Featured Highlight

Heating Up Dredged Sediment Applications

Sediments are continuously deposited in rivers, lakes, and shorelines through natural processes such as erosion and transport by wind or water. Because of their capacity to adsorb contaminants, these flyaway particles act as an important sink in the aquatic environment. But sediment buildup also becomes a roadblock for navigable waters and harbors. As a result, several hundred million cubic yards of sediment are dredged from U.S. ports, harbors, and waterways each year.

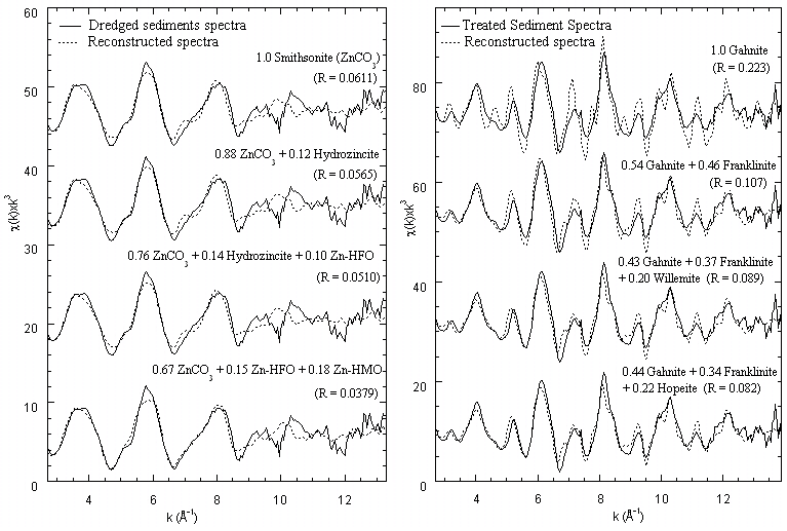
Authors (from left) Peter Nbida and Lisa Axe

"These sediments are often contaminated with heavy metals and toxins from industrial and urban activities," said New Jersey Institute of Technology researcher Lisa Axe. "The big question here is what to do with this waste?"

Historically, dredged materials were dumped in open waters, rivers, estuaries, or wetlands. But heightened environmental regulations and increasing costs for land deposition has presented a major challenge for dredging projects. As an alternative, attention has turned to the treatment and reuse of sediments, a move that would reduce costs and conserve resources. Most of these alternative technologies involve heating the sediment to extreme temperatures in order to eliminate its toxic nature and make it environmentally safe for products such as cement, lightweight bricks, and ceramic and glass tiles. However, few existing technologies are actually commercially used, stressing the need for further development.

"The trick is to reduce the toxicity of these sediments and create something that can be reused in everyday applications," said Axe, who along with NJIT researchers Peter Ndiba and Thipnakarin Boonfueng, used the NSLS to study a recently demonstrated thermal technique that incorporates the addition of phosphate. "This technique has been shown to work and we wanted to find out how."

After obtaining sediment from waterways in Belgium, the group added phosphoric acid to the samples and then heated them to 700 degrees Celsius. Next, they used x-ray absorption spectroscopy at NSLS beamline X11A to investigate the heavy metals' speciation, which primarily determines how easily they leach from the sediment and into the surrounding environment. Looking primarily at zinc – found in abundance in contaminated sediment from both the United States and Europe – the group applied principle component analysis (PCA), target transformation (TT), and linear combination factors (LCF) techniques on dredged and treated sediments spectra using 14 reference compounds. They discovered that the thermal phosphate treatment transformed the metal into more stable phases, phosphate minerals and spinels. The result was an 89 percent reduction in zinc leachability. Their



Experimental and linear combination fitting reconstructed $\chi(k)\cdot k^3$ spectra for dredged and treated sediments. Only spectra with more than 10% contributions are included. The fitting factor $R = \Sigma[(k^3\chi_{exp}-k^3\chi_{model})/k^3\chi_{exp}]^2$ where χ_{model} refers to spectra reconstruction with PCA decomposed components. Zn-HFO and Zn-MnO refer Zn sorbed to hydrous iron oxide and hydrous manganese oxide respectively.

results were published in the February 1, 2008 issue of *Environmental Science and Technology*.

"This suggests that even if zinc does leach in its final form, it probably won't be at a measureable level," Ndiba said, adding that the researchers plan to continue their studies, for example, to determine whether the thermal phosphate technique has the same stabilizing effect on other heavy metals.

"This continues to be an important issue," Axe said. "Particularly in the New Jersey and New York harbor areas. If we can help show that these treated sentiments are safe to reuse in things like road base construction and bricks, the application options would be wide open."

This study was initiated as the result of a collaboration between Solvay Company of Belgium and the New Jersey Institute of Technology. Funding was provided by the New Jersey Water Resources Research Institute.

For more information, please see: P. Ndiba, L. Axe, T. Boonfueng, "Heavy Metal Immobilization through Phosphate and Thermal Treatment of Dredged Sediments," Environ. Sci. Technol., ***42****, 920-926 (2008).*

— Kendra Snyder