

@ Bacteria found in the soil and subsurface can release phosphate that converts the radioactive element uranium into an insoluble and immobile form, which helps control contamination.

Conversion Experience

Subsurface bacteria release phosphate to convert uranium contamination to immobile form.

BY JANE M. SANDERS

In research that could help control contamination from the radioactive element uranium, scientists have discovered that some bacteria found in the soil and subsurface can release phosphate that converts uranium contamination into an insoluble and immobile form.

Based on laboratory studies, Georgia Institute of Technology researchers report promising results using bacterial species from three genera isolated from subsurface soils collected at a U.S. Department of Energy (DOE) Field Research Center site in Oak Ridge, Tenn. Researchers conducted preliminary screenings of many bacterial isolates

and found several candidate strains that released inorganic phosphate after hydrolyzing an organo-phosphate source the researchers provided.

The bioremediation research project, funded for three years by DOE's Environmental Remediation Sciences Division, is in its early stages. Research team member Melanie Beazley, a Ph.D. student in the Georgia Tech School of Earth and Atmospheric Sciences, presented preliminary findings at the 231st American Chemical Society National Meeting in Atlanta in March.

RIGHT: Georgia Tech graduate students Melanie Beazley, left, and Robert Martinez are part of a research team studying the ability of subsurface bacteria to release phosphate that converts uranium contamination into an insoluble and immobile form.



PHOTO BY GARY MEEK

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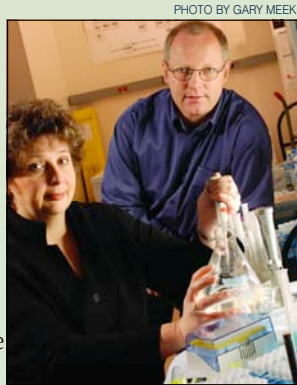
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“The devil’s in the details with the chemistry of uranium: There are numerous forms of uranium in the environment, which are all influenced by the natural properties of soil and groundwater.”

Martial Taillefert, assistant professor of earth and atmospheric sciences at Georgia Tech

LEFT: Uranium is a radioactive element. This symbol indicates radioactivity.

“These organisms release phosphate into the medium, but the precipitation (of uranium phosphate) occurs chemically,” explains Assistant Professor of Earth and Atmospheric Sciences Martial Taillefert, co-director of the study. “That is the biomineralization of uranium and the novelty of this approach.”



LEFT: Scientists Patricia Sobecky, left, and Martial Taillefert have discovered that some bacteria found in the soil and subsurface can release phosphate that converts uranium contamination into an insoluble and immobile form.

The process begins when the bacteria — from the genera *Rhanelia*, *Bacillus* and possibly *Arthrobacter* — degrade an organo-phosphate compound such as glycerol-3-phosphate (G3P) or phytic acid (IP6), which can be present in subsurface soils.

“During their growth, the organisms liberate phosphate they derive from the organo-phosphate compound,” says project co-director Patricia Sobecky, an associate professor of biology. “The free phosphate is released to the surrounding media, which is a solution in the lab. Then we conduct assays to see how much uranium is mineralized by the phosphate released by the bacteria.”

The bacteria’s role is crucial in this process because uranium cannot dissociate the organo-phosphate compound chemically, Taillefert explains. So uranium in the presence of organo-phosphate alone does not result in significant uranium precipitation.

Sobecky and her Ph.D. student Robert Martinez are conducting the microbiological and physiological component of the research, while Taillefert and Beazley study the uranium chemistry and analyze distribution of different forms of uranium during incubation in the lab.

“The devil’s in the details with the chemistry of uranium: There are numerous forms of uranium in the environment, which are all influenced by the natural properties of soils and groundwater,” Taillefert says.

Sobecky adds, “What we’re doing now is optimizing the assay conditions and the techniques to analyze the distribution of uranium species in the lab.”

Traditionally, DOE has funded research investigating the chemical reduction of uranium contamination. But there are two approaches to immobilizing uranium. One strategy reduces uranium (VI) to uranium (IV), which is, in principle,

immobile. But the uranium can re-oxidize even with traces of oxygen from rainwater seeping into the groundwater. The Georgia Tech approach biomineralizes uranium (VI) into an insoluble form of uranium via phosphate precipitation.

As they work toward a bioremediation strategy that will work in the field, researchers must design a mechanism to deal with competing organisms in the soil that might sequester the free phosphate, Sobecky notes. Though their current grant does not cover the cost of a field study, researchers hope to obtain funds in the future to test their strategy at Oak Ridge and potentially other DOE sites. Uranium contamination is a concern at DOE sites because it can migrate to groundwater in surrounding areas, Taillefert notes.

“At this point, we know the organisms we’re studying are active in precipitating uranium phosphate,” he says. “Now we need to determine how chemically stable it is.”

Researchers also have learned that when the bacteria are releasing phosphate from G3P, the bacteria can tolerate the toxic uranium and can continue to grow once the uranium is precipitated by the released phosphate.

“Our challenge now is fine-tuning the conditions around the bacterium so eventually it can thrive and work chemically in a natural setting,” Taillefert says.

@ Read online at: gtresearchnews.gatech.edu/newsrelease/uranium.htm



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