Rapid Determination of Actinides and $^{210}$Po in Water

**Summary of Method**  A method for the measurement of $^{210}$Po and actinides in terrestrial water samples is described, offering significant advantages in detection limit, processing time, and resistance to chemical and radiochemical interferences over standard methods where polonium is determined following spontaneous deposition onto metal planchets. $^{210}$Po and actinides are concentrated from up to 1L samples of ground water or 2L samples of drinking water using a calcium phosphate precipitate. $^{210}$Po and actinides are then separated from matrix ions and potentially interfering radionuclides using stacked 2mL cartridge of Eichrom TRU and DGA Resin. $^{210}$Po and actinides are measured using alpha spectrometry following bismuth phosphate and cerium fluoride microprecipitation, respectively, onto Eichrom Resolve® Filters. Tracer recoveries averaged $81.5 \pm 2.6\%$ for $^{209}$Po, $93.4 \pm 6.8\%$ for $^{242}$Pu, $100.2 \pm 6.9\%$ for $^{243}$Am and $96.6 \pm 2.5$ for $^{232}$U. Measured values typically agreed to within 3-5% of reference values. A single operator can prepare batches of 12-24 samples for alpha counting in 4-6 hours. Alpha spectrometry count times will vary depending on desired detection limit and data quality objectives.

**Reagents**
- TRU Resin, 2mL Cartridges (Eichrom TR-R50-S)
- DGA Resin, 2mL Cartridges (Eichrom DN-R50-S)
- Ammonium Hydroxide (Listed as 28% NH₃ or 56% NH₄OH)
- $^{209}$Po, $^{232}$U, $^{243}$Am, $^{242}$Pu tracers
- Bi and Ce carriers (1mg/mL)
- Nitric Acid (70%)
- Hydrochloric Acid (37%)
- Hydrofluoric Acid (49%)
- Hydrogen Peroxide (30%)
- Deionized Water
- $^{1.25M}$ Ca(NO₃)₂
- $^{3M}$ (NH₄)₂HPO₄
- $^{10\% (w:w)}$ TiCl₃
- Denatured Ethanol
- Oxalic acid/Ammonium Oxalate

**Equipment**
- Vacuum Box (Eichrom AR-24-BOX or AR-12-BOX)
- Cartridge Reservoir, 20mL (Eichrom AR-200-RV20)
- Inner Support Tubes-PE (Eichrom AR-1000-TUBE-PE)
- Yellow Outer Tips (Eichrom AR-1000-OT)
- Resolve Filters in Funnel (Eichrom RF-DF25-25PP01)
- 50mL and 250mL Centrifuge Tubes
- Centrifuge
- Alpha Spectrometry System
- Analytical Balance
- Vacuum Pump
- Heat Lamp
- Stainless steel planchets (1.25 inch) with adhesive tape

**Figure 1. Sample Preparation**

1-2L Water Sample.  
Add tracers.  
Add 1-2mL of 30% H₂O₂.  
Add 1mL 1.25M Ca(NO₃)₂ and 3mL 3.2M (NH₄)₂HPO₄. Mix Well.  
Adjust to pH 9 with NH₄OH. Mix. Allow precipitate to settle. Decant supernate to <200mL.  
Transfer remaining supernate and precipitate to 250mL centrifuge tubes. Centrifuge 3500rpm for 10 minutes. Decant supernate.  
Dissolve precipitate in 10mL 8M HNO₃, 3mL 2M Al(NO₃)₃, and 100uL 30% H₂O₂.  
Load Solution for resin separation.
References


Method Performance: 210Po and Actinides in Water

<table>
<thead>
<tr>
<th>Analyte</th>
<th>Tracer</th>
<th>% Recovery of tracer</th>
<th>Analyte (mBq/L)</th>
<th>Analyte (mBq/L)</th>
<th>% Bias</th>
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<tbody>
<tr>
<td>210Po</td>
<td>209Po</td>
<td>81.5 ± 2.6</td>
<td>Reference</td>
<td>Measured</td>
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<tr>
<td>238Pu</td>
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<td>93.4 ± 6.8</td>
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<td>381 ± 4</td>
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<td>241Am</td>
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<td>100.2 ± 6.9</td>
<td>370</td>
<td>381 ± 3</td>
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<td>243Am</td>
<td>100.2 ± 6.9</td>
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<tr>
<td>238U</td>
<td>232U</td>
<td>96.6 ± 2.5</td>
<td>655</td>
<td>627 ± 4</td>
<td>-4.4</td>
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200mL ground water samples, 6 replicates
8-16 hour count time