AN-1404-10

Rapid Determination of Sr in 1-2 Liter Seawater Samples

Summary of Method Strontium is separated and concentrated from 1-2L samples of seawater with a calcium phosphate precipitation, enhanced with 200mg of iron. 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 or liquid scintillation counter. Chemical yield of strontium is determined by gravimetric recovery of native stable strontium in the seawater or by ICP-AES measurement. Average chemical recovery of strontium is 89 ± 5% for 1L samples and 82 ± 4% for 2L samples. Measured values of ^{90}Sr agreed to within 1% and 4% of reference values, for 1L and 2L, respectively, with two hour count times. The minimum detectable activity for ^{90}Sr for 2L samples with a two hour count time is 9.1Bq/L. A single operator can prepare batches of 12-24 samples for measurement of radiostrontium in less than 8 hours.

Reagents

Sr Resin, 2mL Cartridges (Eichrom SR-R50-S)
Nitric Acid (70%)
Ammonium Hydroxide (listed as 28% NH_3 or 56% NH_4OH)
Deionized Water
Iron Carrier (50mg/mL Fe, as ferric nitrate)
3.2M $(NH_4)_2HPO_4$
2M $Al(NO_3)_3$
^{90}Sr standard
Oxalic 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 Centrifuge Tubes
250-500mL Centrifuge Tubes
Centrifuge
Cupped Stainless Steel Planchets (~5mL volume)
Gas Flow Proportional Counter
Hot Plate
Analytical Balance
Vacuum Pump

Figure 1. Sample Preparation

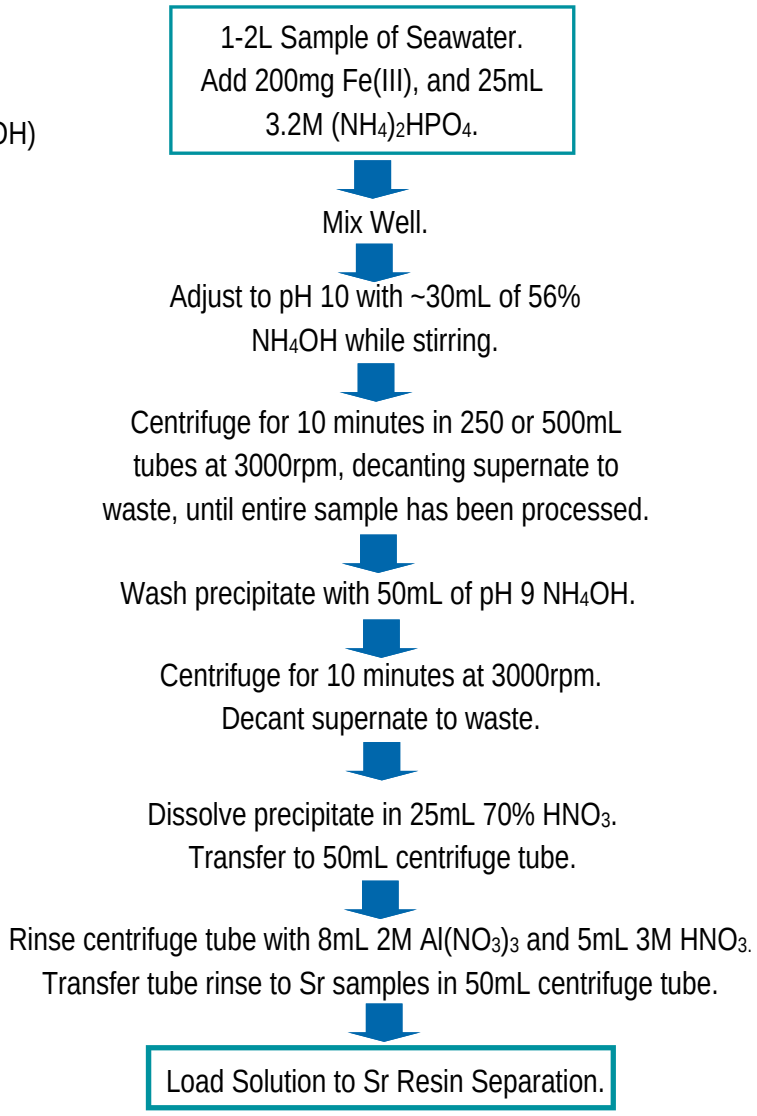


Figure 2. Strontium Resin Separation (Optional ^{90}Y Ingrowth)

(1) Precondition Sr Resin with 10mL 8M HNO_3.
(2) Load sample at 1-2mL/min.
(3) Rinse sample tube with 5mL 8M HNO_3.
(4) Add tube rinse to Sr Resin. Elute at 1-2mL/min.
(5) Rinse Sr Resin sequentially with:
- 15 mL 8M HNO_3
- 10mL 3M HNO_3 - 0.05 oxalic acid
- 10mL 8M HNO_3

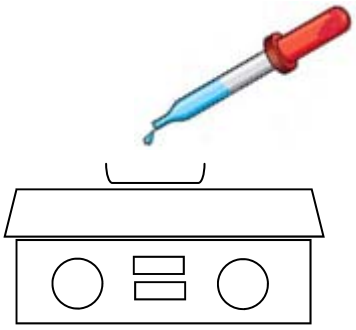
(6) Dispose of (1) to (5) as waste.
(7) Strip Sr with 20mL 0.05M HNO_3 at 1mL/min.

2 x 2mL Sr Resin Cartridges

^{90}Sr

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_3. Transfer vial rinse to planchets. Evaporate to dryness.



(10) Weigh planchets on an analytical balance to determine gravimetric yield of stable $Sr(NO_3)_2$.

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

*(Options for $^{89/90}$Sr Discrimination)
(a) Sr fraction from step (7) can be transferred to a liquid scintillation vial. ^{89}Sr can be measured by Cerenkov counting (no LSC cocktail). $^{89/90}$Sr can then be measured by adding liquid scintillation cocktail.

(b) Sr fraction from step (10) can be dissolved in 10mL 8M HNO_3 after >7 days of ^{90}Y ingrowth. $^{89/90}$Sr can be removed on Sr Resin. ^{90}Y will elute in Sr Resin load and can be counted by liquid scintillation or gas flow proportional counting.

Performance of ^{90}Sr Method for 1L and 2L Seawater Samples

Sample Replicates	Sample Volume, L	^{90}Sr, Reference Value (mBq/L)	^{90}Sr, Measured Value (mBq/L)	% Bias	Sr carrier % Recovery
11	1	148	150 ± 11	1.2	89 ± 5
4	2	148	154 ± 5	4.2	82 ± 4

2 hour count times
MDA = 9.1 mBq/L for 2L sample

References

1) Sherrod L. Maxwell, Brian K. Culligan, Robin C. Utsey, "Rapid determination of radiostrontium in seawater samples," *J. Radioanal. Nucl. Chem., 298(2), 867-875* (2013).