

# Determination of $^{225}\text{Ac}$ in Water Samples

**Summary of Method**  $^{225}\text{Ac}$  ( $t_{1/2} = 10$  days) is preconcentrated from up to 1L of water sample using a ferric hydroxide precipitation. Following dissolution in 4M HCl,  $^{225}\text{Ac}$  is separated from radiometric impurities using 2mL cartridges of TRU and DGA, Normal resin.  $^{225}\text{Ac}$  is prepared for measurement using a  $\text{LaF}_3$  or  $\text{CeF}_3$  microprecipitation onto Resolve<sup>(R)</sup> Filters.

Chemical recovery of actinium can be traced using  $^{227}\text{Ac}$  (alpha spectrometry) or stable La (ICP-MS or ICP-AES).  $^{225}\text{Ac}$  may be measured by alpha spectrometry (5.54-5.83 MeV) or gamma spectrometry (via its  $^{221}\text{Fr}$  daughter, 218 keV, 11.44%).

The alpha emission from  $^{227}\text{Ac}$  tracer (4.71-4.90 MeV) only occurs in 1.38% of decays. Therefore, use of  $^{227}\text{Ac}$  tracer may be more efficient by measuring its  $^{227}\text{Th}$  (5.59-6.04 MeV) or  $^{223}\text{Ra}$  (5.24-5.87 MeV) daughters after a period of ingrowth and decay of  $^{225}\text{Ac}$ .

The mass of La that can be added to use a yield tracer must be minimized (55  $\mu\text{g}$ ) to prevent degradation of the alpha spectra through self-absorption. However, this amount of La should be sufficient to measure via ICP-MS or

## Reagents

DGA Resin, 2 mL Cartridges (Eichrom DN-R50-S)  
 TRU Resin, 2 mL cartridges (Eichrom TR-R50-S)  
 Iron Carrier (50 mg/mL Fe, as ferric nitrate)  
 Cerium Carrier (10 mg/mL)  
 $^{227}\text{Ac}$  tracer or Lanthanum Carrier (10 mg/mL)  
 Hydrofluoric Acid (49%) or Sodium Fluoride  
 Nitric Acid (70%)  
 Hydrochloric Acid (37%)  
 Sodium Hydroxide  
 Deionized Water  
 $\text{H}_2\text{O}_2$  (30%)

## Equipment

Vacuum Box (Eichrom AR-24-BOX or AR-12-BOX)  
 Cartridge Reservoir, 20 mL (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)  
 50 mL and 250 mL Centrifuge Tubes  
 Alpha Spectrometry System  
 Centrifuge  
 Vacuum Pump  
 Heat Lamp  
 Analytical Balance  
 Hot Plate  
 1L Glass beakers  
 pH meter or pH strips or pH indicator (pH 8-9)

## Sample Preparation

Up to 1L Sample

Aliquot Sample. Add tracer ( $^{227}\text{Ac}$  or 55  $\mu\text{g}$  La) and 25 mg of Fe carrier.

Heat sample to 80°C and mix well to equilibrate sample and tracer.

Adjust pH to 8-9 with NaOH.

Cool sample and allow ppt to settle.

Decant supernate to ~200 mL.

Transfer sample to 250 mL centrifuge tube.

Centrifuge 2500 rpm for 10 minutes.  
 Decant Supernate.

Rinse ppt with 50 mL water. Centrifuge.  
 Decant Supernate.

Dissolve precipitate with 10mL conc.  $\text{HNO}_3$ .  
 Dilute to 25 mL.

## Ac Separation on TRU-DGA

(1) Precondition 2mL TRU and DGA with 10mL 6M HNO<sub>3</sub>.

(2) Load sample solution.

(3) Rinse sample tube with 5mL 6M HNO<sub>3</sub>. Add tube rinse to TRU-DGA.

(4) Rinse TRU-DGA with 10mL 3M HNO<sub>3</sub>.

(5) Rinse TRU-DGA with 15mL 2M HCl (transfers La/Ac to DGA).

(6) Discard TRU. Rinse DGA with 20mL 0.5M HNO<sub>3</sub>.

(7) Strip Ac from DGA with 20 mL 2M HCl. (2M HCl is used to achieve additional decontamination from Th.)

\*If using stable La as the yield tracer, remove 2 mL aliquot and dilute to 10 mL for recovery measurement by ICP-MS or ICP-AES.



(7) Add 0.5mL 30% H<sub>2</sub>O<sub>2</sub> to samples.

(8) Add 50ug Ce carrier\*\* to samples.

Mix well. Add 1mL 49% HF.

Mix well. Wait 15-20 minutes.

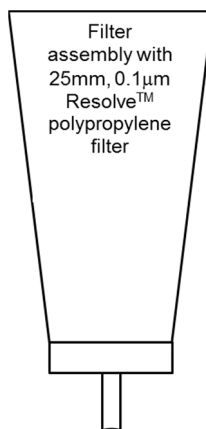
\*\*If stable La is used as the yield tracer, omit the addition of 50 ug of Ce. The La will serve as the carrier for the rare earth fluoride micro-ppt.

(9) Set up Resolve® Filter Funnel on vacuum box.

(10) Wet filter with 3mL 80% ethanol followed by 3mL DI water.

(11) Filter sample.

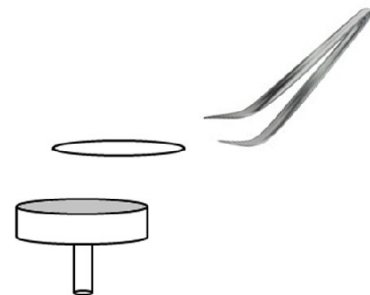
(12) Rinse sample tube with 5mL DI water and add to filter.



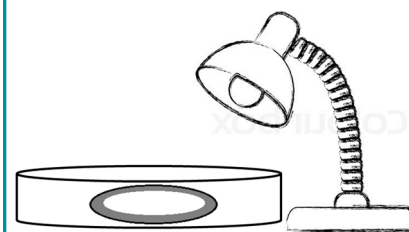
(13) Rinse filter funnel with 3mL DI water and 2mL 100% ethanol.

(14) Draw vacuum until filter is dry.

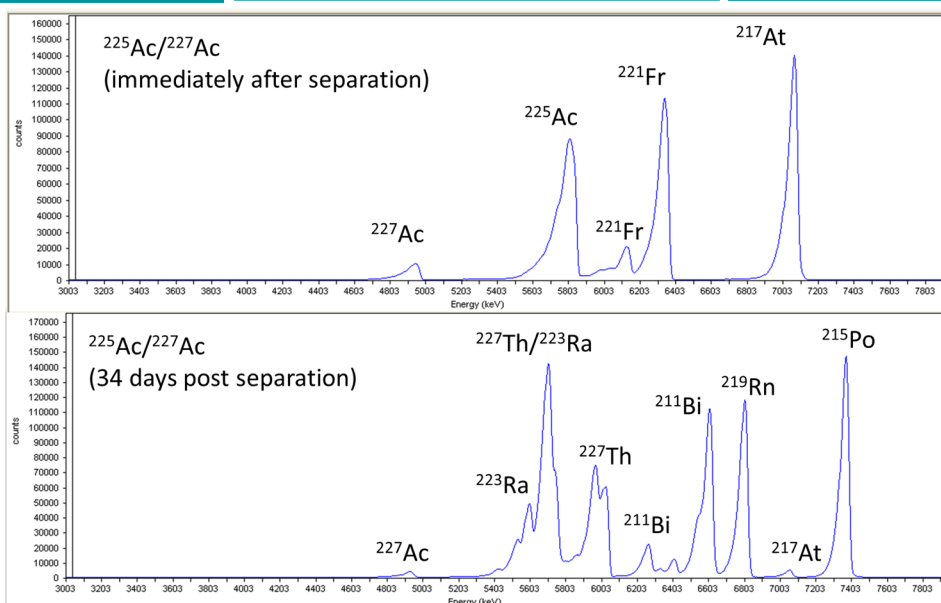
(15) Remove filter from funnel assembly and mount filter on stainless steel planchet with 2-sided tape.



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



(17) Measure actinides by alpha spectrometry.



### References

1) H. Dulaiova, K.W.W. Sims, M.A. Charette, J. Prytulak, J.S. Blusztajn "A new method for the determination of actinium-227 in geological samples," *J. Radioanal. Nucl. Chem.*, 296, 279-283 (2013).