

## DREDGING FOR ANSWERS

INTERDISCIPLINARY RESEARCH TEAM AWARDED \$1 MILLION

TO STUDY PCBS IN RIVER SEDIMENTS

Late last year, the Bush administration ordered that tons of PCBs be removed from sediment beds of the upper Hudson River, mandating one of the largest dredging operations for environmental remediation in U.S. history. Not only is the process costly (at least \$500 million), there's no guarantee that the dredging will eradicate all of the PCBs. Removal of the river's sediment has stirred heated debates, along with fundamental questions about PCB eradication, which Carnegie Mellon researchers are helping to investigate.

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The David and Lucile Packard Foundation awarded a \$1 million grant to a Carnegie Mellon team to research the physical, chemical and biological processes that affect PCBs (polychlorinated biphenyls) in river sediments. The primary investigators, David Dzombak, CEE; Ned Minkley, the director of the Center for Biotechnology and Environmental Processes; Mitch Small, CEE and EPP; Jeanne VanBriesen, BHE and CEE; and William Brown, Biology, are working on a three-year project called "Effects of Sediment Biogeochemistry on the Environmental Fate and Persistence of Polychlorinated Biphenyls (PCBs)." The Packard Foundation "Interdisciplinary Science Program" selected the team from a pool of 51 U.S. research institutions. Created in 1964, this philanthropic establishment

provides nonprofit organizations with grants in areas such as conservation, the arts and science.

### COMPOUNDS THAT DON'T GO AWAY

According to the Environmental Protection Agency, PCBs may cause cancer and birth defects. Many of the 209 different PCB compounds are not only hydrophobic, embedding themselves in organic substances, such as fish and human tissue, but they are also highly stable and can persist for hundreds of years, according to Dzombak. Therefore, they can pose a long-term threat to aquatic and human life. Take the fisheries on the Hudson River, for example. Because of chemical contamination and risks imposed on human health, much of this industry has been shut down.

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their knowledge and experience to the problem.*

At one time, PCBs served a purpose. From the 1930s to the 1970s, they were synthesized and sold commercially in liquid form as fire-retardant lubricants and insulating fluids, which could withstand rigorous industrial conditions. But in the late 1970s, they were banned because of their toxic effects.

As concern about long-lasting PCB contamination grew, research studies were conducted, which explored the distribution and transport of these compounds in the environment and ways to clean up PCBs in contaminated environments, such as river sediments. However, little progress has been made in finding comprehensive ways to eliminate PCBs. For example, river dredging, a process that churns up the river's floor, can damage ecosystems and

doesn't capture all of the contaminants. So the Carnegie Mellon team is taking a fundamental, process-oriented approach to understand the clouded issue of PCB removal, not so much with the hope of creating an immediate solution, but rather to lay the groundwork for additional research that may eventually produce an answer.

#### STRATEGY FOR STUDY

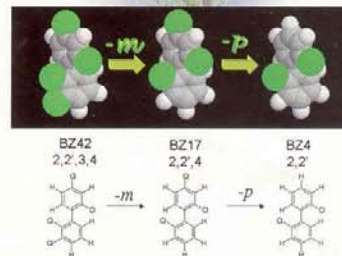
The group is studying the natural chemical and biochemical reactions that affect PCBs at various depths in contaminated river sediments. They plan to map how various PCB compounds are currently being broken down by naturally occurring bacteria — information that may lead to establishing a comprehensive cleanup program. The team has divided the project into six tasks.

- Examine how bacteria, through a process called reductive dechlorination, transforms PCBs into other, in some cases less toxic, compounds and eventually into water and carbon dioxide.
- Evaluate the types and growth patterns of the bacteria that degrade PCBs.
- Investigate the effect of dissolved oxygen on the rate of PCB biodegradation in specific layers of the sediment.
- Construct models of how PCBs biodegrade in the different sediment layers. This step will provide understanding about the various ways bacteria remove chlorine molecules from PCBs.
- Investigate the physical-chemical processes that govern release of PCBs from the sediment into the river water.
- Construct an integrated model for describing PCB biodegradation in and transport through layers of sediment. This step will help the researchers evaluate the relative importance of the numerous processes and system conditions that influence the long-term fate of PCBs in river sediments.



David Dzombak's teaching and research emphasizes water and soil quality engineering.

The illustrations below show the PCB dechlorination process: -m and -p refer to the removal of chlorines from the meta and para positions on the rings of the biphenyl.



The team hopes that the data they collect will pave the way for improving the management and cleanup of PCBs and perhaps other hazardous persistent chemicals in river sediments. According to VanBriesen, understanding these systems at such a fundamental level produces transferable information that could apply to a host of other contaminant dilemmas. Although it's too early to predict the results of this project, VanBriesen isn't concerned, stating, "One of the wonders and challenges of multidisciplinary work is how the research evolves over time and how the many different experts bring their knowledge and experience to the problem."

By KURT LARSEN

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