

Rapid Determination of ^{210}Po in Water Samples

Summary of Method A method for the measurement of ^{210}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}Po is concentrated from up to 1L samples of ground water or 2L samples of drinking water using a calcium phosphate precipitate. ^{210}Po is then separated from matrix ions and potentially interfering radionuclides using a 2mL cartridge of Eichrom DGA Resin. ^{210}Po is measured using alpha spectrometry following bismuth phosphate microprecipitation onto an Eichrom Resolve® Filter. Chemical recoveries of polonium, determined with a ^{209}Po tracer, were typically 80-90%. ^{210}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% NH_3 or 56% NH_4OH)
 Hydrogen Peroxide (30%)
 Deionized Water
 1.25M $\text{Ca}(\text{NO}_3)_2$
 3.2M $(\text{NH}_4)_2\text{HPO}_4$
 ^{209}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

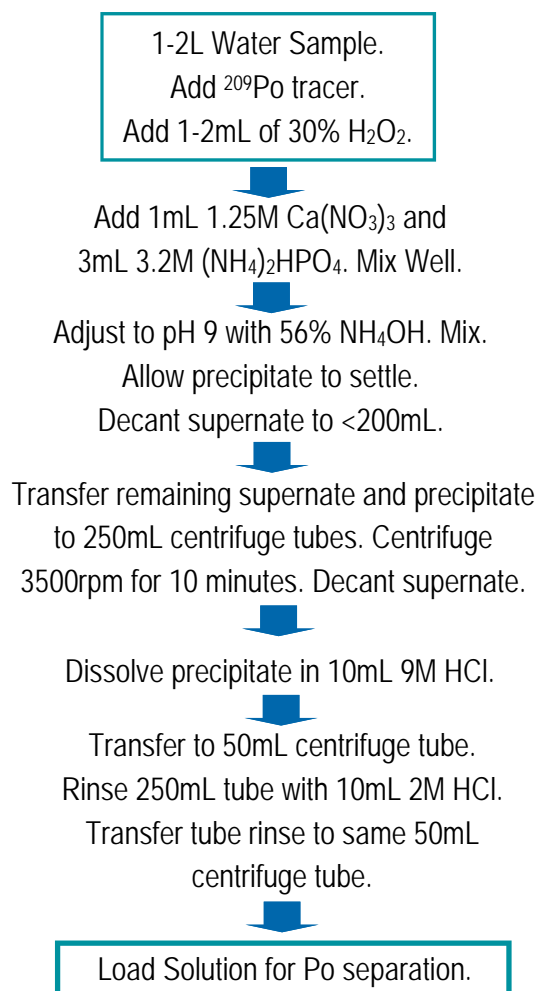


Figure 2. Polonium Separation on DGA and BiPO₄ Microprecipitation

(1) Precondition DGA Resin with 5mL 2M HCl.

(2) Load ²¹⁰Po 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 HNO₃

(6) Dispose of (1) to (5) as waste.

(7) Strip Po with 15mL 0.05M HNO₃ at 1mL/min.

(8) To polonium sample:

- Add 125ug Bi carrier.
- Add 0.1mL 30% H₂O₂.
- 0.75mL 3.2M (NH₄)₂HPO₄.
- Mix well.
- Add 200uL 56% NH₄OH.
- Mix well. Wait 15-20 minutes.

(9) Set up Resolve® 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.

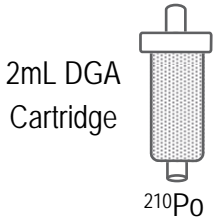
(14) Rinse filter funnel with 1-2mL 100% ethanol.

(15) Draw vacuum until filter is dry.

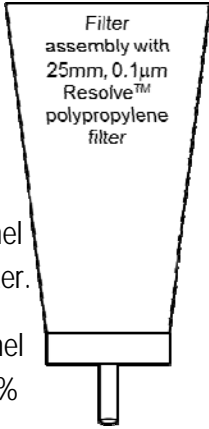
(16) Remove filter from funnel assembly and mount filter on stainless steel planchet with adhesive tape.

(17) Dry filter under heat lamp for 3-5 minutes.

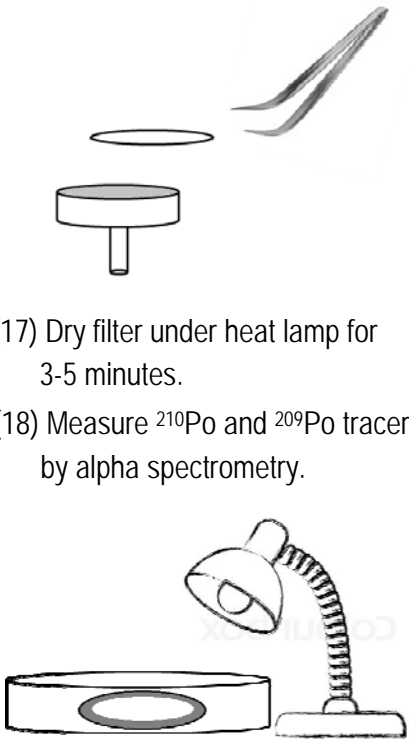
(18) Measure ²¹⁰Po and ²⁰⁹Po tracer by alpha spectrometry.



2mL DGA Cartridge
²¹⁰Po



Filter assembly with 25mm, 0.1µm Resolve™ polypropylene filter



Method Performance ²¹⁰Po in Water

Sample	Volume mL	Replicates	% Recovery		²¹⁰ Po (mBq/L)	²¹⁰ Po (mBq/L)	% Bias
			²⁰⁹ Po tracer	Reference	Measured		
Ground Water	200	6	87.4 ± 5.8	316	308 ± 5	-2.5	
Ground Water	200	7	82.3 ± 3.9	1262	1289 ± 6	2.1	
Ground Water	1000	6	85.0 ± 8.2	63.3	61.5 ± 5.1	-2.8	
Drinking Water	2000	4	80.0 ± 9.6	63.3	61.1 ± 6.2	-3.5	

6-12 hour count time

References

1) Sherrod L. Maxwell, Brian K. Culligan, Jay B. Hutchinson, Robin C. Utsey, Daniel R. McAlister, "Rapid determination of ²¹⁰Po in water samples," *J. Radioanal. Nucl. Chem.*, 298(3), 1977-1989 (2014).