Argonne NATIONAL LABORATORY

News Release

Media Contact: Brock Cooper
(630) 252-5565
bcooper@anl.gov

Scientists discover how the structure of plutonium nanocluster contaminants increases risk of spreading

ARGONNE, Ill. (April 22, 2008) — For almost half a century, scientists have struggled with plutonium contamination spreading further in groundwater than expected, increasing the risk of sickness in humans and animals.

It was known nanometer-sized clusters of plutonium oxide were the culprit, but no one had been able to study its structure or find a way to separate it from the groundwater.

Scientists at the U.S. Department of Energy's Argonne National Laboratory, in collaboration with researchers from the University of Notre Dame, were able to use high-energy X-rays from the Advanced Photon Source (APS) at Argonne to finally discover and study the structure of plutonium nanoclusters.

"When plutonium forms into the clusters, its chemistry is completely different, and no one has really been able to assess what it is, how to model it or how to separate it," said Argonne senior chemist Lynda Soderholm. "People have known about and tried to understand the nanoclusters, but it was the modern analytical techniques and the APS that allowed us understand what it is."

The nanoclusters are made up of exactly 38 plutonium atoms and have almost no charge. Unlike stray plutonium ions, which carry a positive charge, they are not attracted to the electrons in plant life, minerals, etc. which stopped the ions' progression in the ground water.

Models have been based on the free-plutonium model, creating discrepancies between what is expected and reality. Soderholm said that with knowledge of the structure, scientists can now create better models to account for not only free-roaming plutonium ions, but also the nanoclusters.

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The clusters also are a problem for plutonium remediation. The free ions are relatively easy to separate out from groundwater, but the clusters are difficult to remove.

"As we learn more, we will be able to model the nanoclusters and figure out how to break them apart," Soderholm said. "Once they are formed, they are very hard to get rid of."

Soderholm said other experiments have shown some clusters with different numbers of plutonium atoms, and she plans to examine their unique electric and magnetic properties – together with her collaborators S. Skanthakumar, Richard Wilson and Peter Burns of Argonne's Chemical Sciences and Engineering Division.

Funding for the research was provided by the U.S. Department of Energy, Office of Science, Office of Basic Energy Sciences.

The mission of the Basic Energy Sciences (BES) program – a multipurpose, scientific research effort – is to foster and support fundamental research to expand the scientific foundations for new and improved energy technologies and for understanding and mitigating the environmental impacts of energy use. The portfolio supports work in the natural sciences, emphasizing fundamental research in materials sciences, chemistry, geosciences, and aspects of biosciences.

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