Lichens detect past fallout

November 8, 2015

Los Alamos researchers and a collaborator at the University of Cincinnati used lichens collected from remote locations in New Mexico to detect trace residual airborne transuranic isotopes from atmospheric nuclear testing that happened as long ago as 50 years. The lichens serve as bioaccumulators of the low background concentration of actinide isotopes of neptunium and plutonium. The *Journal of Radioanalytical and Nuclear Chemistry* published the research.

Significance of the research

The team conducted this investigation to define the background concentrations of actinide isotopes present in the environment. Lichens are symbiotic organisms that consist of both an alga (or cyanobacterium) and a fungus. They obtain essential nutrients directly through atmospheric deposition and have evolved highly efficient mechanisms to bioconcentrate trace elements within their tissues. In other studies, scientists have used this characteristic of lichen to monitor the distribution of atmospheric pollutants in Europe and North America.The Los Alamos researchers

measured the trace concentrations of neptunium and plutonium isotopes (^{237}Np, ^{239}Pu, and ^{240}Pu) in lichen samples. They studied Usnea arizonica lichen, which is commonly called “Western Brushy Beard.” The lichen typically grows on ponderosa and piñon pine trees several meters above the ground surface. This characteristic makes *Usnea spp.* a better choice for studying actinide atmospheric transport compared with ground-growing species, which would more likely absorb superficial contamination from adjacent soils.The observed isotopic ratios indicate trace contamination from global fallout and regional fallout (e.g. Trinity test and atmospheric testing at the Nevada Test Site). Each of these sources has a unique isotopic composition that influences the isotopic pattern measured in the environmental samples. The occurrence of transuranic isotopes in modern lichen samples reflects the background concentration of nuclear fallout that is actively redistributed through wind erosion and atmospheric transport. Detection of actinide contamination in recent lichen collections suggests that continuous re-suspension of fallout radionuclides occurs even 50 years after ratification of the Limited Test Ban Treaty. Studies of this type could be used in environmental monitoring programs associated with modern nuclear activities.

Research achievements

The team collected lichen samples from 10 locations in New Mexico between 2011 and 2013. The researchers dried and ashed the lichen. Isotope dilution inductively-coupled plasma mass spectrometry determined the trace concentrations and ratios of the actinide isotopes. The investigators compared the isotopic ratios with the unique signatures of global and regional fallout. The measured isotopic ratios reveal mixing of the different fallout sources. The scientists concluded that the concentration of the isotopes in lichen samples is comparable to or slightly elevated compared with regional soils. The isotopic composition of transuranic elements in lichens most likely reflects the uppermost layer of soils that are also the most easily eroded and carried by wind.

The research team

The researchers include Warren J. Oldham, Susan K. Hanson, and Jeffrey L. Miller of LANL's Nuclear and Radiochemistry group and Kevin B. Lavelle of the University of Cincinnati.The Laboratory Directed Research and Development (LDRD) program funded the Los Alamos work, and the Department of Homeland Security sponsored Kevin Lavelle as a Nuclear Forensics Graduate Fellow. The research supports the Laboratory’s Global Security mission area and the Science of Signatures science pillar through the analysis of actinides in the environment.

Caption for image below: A plot of isotope ratios for lichen collected in New Mexico, compared with the isotopic composition of global fallout and regional fallout (Nevada Test Site and the Trinity Test).