

Determination of ^{227}Ac in Water Samples

Summary of Method ^{227}Ac is preconcentrated from up to 1L of water sample using a ferric hydroxide precipitation. Following dissolution in 4M HCl, ^{227}Ac is separated from radiometric impurities using a 2mL cartridge of DGA, Normal resin. ^{227}Ac is prepared for measurement using a CeF_3 microprecipitation onto Resolve^(R) Filters. An ^{225}Ac (^{229}Th) tracer is used to measure chemical recovery of actinium. After a 30 minute ingrowth time, the ^{225}Ac tracer yield is measured via alpha spectrometry. ^{227}Ac is measured via its ^{227}Th and ^{223}Ra daughters after a longer period of ingrowth (30-90 days). Actinium yields are typically 70-90%. MDA for ^{227}Ac was 0.05Bq/L for 3 day count times after 90 days ingrowth period.

Reagents

DGA Resin, 2mL Cartridges (Eichrom DN-R50-S)

Iron Carrier (50mg/mL Fe, as ferric nitrate)

Cerium Carrier (10mg/mL)

^{229}Th (^{225}Ac) tracer

Hydrofluoric Acid (49%) or Sodium Fluoride

Nitric Acid (70%)

Hydrochloric Acid (37%)

Sodium Hydroxide

Deionized Water

H_2O_2 (30%)

Optional for additional Th/U removal:

TRU Resin, 2mL cartridges (Eichrom TR-R50-S)

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

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 ^{229}Th (^{225}Ac) tracer 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 ~200mL.

Transfer sample to 250mL centrifuge tube.

Centrifuge 2500 rpm for 10 minutes.

Decant Supernate.

Rinse ppt with 50mL water. Centrifuge.

Decant Supernate.

Dissolve precipitate with 10mL conc. HCl.

Dilute to 30mL.

Ac Separation on DGA

(1) Precondition 2mL DGA with 10mL 4M HCl.*

(2) Load sample solution.

(3) Rinse sample tube with 5mL 4M HCl. Add tube rinse to DGA. (If TRU cartridge is used, remove following this step.)

(4) Rinse DGA with 10mL 3M HNO₃.

(5) Rinse DGA with 20mL 0.5M HNO₃.

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

*A 2mL cartridge of TRU resin may be added above DGA for additional decontamination from U/Th.

However, elution conditions should be modified as in AN-2101.



(7) Add 0.5mL 30% H₂O₂ to samples.

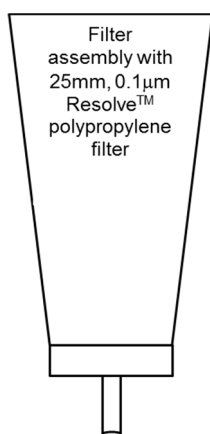
(8) Add 50ug Ce carrier to samples. Mix well. Add 1mL 49% HF. Mix well. Wait 15-20 minutes.

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

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

(11) Filter sample.

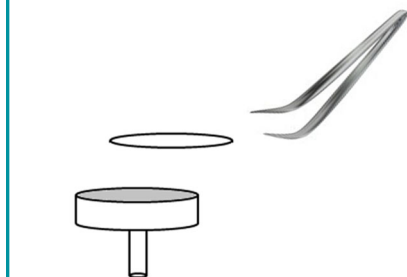
(12) Rinse sample tube with 5mL DI water and add to filter.



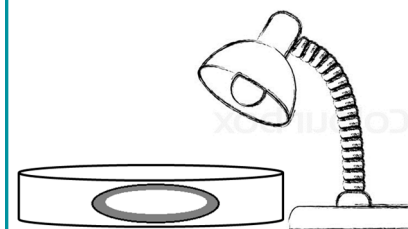
(13) Rinse filter funnel with 3mL DI water and 2mL 100% ethanol.

(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.

Method Performance

Water Standard	²²⁷ Ac	²²⁷ Ac	% Bias	Tracer Recovery
	Measured Bq/kg	Reference Bq/kg		
IAEA Standard	333 ± 16	329 ± 16	1.2	75

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).