Rapid Determination of $^{210}\text{Po}$ in Water Samples

**Summary of Method** A method for the measurement of $^{210}\text{Po}$ 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. $^{210}\text{Po}$ is concentrated from up to 1L samples of ground water or 2L samples of drinking water using a calcium phosphate precipitate. $^{210}\text{Po}$ is then separated from matrix ions and potentially interfering radionuclides using a 2mL cartridge of Eichrom DGA Resin. $^{210}\text{Po}$ is measured using alpha spectrometry following bismuth phosphate microprecipitation onto an Eichrom Resolve® Filter. Chemical recoveries of polonium, determined with a $^{209}\text{Po}$ tracer, were typically 80-90%. $^{210}\text{Po}$ measurements typically agreed to reference values to within 3-5%. A single operator can prepare batches of 12-24 samples for alpha counting in 3-4 hours. Alpha spectrometry count times will vary depending on desired detection limit and data quality objectives. Polonium determination may also be integrated into methods for the determination of actinides (Eichrom Application Note AN-1416).

**Reagents**
- DGA Resin, 2mL Cartridges (Eichrom DN-R50-S)
- Nitric Acid (70%)
- Hydrochloric Acid (37%)
- Ammonium Hydroxide (listed as 28% NH₃ or 56% NH₄OH)
- Hydrogen Peroxide (30%)
- Deionized Water
- 1.25M Ca(NO₃)₂
- 3.2M (NH₄)₂HPO₄
- $^{209}\text{Po}$ tracer
- Bi standard solution (1mg/mL)
- Denatured Ethanol

**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
- Stainless steel planchets (1.25 inch) with adhesive tape
- Heat Lamp

**Figure 1. Sample Preparation**

1. 1-2L Water Sample.
   - Add $^{209}\text{Po}$ tracer.
   - Add 1-2mL of 30% H₂O₂.

2. Add 1mL 1.25M Ca(NO₃)₂ and
   - 3mL 3.2M (NH₄)₂HPO₄. Mix Well.
   - Adjust to pH 9 with 56% NH₄OH. Mix.
   - Allow precipitate to settle.
   - Decant supernate to <200mL.

3. Transfer remaining supernate and precipitate to 250mL centrifuge tubes. Centrifuge 3500rpm for 10 minutes. Decant supernate.

4. Dissolve precipitate in 10mL 9M HCl.

5. Transfer to 50mL centrifuge tube.
   - Rinse 250mL tube with 10mL 2M HCl.
   - Transfer tube rinse to same 50mL centrifuge tube.

6. Load Solution for Po separation.
(1) Precondition DGA Resin with 5mL 2M HCl.
(2) Load $^{210}$Po sample at 1-2mL/min.
(3) Rinse sample tube with 5mL 2M HCl.
(4) Add tube rinse to DGA Resin. Elute at 1-2mL/min.
(5) Rinse DGA Resin sequentially with:
- 5mL 2M HCl
- 15mL 0.25M HCl
- 5mL 6M HNO$_3$
(6) Dispose of (1) to (5) as waste.
(7) Strip Po with 15mL 0.05M HNO$_3$ at 1mL/min.

(8) To polonium sample:
- Add 125ug Bi carrier.
- Add 0.1mL 30% H$_2$O$_2$.
- 0.75mL 3.2M (NH$_4$)$_2$HPO$_4$.
  - Mix well.
- Add 200uL 56% NH$_3$OH.
  - Mix well. Wait 15-20 minutes.

(9) Set up Resolve$^\text{®}$ Filter Funnel on vacuum box.
(10) Wet filter with 3mL 80% ethanol followed by 3mL DI water.
(11) Filter sample.
(12) Rinse sample tube with 5mL DI water and add to filter.
(13) Rinse filter funnel with 3mL DI water.
(14) Rinse filter funnel with 1-2mL 100% ethanol.
(15) Draw vacuum until filter is dry.
(16) Remove filter from funnel assembly and mount filter on stainless steel planchet with adhesive tape.
(17) Dry filter under heat lamp for 3-5 minutes.
(18) Measure $^{210}$Po and $^{209}$Po tracer by alpha spectrometry.

### Method Performance $^{210}$Po in Water

<table>
<thead>
<tr>
<th>Sample</th>
<th>Volume mL</th>
<th>Replicates</th>
<th>$^{209}$Po tracer</th>
<th>$^{210}$Po (mBq/L) Reference</th>
<th>$^{210}$Po (mBq/L) Measured</th>
<th>% Bias</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ground Water</td>
<td>200</td>
<td>6</td>
<td>87.4 ± 5.8</td>
<td>316</td>
<td>308 ± 5</td>
<td>-2.5</td>
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<tr>
<td>Ground Water</td>
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<td>7</td>
<td>82.3 ± 3.9</td>
<td>1262</td>
<td>1289 ± 6</td>
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<tr>
<td>Ground Water</td>
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<td>6</td>
<td>85.0 ± 8.2</td>
<td>63.3</td>
<td>61.5 ± 5.1</td>
<td>-2.8</td>
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<td>Drinking Water</td>
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<td>80.0 ± 9.6</td>
<td>63.3</td>
<td>61.1 ± 6.2</td>
<td>-3.5</td>
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</tbody>
</table>

6-12 hour count time

### References