RAPID DETERMINATION OF ACTINIDES IN SEAWATER SAMPLES

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In light of the nuclear accident at Fukushima Nuclear Power Plant in March, 2011, there is a need for a rapid method to determine actinide levels in seawater samples that can be applied quickly with high chemical yields and effective removal of interferences. Laboratory methods that take one to two weeks to determine actinide levels in seawater are simply not rapid enough following a radiological release. Radiological information is needed immediately to allow adequate protection of the public and assess environmental contamination and damage to ecosystems. The recent theft of nuclear material in Mexico highlights the need for nuclear safeguards and raises concerns about a radiological dispersive device (RDD) or "dirty bomb", again illustrating the need for rapid environmental methods. [1] The measurement of actinide levels in seawater can be quite challenging, due to the difficulty of the seawater matrix and low detection limits required. Surface concentrations of plutonium in seawater, for example, are usually very low (<5 μBqL^{-1}), except for contaminated areas such as in the Irish Sea.[2] While fresh water sample aliquots taken for analysis are often 1 liter or less, seawater aliquots up to 200 liters or more have been analyzed to lower detection limits as much as possible. Unfortunately, many of the methods used provide chemical yields of only 30-60%. The time frame needed to determine actinide levels in environmental samples, including seawater samples, after a nuclear accident is in hours, not weeks, to allow appropriate assessment of environmental contamination as well as protection of the public and marine ecosystems.

A new rapid method for the determination of actinides in seawater samples has been developed at the Savannah River National Laboratory (SRNL). The actinides can be measured by alpha spectrometry or inductively-coupled plasma mass spectrometry (ICP-MS). The new method employs novel pre-concentration steps to collect the actinide isotopes quickly from 80L or more of seawater. Actinides are co-precipitated using an iron hydroxide co-precipitation step enhanced with Ti^{+3}reductant to ensure tracer equilibration and enhance chemical yields, followed by lanthanum fluoride co-precipitation. Stacked TEVA Resin and TRU Resin cartridges are used to rapidly separate Pu, U, and Np isotopes from seawater samples. TEVA Resin and DGA Resin were used to separate and measure Pu, Am and Cm isotopes in seawater volumes up to 80 liters or more. This robust method is ideal for emergency seawater samples or the routine analysis of seawater samples for oceanographic studies to enhance efficiency and productivity.

[1] Mexico Finds Stolen Radioactive Material Amid Dirty Bomb Fears" http://www.voanews.com/content/nuclear-material-stolen-in-mexico/1803195.html, 12/4/13

[2] Hirose K (2009) Plutonium in the Ocean Environment: Its Distributions and Behavior. Journal of Nuclear and Radiochemical Sciences, Vol. 10, No.1: R7-R16