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Development and characterization of nuclear forensic reference materials for measurement of trace-level actinide elements

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Content

Since 2009, the Department of Homeland Security National Technical Nuclear Forensics Center (NTNFC) has been sponsoring the development of reference materials to enhance the accuracy, precision, and traceability of nuclear forensic analytical capabilities. This work has been a collaborative effort between NTNFC, the Federal Bureau of Investigation, the National Institute of Standards and Technology, the Department of Energy, DOE National Laboratories, and international partners. The goal of this program is to provide certified analytical standards that can improve the resolution of current measurement capabilities and/or provide a level of quality control necessary to demonstrate the reliability of analytical results and meet evidentiary requirements for a court of law. As such, these new reference materials should be homogeneous and be provided in an appropriate form, quantity, and purity to meet analytical needs. Furthermore, characterized attributes must be reproducible, have reasonably low measurement uncertainties, and be traceable to national and international standards. To date, most of the nuclear forensic reference material projects have focused on challenging measurements of amount fraction and isotope amount ratios of actinide elements, including transuranic elements, that occur as trace constituents («100 mg / kg) in other materials. Meeting all of these requirement for low-level actinide analytical standards is a complex task and each reference material project presents a unique set of challenges. Despite the complexity of the task, this collaborative project has successfully produced and certified nuclear forensic reference material and is making significant progress toward the development, characterization, and certification of additional reference material that will improve and expand measurement capabilities for trace quantities of actinide elements.

Individual reference material projects are at various stages of completion from initial planning to currently available CRMs and fall into two main categories: enriched isotope tracers for low-level isotope dilution mass spectrometry (IDMS) measurements and matrix reference material for method development, validation, and quality control. New IDMS tracer reference materials that have been produced include solutions of Am-243 (isotope amount fraction of 0.9999 at 0.4 µmol / kg) and Th-229 (isotope amount fraction of 0.99987 at 0.115 µmol / kg). IDMS tracers that are in the planning or early production stages include Np-237 (target attributes: isotope amount fraction of 0.8 to 0.9 at 0.04 µmol / kg), Pa-231 (target attributes: isotope amount fraction >0.999 at 0.01 µmol / kg) and U-233 (Target attributes: isotope amount fraction > 0.999 at 4.3 µmol / unit). Matrix reference materials include U reference materials for radiochonometric measurements (certified Th-230 / U-234 model purification ages), trace U isotopes in U materials (U-232 isotope amount fractions ranging from 460 x 10ˆ-12 to 8.2 x 10ˆ-12 and isotope amount fractions for 233U ranging from 1.5 x 10ˆ-6 to 0.2 x 10ˆ-6), Trace actinide elements in a U oxide matrix (amount fractions at mg / kg levels or lower for Th, Pu, Am, Np) and Trace actinide elements in a Pu oxide matrix (amount fractions at mg / kg levels for U, Np, Am).

About the Presenter

Richard Essex has be working on the production, characterization, and certification and nuclear and nuclear forensic reference materials for the last 15 years. This includes his current position at the National Institute of Standards and Technology and his previous position at the Department of Energy's New Brunswick Laboratory. His academic background is in geology and isotope geochemistry with a BS from the University of Rhode Island, an MS from Virginia Tech, and a PhD from Brown University.

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