DEPARTMENT OF CHEMISTRY AND ENVIRONMENTAL SCIENCE
SEMINAR SERIES
FALL 2019

DATE: WEDNESDAY, SEPTEMBER 18, 2019

WHERE: TIERNAN HALL LECTURE 1
TIME: 1:00-2:20PM

GUEST SPEAKER

Dr. Michelle M. Lorah

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MD-DE-DC Water Science Center

Baltimore, MD

TOPIC

Development and Testing of a Bioaugmented, Activated Carbon Reactive Barrier for Bioremediation of Chlorinated Benzenes at the Groundwater/Surface-Water Interface

ABSTRACT

Aerobic and anaerobic bacteria can naturally coexist at the groundwater/surface-water interface and together can completely biodegrade chlorinated solvents that typically have recalcitrant daughter products under strictly anaerobic conditions. Short flowpaths and DNAPL sources in surficial sediments and underlying groundwater, however, can cause natural biodegradation rates to be insufficient for remediation in these environments. We developed and tested the use of bioaugmented, granular activated carbon (GAC) in a reactive barrier at the wetland surface to treat chlorinated benzenes at the Standard Chlorine of Delaware Superfund site. GAC was bioaugmented with an anaerobic, dechlorinating culture (WBC-2), enriched previously from another wetland site, and an aerobic consortium (15B), enriched from the Delaware site. Laboratory testing and microbial analyses showed that GAC enhanced the degradation activity of the cultures. Two pilot test plots were constructed by mixing bioaugmented GAC, sand, and chitin into the upper 25 cm of wetland sediment at the site. To quantify reactive barrier performance, the change in dissolved contaminant concentrations along upward groundwater flowpaths and the change in contaminant mass in the sediments was measured over an 18-month period (1900 pore volumes). Microbial community data and stable isotope probing in *in situ* microcosms were used to verify biodegradation processes.

Attenuation rates of dissolved chlorobenzenes along upward flowpaths in the reactive barriers were consistently high, with half-lives ranging from 0.97 to 1.8 hours. Although groundwater influx contributed 5 to 12 grams of chlorobenzenes per day to the reactive barriers, biodegradation rates approximately equaled the contaminant influx rates, preventing an increase in the contaminant mass in the reactive barrier sediment over time due to sorption to the GAC. Degradation rates estimated from increases in mass discharge of chloride in the reactive zones confirmed efficient bioremediation.

Microorganisms associated with anaerobic reductive dechlorination and aerobic oxidation of chlorobenzenes and benzene, occurring together, were prevalent in the reactive barrier sediment. Members of the Desulfuromonadales and the Burkholderiales orders that were present in the bioaugmented cultures showed enhanced populations in the reactive barriers compared to the control areas. Incorporation of ^{13}C-labeled chlorobenzene into the microbial biomass and the dissolved inorganic carbon was 2 to 4 orders of magnitude higher in the reactive barriers compared to the controls and conclusively demonstrated enhanced biodegradation. Thus, the microbial and isotopic data confirmed that biodegradation was responsible for the observed mass removal of chlorinated benzenes in the reactive barriers, showing the potential long-term effectiveness of the reactive barriers.

BIO

Dr. Michelle Lorah is a Research Hydrologist and has been with the U.S. Geological Survey in the Maryland Water Sciences Center since 1985. She directs the Fate and Bioremediation Team (FAB) and leads multiple projects on contaminant fate, microbial process, and bioremediation. She has a Ph.D. in Environmental Chemistry through the Marine-Estuarine-Environmental Sciences Program at the University of Maryland, M.S. in Environmental Science from the University of Virginia, and B.S. in Geosciences and Marine Science from Penn State University. Her current research includes PFAS biotransformation and bioremediation of chlorobenzenes at groundwater-surface-water interfaces, biodegradation of TCE in fractured rock, and PCB biodegradation and source determination in wetlands and streams. She has served as a technical expert for the National Research Council, Department of Defense, Department of Energy, and currently serves as a member of EPA's Board of Scientific Counselors Safe and Sustainable Water Resources Subcommittee. She was recently profiled in "A snapshot of women of the U.S. Geological Survey in STEM and related careers." https://doi.org/10.3133/cir1443

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