

METALS

Remediating Soil Lead with Fish Bones

Fish bones are made of the phosphate mineral apatite, which readily combines with lead to form pyromorphite, a stable crystalline mineral that can't be absorbed by the human digestive system.^{1,2} Now researchers are using fish bones and other phosphate-rich amendments to remediate lead in urban soils. "We have seen reduction in bioaccessibility in some lab samples up to fifty percent within just a few weeks of treatment," says Steve Calanog of the U.S. Environmental Protection Agency (EPA), who is overseeing an agency project using fish bones to clean up soils in the South Prescott neighborhood of Oakland, California.³

In situ and laboratory tests have shown that phosphates can also immobilize other potentially toxic metals, including copper, zinc, cadmium, and uranium.^{1,4,5,6,7,8} In one of these studies, lead concentrations in soil leachate treated with fish bones dropped from 0.28 mg/L to 0.00065 mg/L within weeks.^{6,7} Unlike phosphate fertilizers, the apatite in fish bones does not run off the soil.² Fish bones also are being used as a phosphate source for lead remediation projects in other urban areas, including a pilot project in New Orleans, Louisiana, funded by the U.S. Department of Housing and Urban Development.⁹

Excessive blood lead can cause delays in neurological and physical development in children, and high blood pressure, kidney problems, and cancer in adults. Lead added to house paints and fuels decades ago still lingers in urban neighborhoods across the country, and children can be exposed through the soil in yards and playgrounds. Total lead levels in soils tested in the Oakland/San Francisco Bay area average 300–600 ppm, according to Calanog. The U.S. EPA considers lead in bare soil in play areas to be a hazard at a concentration of 400 ppm,¹⁰

and the California Office of Environmental Health Hazard Assessment has estimated that exposure to a soil lead concentration of 80 ppm will produce an increase in blood lead of up to 1 µg/dL.¹¹ In South Prescott, which is adjacent to the AMCO Chemical Superfund site, total soil lead levels average 843 ppm, with some spots reaching 2,500 ppm.³

The 2-year, \$4-million South Prescott project is part of a growing trend to treat soils contaminated with lead and other heavy metals in place, rather than removing and replacing soils or capping them with asphalt or concrete, techniques that require dump sites to store contaminated soils as well as sources of uncontaminated soils for replacement. "Lead contamination is a pervasive problem, and our traditional ways of responding are neither economically nor ecologically sustainable," Calanog says.

Phosphate immobilization is not recommended for sites with lead levels above 4,000 ppm, such as those heavily contaminated with lead paint, according to Rufus Chaney, a research agronomist with the U.S. Department of Agriculture Environmental Management and Byproduct Utilization Laboratory. Chaney has worked on soil remediation projects in South Prescott, Baltimore, and other urban neighborhoods, and on the development of less expensive tests for measuring levels of bioaccessible lead.¹²

In South Prescott, workers till 3 pounds of fish bones into each square foot of property treated, then cover the freshly tilled soil with 3–6 inches of clean soil and plants.³ Many project workers are hired locally through the Cypress Mandela Training Center, a pre-apprenticeship program in West Oakland. Workers receive health and safety and lead-abatement training, and they wear personal protective equipment, including respirators, Calanog says.

The fish bones used in South Prescott come from commercial processing of pollock into fillets, fish sticks, and artificial crab meat. Catfish farms are another possible source of fish bones for remediation,

The Beat

by Erin E. Dooley

Rotating Shift Work and Type 2 Diabetes in Women

In a prospective study of more than 175,000 U.S. women, those who worked a rotating schedule that included 3 or more night shifts per month had a higher risk of developing type 2 diabetes than women who worked only days or only nights.¹ Women who worked rotating shifts were also more likely than other women to become obese during the 18–20 years of followup. The results suggest the increased risk of diabetes may be at least partly mediated through weight gain.

NICEATM and ICCVAM Announce Request for Comments

In November 2011 the National Institute of Environmental Health Sciences and the National Toxicology Program Interagency Center for the Evaluation of Alternative Toxicological Methods (NICEATM) issued a request for comments to be considered by NICEATM and the Interagency Coordinating



Committee on the Validation of Alternative Methods (ICCVAM) in updating the current NICEATM/ICCVAM 5-year plan to cover the years 2013–2017.² ICCVAM was established as a permanent committee in 2000 to promote the development, validation, and regulatory acceptance of new or revised alternative toxicological test methods that reduce, refine, or replacing animal tests while ensuring human safety and product effectiveness. Interested parties should submit their comments by 15 January 2012.

Landmark Climate Gains in Durban

In December 2011 the 194-party United Nations Framework Convention on Climate Change reached agreement on a complex and overarching program aimed at setting a new course for worldwide action against climate change.³ The parties agreed to negotiate a legally binding agreement by 2015 to come into force by 2020, which would apply to developed and developing nations alike. They also made progress toward establishing a Green Climate Fund to administer billions of dollars for climate change adaptation measures in developing nations as well as rules for protecting and conserving forests.

Lead Battery Recycling on the Rise in Mexico

A recent investigation by *The New York Times* found that about 20% of spent U.S. vehicle and industrial batteries end up in Mexico, up from 6% in 2007, where weaker environmental standards and lax

according to Judith Wright, the geologist whose studies of fossilized fish bones¹³ inspired her invention (U.S. Patent #6217775) of the process of using fish bones to remediate heavy metals. Wright, owner of PIMS NW, Inc., supplies the cleaned fish bones for projects such as that at South Prescott. Bones from weight-bearing animals, such as cattle, contain the same chemical form of apatite as do fish bones but in a more highly crystallized form that combines less readily with metals, Wright says.

"Many amendments other than fish bones can also be used for phosphate immobilization," Chaney says. Indeed, the EPA, U.S. Army Corps of Engineers, U.S. Department of Defense, and other agencies have tested numerous synthetic, mined, and organic sources of phosphates for remediation, including mineral apatite, rock phosphate, soluble phosphate fertilizers, and biosolids compost from treated sewage.^{1,4,5,6,7,8} Calanog says many of these possible amendments are fairly accessible in terms of cost, but the beauty of the fish bones, according to Wright, is that they're free of contaminants. Using fish bones also avoids ecological issues involved with mining phosphates, and the bones will not dissolve but "will remain in place to stabilize metals for millennia," she says.²

Chaney favors the use of organic amendments such as composts that are high in iron, as well as phosphates. Whereas phosphates transform lead into other compounds, iron compounds physically bind with lead through adsorption, a process in which one compound adheres to the surface of another. When lead molecules adsorb to iron-based compounds such as ferrihydrite, he says, they are no longer soluble and can't be absorbed through the lining of the small intestine. Without realizing it, many urban gardeners are already remediating their soils by adding fertilizers and composts that contain phosphates and iron. "Only about five to ten percent of lead in urban gardens is bioavailable, compared to fifty to sixty percent in urban soils elsewhere,"¹² Chaney says.

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enforcement jeopardize communities near recycling plants.⁴ Spent batteries can contain up to 40 pounds of lead, which can be released as dust or fumes during the recycling process. Advocacy groups are calling on U.S. companies to export spent batteries only to countries whose standards are as strict as those in the United States.

New Tool Maps Pollution, Noise Levels across Europe

In December 2011 the European Environment Agency (EEA), Microsoft, and

technology company Esri launched the Eye on Earth network, a "cloud computing" platform that maps air, water, and noise pollution across Europe based on government data and information uploaded by users.⁵ The WaterWatch feature displays 22,000 locations where the EEA monitors water quality, AirWatch provides information on more than 1,000 air-monitoring stations, and NoiseWatch allows users to directly upload noise-level readings from their personal mobile devices.

"The vision of the Eye on Earth is to help communities around the world get easier and more timely access to environmental and societal data and information they need to design and create a future that is sustainable and resilient to the changes and challenges ahead," says EEA executive director Jacqueline McGlade. Additional services are planned for the network over the next five years.

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