

# Rapid Determination of Sr in 50g Soil Samples

**Summary of Method** Strontium is separated and concentrated from 50 gram soil samples. Soils are leached with concentrated nitric and hydrochloric acid. The leachate is evaporated to dryness, and the residue is dissolved in 1M HCl. A ferric hydroxide-calcium phosphate precipitate concentrates strontium and removes matrix components leached from the soil. A calcium fluoride precipitate further concentrates and purifies the strontium fraction. Strontium is separated from matrix impurities and potentially interfering radionuclides in the sample using two stacked 2mL cartridges of Eichrom Sr Resin. Radiostrontium is measured on a low background gas flow proportional counter. Average chemical recovery of strontium, determined by gravimetric yield of stable strontium carrier, is  $91 \pm 4\%$ . Measured values of  $^{90}\text{Sr}$  agreed to within 2% of reference values for 90 minute count times. The minimum detectable activity for  $^{90}\text{Sr}$  in 50g samples with 90 minute count times is 0.41Bq/g. A single operator can prepare batches of 12 samples for the measurement of  $^{90}\text{Sr}$  in less than 16 hours.

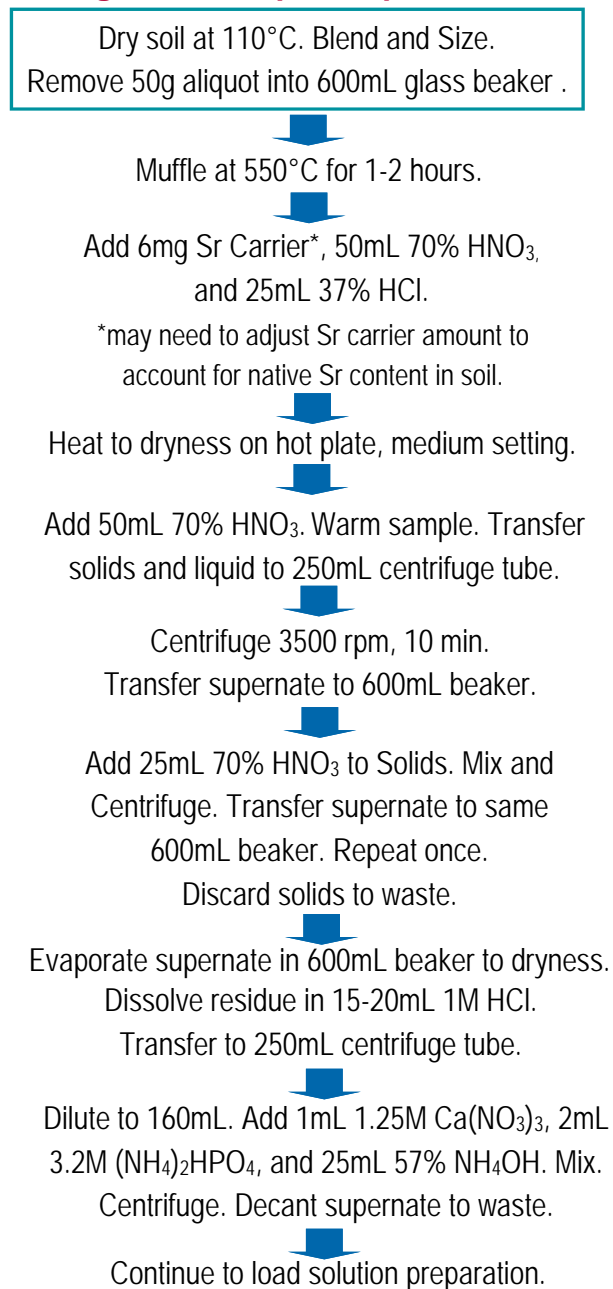
## Reagents

Sr Resin, 2mL Cartridges (Eichrom SR-R50-S)  
 Nitric Acid (70%)  
 Hydrochloric Acid (37%)  
 Hydrofluoric Acid (49%) or Sodium Fluoride  
 Ammonium Hydroxide (listed as 28%  $\text{NH}_3$  or 56%  $\text{NH}_4\text{OH}$ )  
 Deionized Water  
 1.25M  $\text{Ca}(\text{NO}_3)_2$   
 3.2M  $(\text{NH}_4)_2\text{HPO}_4$   
 Strontium Carrier (10mg/mL)  
 2M  $\text{Al}(\text{NO}_3)_3$   
 Sr-90 standard  
 Oxalic acid  
 Boric acid

## 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)  
 50mL and 250mL Centrifuge Tubes  
 Centrifuge  
 Cupped Stainless Steel Planchets (~5mL volume)  
 Gas Flow Proportional Counter  
 Muffle Furnace  
 Hot Plate  
 Analytical Balance  
 600mL Glass Beakers  
 Vacuum Pump

**Figure 1. Sample Preparation**



## Figure 2. Load Solution Preparation and Strontium Separation

Dissolve residue in 40mL 1.5M HCl.  
Dilute to 170mL with H<sub>2</sub>O.  
Add 25mL 49% HF.

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Mix well. Centrifuge 10 min.


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Discard Supernate.  
Dissolve residue in 7mL 70% HNO<sub>3</sub>,  
7mL 3M HNO<sub>3</sub>-0.25M Boric Acid,  
7mL 2M Al(NO<sub>3</sub>)<sub>3</sub>.

Gas Flow Proportional Counting\*:

(8) Evaporate samples to dryness on tared cupped stainless steel planchets.

(9) Rinse Sr sample vials with 2mL 0.05M HNO<sub>3</sub>. Transfer vial rinse to planchets. Evaporate to dryness.



(10) Weigh planchets on an analytical balance to determine gravimetric yield of stable Sr(NO<sub>3</sub>)<sub>2</sub>.

(11) Measure radiostrontium in samples on low background gas flow proportional counter.

\*(Options for <sup>89/90</sup>Sr Discrimination)

(a) Sr fraction from step (7) can be transferred to a liquid scintillation vial. <sup>89/90</sup>Sr can be measured by Cerenkov counting (no LSC cocktail). <sup>89/90</sup>Sr can then be measured by adding liquid scintillation cocktail.

(b) Sr fraction from step (10) can be dissolved in 10mL 8M HNO<sub>3</sub> after >7 days of <sup>90</sup>Y ingrowth. <sup>89/90</sup>Sr can be removed on Sr Resin. <sup>90</sup>Y will elute in Sr Resin load and can be counted by liquid scintillation or gas flow proportional counting.

(1) Precondition Sr Resin with 10mL 8M HNO<sub>3</sub>.

(2) Load sample.

(3) Rinse sample tube with 5mL 8M HNO<sub>3</sub>.

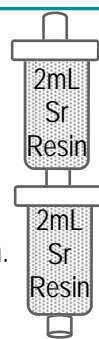
(4) Add tube rinse to Sr Resin.

(5) Rinse Sr Resin sequentially with:

- 15 mL 8M HNO<sub>3</sub>
- 10mL 3M HNO<sub>3</sub> - 0.05 oxalic acid
- 10mL 8M HNO<sub>3</sub>

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

(7) Strip Sr with 18mL 0.05M HNO<sub>3</sub>.



### Method Performance for 50g Soils Spiked with <sup>90</sup>Sr

Sample replicates	<sup>90</sup> Sr Reference Value (mBq/g)	<sup>90</sup> Sr Measured Value (mBq/g)	% Bias	Sr Carrier % Yield
7	5.92	5.95 ± 0.22	5.0	94.0 ± 2.6
7	11.8	11.5 ± 0.7	-2.5	89.6 ± 2.7
7	59.2	57.8 ± 1.7	-2.4	89.3 ± 4.7

MDA <sup>90</sup>Sr, 90 minute count, 50g Soil = 0.41 mBq/g

## References

1) Sherrod L. Maxwell, Brian K. Culligan, Patrick J. Shaw "Rapid determination of radiostrontium in large soil samples," *J. Radioanal. Nucl. Chem.*, 295(2), 965-971 (2013).