systems without, oxidation occurred most readily under acidic conditions. In experiments comparing material types, systems with activated carbon supported a more diverse microbial community and contained higher copy numbers of *nahAc*. In contrast, enrichment of known aerobic naphthalene degraders from the genera *Pseudomonas* was observed in sand systems. These results suggest that adding activated carbon into sediments as solid-phase amendments will increase contaminant oxidation but that solution chemistry and surface

weathering should be considered, as these too may influence microbial behavior.