Mitigating Airborne PCB Emissions from Sediments with Black Carbon Materials and PCB-Degrading Biofilms

Project 5’s long-term goal is to provide environmental science and engineering solutions to decrease the flux of airborne PCBs at Superfund sites. Our objective is to develop novel synergistic coupled sorptive and reactive black carbon materials (e.g., biochars) containing aerobic PCB-degrading biofilms and evaluate the efficacy of these materials to remove LC-PCBs from sediments under variable salinity, temperature, and dissolved oxygen concentrations. We will do this by:

1) Optimizing tailored black carbon materials with sorptive and reactive properties toward LC-PCBs and the ability to host aerobic PCB-degrading biofilms. We hypothesize that black carbon materials can be tailored as delivery vehicles for aerobic PCB-degrading microorganisms. We will develop and test several new materials for their ability to harbor bacterial and/or fungal PCB-degrading biofilms.

2) Evaluating the performance of black carbon materials containing aerobic PCB-degrading biofilms to lower LC-PCB concentrations in water and air under relevant environmental conditions. We have preliminary evidence that bacteria and fungi form biofilms on biochar, and hypothesize that application of these materials to PCB-contaminated sediment will elevate active aerobic PCB-degrader populations, significantly remove LC-PCBs from water, and enhance their conversion to non-volatile products under variable environmental conditions (e.g., salinity, temperature, and dissolved oxygen concentrations).

3) Scaling up production of biofilm-coated black carbon materials and demonstrate the feasibility of decreasing airborne PCB flux from contaminated sediments at the mesocosm-scale. We hypothesize that production of novel black carbon materials containing PCB-degrading biofilms can be scaled up and effectively applied in laboratory-based mesocosms. The ISRP has access to University of Iowa campus facilities and expertise for biological process development and scale-up of microbial cultures. We will utilize these unique resources to scale up production of our novel material and biofilm combinations, develop potential technology transfer opportunities, and to demonstrate enhanced aerobic biodegradation of LC-PCB.


Datasets:

Datasets from Project 5 can be found on the NIEHS University of Iowa Superfund Research Program website.

Project Leader: Tim Mattes, PhD

Dr. Mattes is a Professor in Civil and Environmental Engineering at the University of Iowa. He is an expert in environmental microbiology and biotechnology, and molecular microbial ecology, will be responsible for the overall direction and management of Project 5. He will be principally responsible for the work described in Aims 2 and 3, where the black carbon materials with biofilms will be tested under different environmental conditions.

Jerald L. Schnoor, PhD, PE, Co-Investigator

Dr. Schnoor has considerable experience as the Editor-in-Chief of \textit{Environmental Science and Technology}, and serves as the Chair of the EPA-ORD Board of Scientific Counselors. Dr. Schnoor is an international leader in the field of phytoremediation and has expertise in developing super-sorbent biochar materials for use in remediation. Schnoor will actively participate in the design of laboratory experiments for Aim 1, where he will develop biochar materials from different feed stocks and under different pyrolysis conditions. In 2019 Schnoor received the American Chemical Society Award for Creative Advances in Environmental Science and Technology for pioneering the science and practice of phytoremediation.

Andres Martinez, PhD, Co-Investigator

Dr. Martinez has expertise in analytical chemistry and passive sampling approaches for detection of PCB in air, pore water and sediments. Andres will develop the materials and methods for the Aim 2 passive sampler experiments as well as the PCB passive samplers in the Aim 3 mesocosm experiments. In addition to supervising and participating in activities relevant to this ISRP project, he will work closely with ISRP researchers to coordinate the overall project, design experiments, analyze data, and disseminate experimental findings.

Greg Lefevre, PhD, Co-Investigator

Dr. LeFevre has expertise in fungal biotransformation processes and development of synergized biological-abiotic surface mediated redox reactions. He will contribute this expertise in the Aim 1 experiments with developing fungal and bacterial biofilms on biochar surfaces and investigating the synergistic combinations between reactive black carbon surfaces and microorganisms in the context of PCB biodegradation.
National Institute of Environmental Health Sciences

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