

Anthropogenic sources of uranium and plutonium in the environment: studies with mass spectrometry

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Abstract: This presentation will describe mass spectrometric studies of uranium and plutonium in the environment, with emphasis on understanding anthropogenic contamination sources. Isotope signatures, especially when measured by mass spectrometry, are powerful and versatile tools for recognition of the presence of small quantities of enriched or depleted U mixed with a relatively large background of naturally occurring U. When small amounts of enriched or depleted uranium are present, alteration of naturally occurring U ratios ($^{234}\text{U}/^{238}\text{U}$, $^{235}\text{U}/^{238}\text{U}$ and $^{236}\text{U}/^{238}\text{U}$) is observed. The detection of an altered isotope signature, especially when correlated alterations are observed in more than one ratio, is found to be a much more sensitive indicator of contamination than detecting an elevation in concentration/activity.

Plutonium is present in the environment from a myriad of sources, including nuclear weapons testing fallout, the nuclear fuel production cycle, nuclear power plant accidents (e.g., Chernobyl) and nuclear weapons production facilities. Recent research by the author has specifically investigated many of these different sources in local, regional, and global contexts. In the continental US, most Pu originates from stratospheric or “global” fallout from large-scale thermonuclear tests conducted by the US and former Soviet Union in the 1950’s and 1960’s. In the continental US, particularly in the Great basin region, the Nevada Test Site (NTS) represents an additional weapons testing source term. Plutonium originating from the NTS is mainly ^{239}Pu , with smaller mass amounts of other isotopes (^{238}Pu , ^{240}Pu , ^{241}Pu , and ^{242}Pu). Pu from the NTS exhibits a characteristic $^{240}\text{Pu}/^{239}\text{Pu}$ atom ratio of ~ 0.05 , which contrasts with the signature of “stratospheric” fallout ($^{240}\text{Pu}/^{239}\text{Pu} = 0.18$). Hence, isotope measurements can distinguish and apportion Pu inventory between stratospheric fallout, NTS, and perhaps other localized sources.

This seminar will present several case studies of environmental settings where we have investigated sources of U or Pu using these methodologies.

Biography: Michael E. Ketterer obtained his primary and secondary education in Buffalo, NY, and received a B.S. in Chemistry from University of Notre Dame in 1980. He pursued graduate studies in electron transfer and interfacial chemistry at the University of Colorado under the direction of Prof. Carl A. Koval, receiving a Ph.D. in 1985. After brief employment as an industrial electrochemist, he worked from 1987-1993 at the US Environmental Protection Agency’s forensic laboratory, and was Assistant Professor at John Carroll University from 1993-1998. In 1998 Mike moved to Northern Arizona University, where he was Professor of Chemistry and Biochemistry until 2013. From July 2013 to present, he has been Professor and Department Chair of Chemistry at Metropolitan State University of Denver. His current research interests are in environmental geochemistry and environmental radioactivity, and he has a focus on using mass spectrometry in studies of long-lived actinides in the environment.



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