Separation of Uranium and Plutonium Isotopes for Measurement by Mass Spectroscopy.

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Uranium (U) and plutonium (Pu) isotopes in soil contaminated by nuclear weapons testing in the northern Marshall Islands were isolated by ion-exchange and analyzed by mass-spectrometry. Soils samples were dried, weighed, and spiked with ^{233}U and ^{242}Pu tracers prior to total digestion in $HNO_3/H_2O_2/HF$. U and Pu were then isolated on pre-packed ion-exchange columns supplied from EIChrom Industries Inc. (Darien, Il). The ion-exchange technique employed an initial UTEVA column (a nonionic acrylic ester polymer bead coated with dipentyl-pentane phosphonate) coupled to a TEVA column (a nonionic acrylic ester polymer bead coated with an aliphatic quaternary ammonium salt). U and Pu isotope fractions were recovered in separate elution schemes, and then processed for mass spectrometric measurements.

For U isotope measurements, a multi-collector inductively coupled plasma mass spectrometer (MCICP-MS) was employed to obtain high precision measurements of $^{235}U/^{238}U$ and $^{234}U/^{238}U$ and, if present, to determine trace amounts of ^{236}U ($^{236}U/^{235}U$). Plutonium isotopes were determined by accelerator mass spectrometry (AMS). The AMS system at the Lawrence Livermore National Laboratory has a detection sensitivity below 10^6 atoms, and can be used to measure a full range of Pu isotopes including ^{239}Pu, ^{240}Pu, ^{241}Pu and ^{242}Pu at environmental levels. The separation scheme described here has proven to be rapid and convenient method for isolation of U and Pu isotopes in small quantities of soil for measurement by mass spectrometry. Detailed isotopic measurements of U, Pu and other long-lived radionuclides may be useful in identifying and tracing signature inputs and transfers into the near surface environment.

This work was performed under the auspices of the U. S. Department of Energy by the University of California, Lawrence Livermore National Laboratory under Contract No. W-7405-Eng-48.