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A rapid separation method for Pu and Sr-90 in seawater samples for emergency preparedness

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Artificial radionuclides are released into the environment as a result of nuclear facility accidents and nuclear weapon testing. Among them, strontium, plutonium and cesium are the most frequently monitored in environmental studies. After Fukushima accident, changes of Cs-134/137 concentrations in seawater adjacent to Fukushima are well documented. However, radiostrontium or plutonium concentrations are poorly reported. It is reason that the chemical separation is necessary to determine strontium and plutonium, being beta/alpha emitters, while preconcentration of seawater for gamma emitters is relatively easy. Sequential separation method of Sr and Pu in seawater is studied to prepare for emergency.

In general, 50~100L of seawater was needed to determine environmental level of strontium or plutonium in seawater. Casauberta (2013) reported that Sr-90 concentrations were increased by 80 times rather than background levels in Pacific oceans (1.2 Bq/m3) after the accident. At the emergency, 10L of seawater is enough to estimate the impact of the accident. We developed the rapid separation method of Sr and Pu in 1L of seawater and applied it for 10L of seawater. Co-precipitation and extraction chromatography (TEVA, Sr-resin) were used for preconcentration and chemical purification of target radionuclides. And precipitates were dissolved in 8M HNO3, and passed through TEVA resin and Sr-resin, in order. TEVA resin does not hold Sr in the 8M HNO3 medium, while Pu shows maximum uptake. A modular automated radionuclide separator (MARS) developed by our laboratory was applied for purification of Pu and Sr-90. Automated approaches show high potential applicability in emergency preparedness in terms of reducing labor, costs, worker exposure and high throughput. For 1L of seawater, yield of Sr and Pu is 90% and 82%, respectively and finished within 3hrs. The separation of Pu and Sr-90 in 10L of seawater was finished within 10 hrs and yield of Sr and Pu was 60% and 55.2%, respectively.

References:

Casacuberta et al. 90Sr and 89Sr in seawater off Japan as a consequence of the Fukushima Dai-ichi nuclear accident, Biogeoscinece, 2013, 10, 3649-3659.

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