Development of a Radiochemical Method for Determination of Strontium-90 in Soil/Sediment Samples Using Solvent Extraction and Cherenkov Radiation Detection

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THE STRONTIUM-90 CHALLENGE

Sr-90 is a high-risk radioactive isotope
long-lived fission product that decays by beta emission, significant environmental concern due to radiotoxicity.

Major Sources

- Nuclear weapons testing 1950 - 1960
- Nuclear accidents Chernobyl : 1986 Fukushima : 2011

Sr-90 Half life 28.8 years → Yittrium-90 Half life 64.08 hours → Stable Zirconium-90

Health concerns arise
from its chemical similarity to Ca, resulting in bone accumulation and increased risks of **bone cancer** and **leukemia**.

ANALYTICAL CHALLENGES

Chemical similarity between Sr and Ca
makes the separation and quantification of Sr-90 in difficulties of environmental samples.

Soil and sediment samples
present significant matrix interference, resulting in complex and challenging separation of Sr-90.

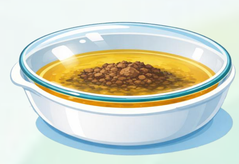
OBJECTIVES

To develop a radiochemical method for Sr-90 determination in soil and sediment samples.

To enhance Y-90 separation efficiency using chemical precipitation and solvent extraction.

METHODOLOGY

Sample pre-treatment
(Chemical precipitation)



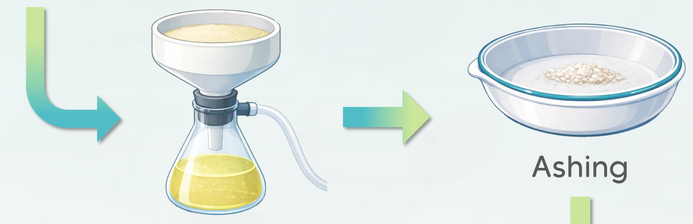
Add conc. HCl & Heat → Collect solution

Add Na_2CO_3
Adjust pH to 9 with NaOH & Heat
[Precipitation : $SrCO_3$ & $Y(OH)_3$]

Collect precipitate

Dissolve precipitate with conc. HCl

Add $H_2C_2O_4 \cdot 2H_2O$
Adjust pH to 4.0-4.2 with NH_4OH & Heat
[Precipitation : $YH(C_2O_4)_2$]

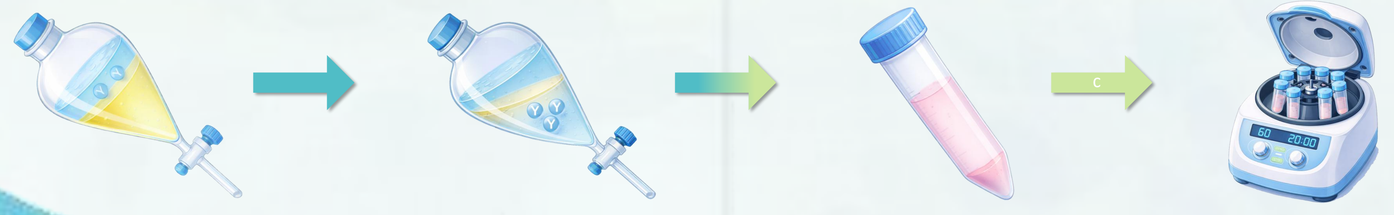


Collect precipitate → Ashing

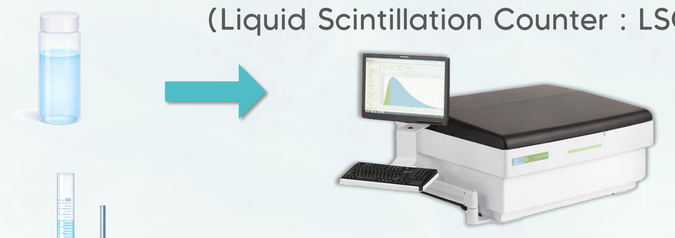
Acid leaching
& Collect the solution

Solvent extraction
(10% HDEHP in Toluene)

Extract with 10% HDEHP in Toluene → Back extract with 3 M HNO_3 → Collect solution & precipitate $Y(OH)_3$ → Centrifuge & Collect precipitate



Dissolve precipitate → **Cherenkov radiation Detection**
(Liquid Scintillation Counter : LSC)



Chemical yield Determination
Titration with 0.1 M Titriplex III
Indicator : Xylenolorange

RESULT & DISCUSSION

Without Chemical precipitation → %RECOVERY ~50%

With Chemical precipitation → %RECOVERY 107.7%

Determination of Sr-90 activity and percent recovery in different fraction steps.

Sample Fraction	Measured Activity (Bq/g)	Spiked Activity (Bq/g)	Recovery (%)
Residue	0.0020	0.101	2.4 ± 1.0
Solution after Na_2CO_3 precipitation	0.0002	0.101	0.2 ± 0.2
Solution after $H_2C_2O_4$ precipitation	0.0030	0.101	3.4 ± 0.2
Precipitate (Target)	0.1080	0.101	**107.7 ± 15.6**

The developed method provides improved analytical performance, allowing precise detection of Sr-90 even in matrices with high calcium content.

CONCLUSION

Cost-effective

Eco-friendly
(no scintillation cocktial)

High sensitivity

Enabling reliable environmental monitoring and radiochemical analysis

ACKNOWLEDGEMENTS

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ERM Environmental Radioactivity Monitoring Group Office of Atoms for Peace

STEC SCIENCE ILPAKORN UNIVERSITY

REFERENCE

Suomela, J., 1993 "Method for Determination of Strontium-90 in Food and Environmental Samples by Cerenkov Counting" Swedish Radiation Protection Institute, Stockholm.

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