Pacific Northwest NATIONAL LABORATORY

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U.S. DEPARTMENT OF ENERGY

Pacific Northwest National Laboratory

ENVIRONMENTAL SUSTAINABILITY SUCCESS STORIES

Digging Into Dirt

Subsurface science at Pacific Northwest National Laboratory

Imagine drinking water that has dripped through the sponge you've just used to clean the breakfast dishes. This is what is happening around the world. Rain and snow pass through soil polluted with pesticides, poisonous metals, and radionuclides into the underground lakes and streams that supply rivers, lakes, and drinking water.

"We need to understand this system better to protect our groundwater and, by extension, our drinking water," said Pacific Northwest National Laboratory's Applied Geology and Geochemistry Group Manager, Wayne Martin.

PNNL BUILDS SYNERGISTIC TEAMS OF EXPERTS

By including biologists, statisticians, hydrologists, geochemists, and computer scientists, these teams study the complexities of the whole environment, not just the soil or just the groundwater. The teams provide regulators with answers to make complex decisions and design innovative technologies to capture or convert pollutants.

DEALING WITH ARSENIC AND LEAD AT OLD FERTILIZER PLANTS

In the mid-1800s, fertilizer manufacturers began obtaining the plant nutrient phosphate by processing apatite ore with sulfuric acid. Pyrite ore, with traces of arsenic and lead, was one of the feedstock used for the onsite production of sulfuric acid. Waste fluids and solids from acid and fertilizer production were disposed of at the sites.

Over a century later, researchers at Battelle[1] are helping ConocoPhillips and others deal with the long-term legacy of contamination and costly clean-up problems at sites in South Carolina and Massachusetts. First, the teams locate contaminated areas, a vexing problem as records may have been lost in the intervening century. Next, they evaluate the site to determine the physical and geochemical processes controlling migration of the dangerous metals. To deal with the challenges of each site's soil, they help design customized remediation methods and assist with long-term monitoring.

[1] Battelle operates the Pacific Northwest National Laboratory for the U.S. Department of Energy and may perform work for private clients through a unique use agreement.

STOPPING RADIONUCLIDES AT A NUCLEAR WEAPONS SITE

Beneath the Hanford Site, a former plutonium production complex in southeastern Washington, lies about 2 million curies of radionuclides. One concern is a persistent plume or smear of uranium that is moving through the subsurface towards the site's eastern border and the Columbia River.

PNNL researchers have taken a holistic approach to understanding where the uranium will move and how it will react. They are studying not only the chemistry of the subsurface sediments and the effect is has on the uranium, but they are also studying how soil-inhabiting microbes may change the uranium. Microbes may change the number of electrons in a uranium atom. This slight change can render the uranium immobile and force it out of the groundwater. By looking at the whole of the environment, not just the soil, researchers can develop methods that stop the migration of uranium and protect the river.

To reliably and cost-effectively test for uranium in the hyporheic zone, where the groundwater bubbles into the river, PNNL's researchers are looking at that ecosystem microbes and fungi that make up common rock slime, which grows at the river's edge. By including ecologists, biologists, and computer scientists, this team is searching for biological signatures – a collection of genes, proteins, and metabolites – that indicate the ecosystem has encountered uranium.

Geostatistics combines geology and mathematical statistics and can be used to understand the spatial distribution of one or more pollutants through a complex environment.

MAPPING THE RESULTS OF PESTICIDE DUMPING

DDT and other pesticides are toxic to insects that can destroy food crops and carry malaria or other diseases; however, when companies dispose of these chemicals improperly, the consequences can be devastating to humans and the environment. Just how devastating is what PNNL's geostatisticians helped determine.

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When high levels of pesticides were discovered on southern California's coastal shelf, PNNL Staff Scientist Chris Murray was asked to produce maps showing the thickness and contaminant concentrations of the polluted sediment. The client used the maps to estimate the mass of contaminants on the shelf and identify the sample locations that would provide the most valuable information at the lowest cost. The Environmental Protection Agency used the maps to evaluate cleanup options.

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THE FUTURE

The future of subsurface science may be up in the air, literally. Researchers at PNNL are working to safely incorporate the greenhouse gas carbon dioxide into the subsurface. As part of a large consortium, the researchers are looking at the feasibility of pumping the gas deep underground. There, it would react and become harmless minerals within the soil.

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