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New development of Radium analysis in Water Samples using MNO₂ resin and alpha spectrometry

Aishah Alboloushi*, Omar Alboloushi ,

Kuwait Institute for Scientific Research

aboloushi@kisir.edu.kw

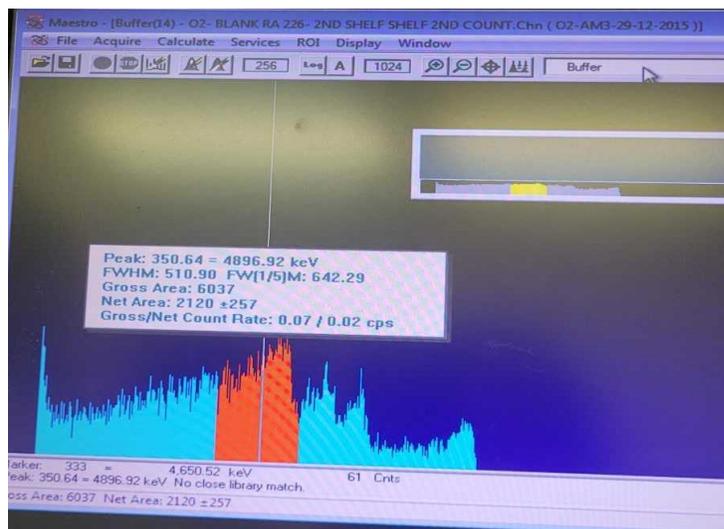
1. Background

- Radium-226 is a natural radioactive element produced by uranium and thorium decay chains in environment.
- 1,600 years half life, 4784 keV alpha energy, and 186.2 keV gamma energy.
- Radium is carcinogenic if a human is exposed for long time (lung and bone cancer).
- The need to develop a new optimized method with low detection limit compared to the routinely used gamma measurements, specially in case of nuclear emergencies.

2. Study Objective

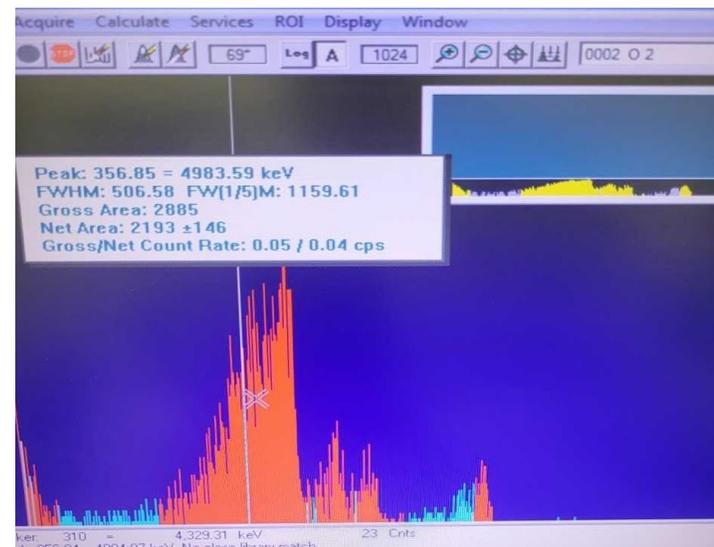
- Determination of ^{226}Ra in water samples by developing a time saving procedure.
- It will be helpful for the in the future for rapid monitoring purposes in case of any nuclear contamination/incidents (regional/global nuclear activities).

3.Challenges in optimization



(Radium-Barium sulfate precipitation)

The first set including 4 samples(three blanks spiked with radium 226+ 1 sample PT 2 50 ml) has been analyzed. However, a big noise was there in the spectra.



(IAEA/AQ/39)

Optimization has been done following One blank sample+rad226 has been prepared a. Good spectra obtained without a noise. the CR% was only 20 %.

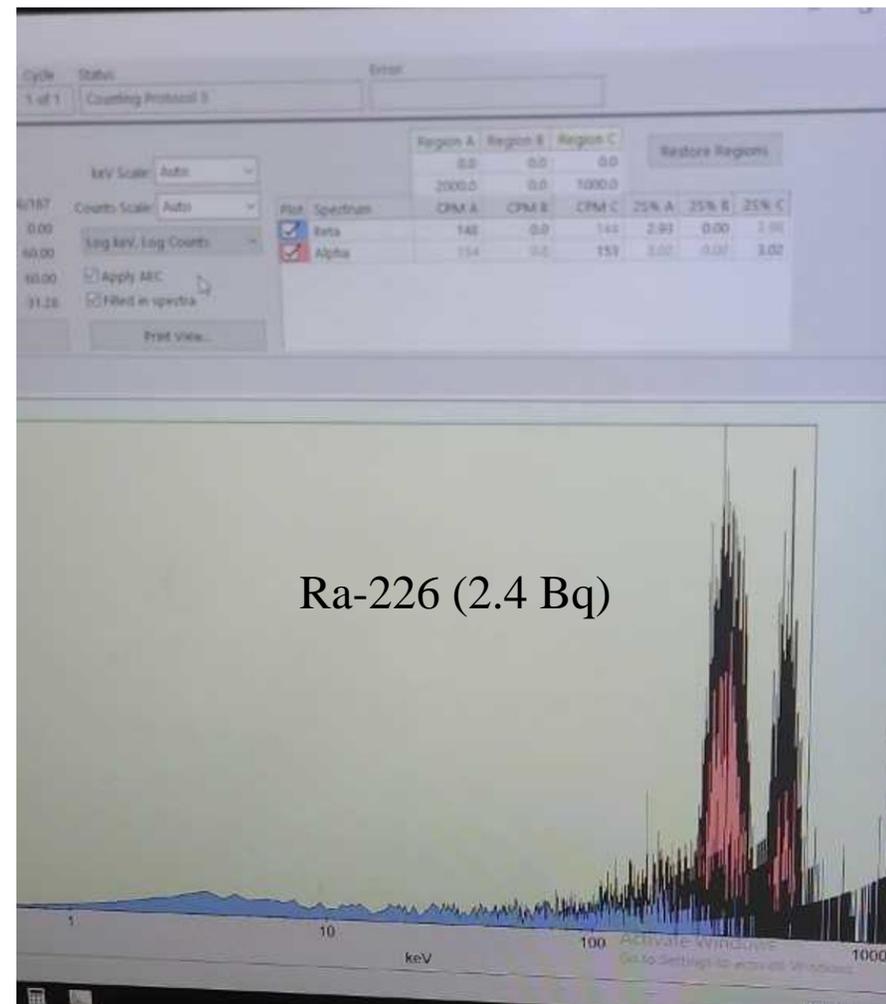
3. Challenges in optimization (Cont.)

Blank spike(2.4 Bq of Ra-226) LSC measurement.

Alpha peaks were detected.

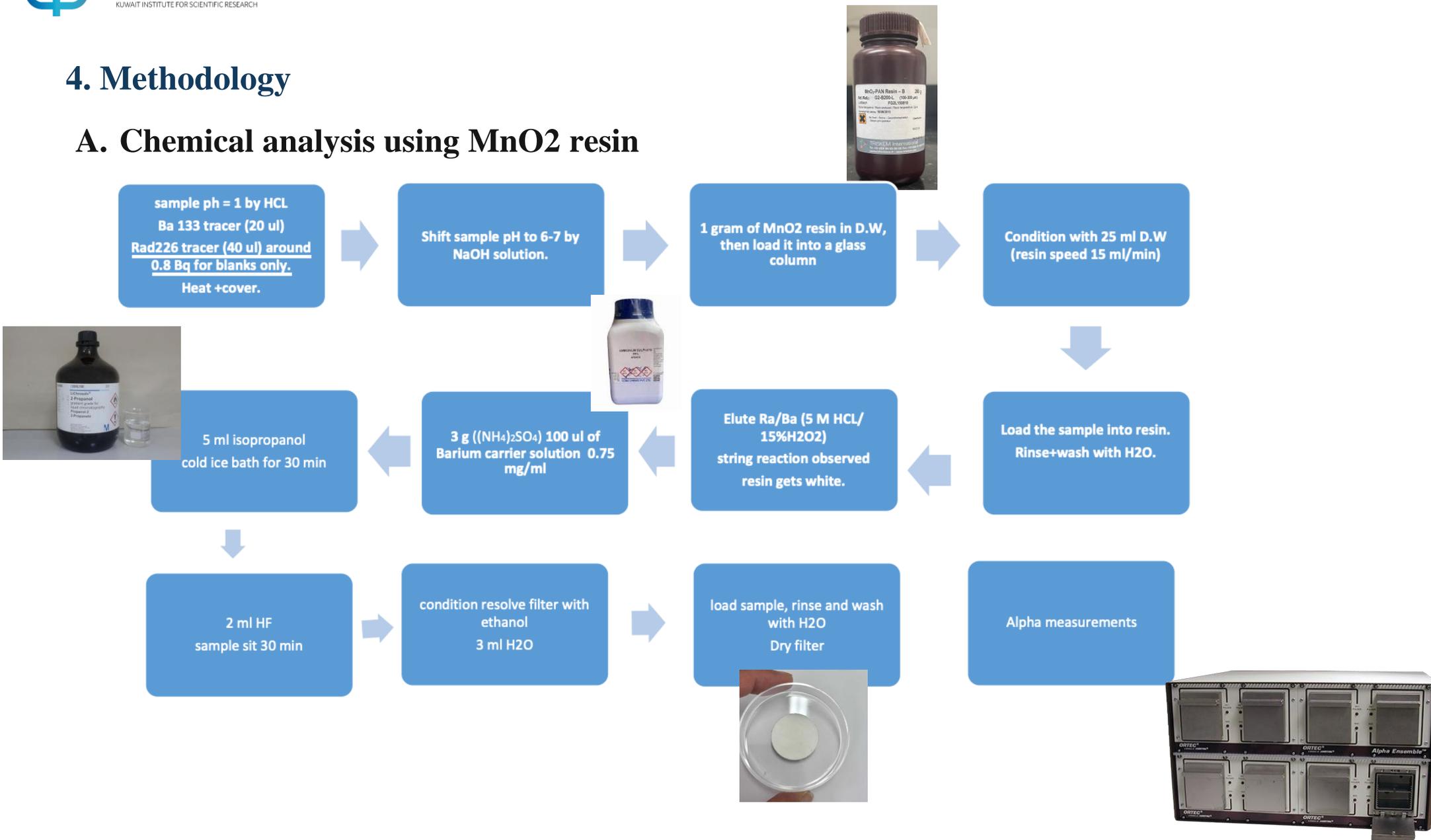
A repetitive sample has been analyzed (0.4 Bq), no alpha peaks detected due to LSC due high detection limit 1.5 Bq/l.

Thus, PT unknown samples that cannot be analyzed.



4. Methodology

A. Chemical analysis using MnO₂ resin



4. Methodology (cont)

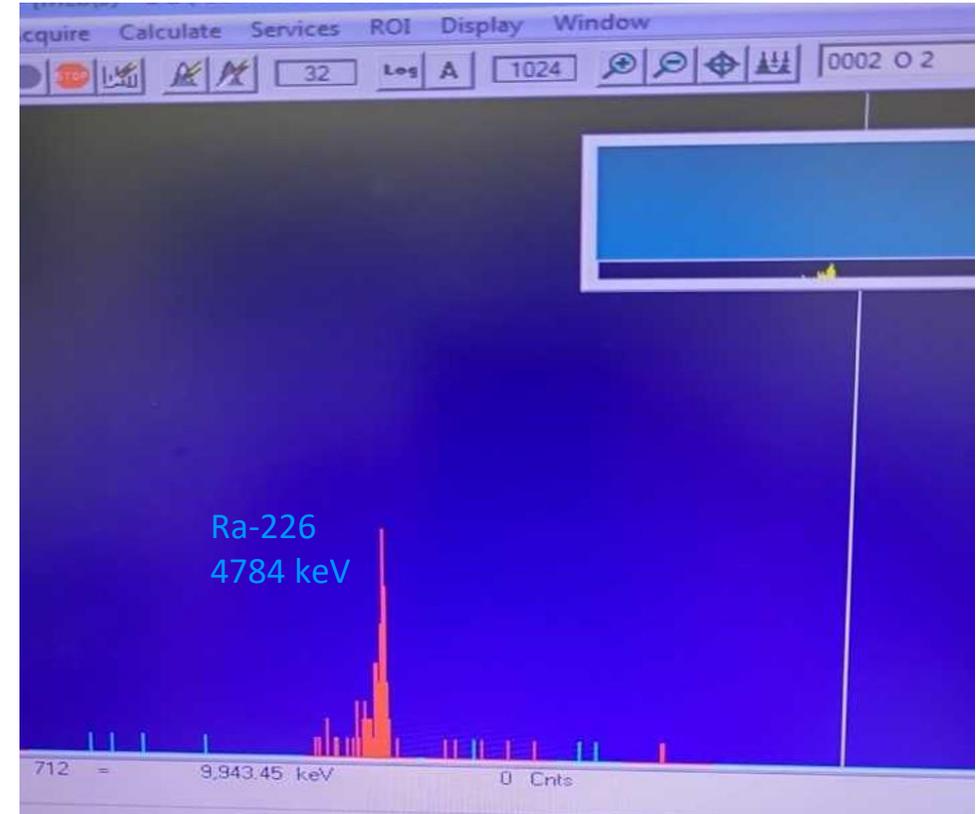
Optimization using MnO₂ resin

The Eichrom method implemented using MnO₂ specific resin for radium analysis.

0.75 Bq has been added to a blank sample.

95% CR.

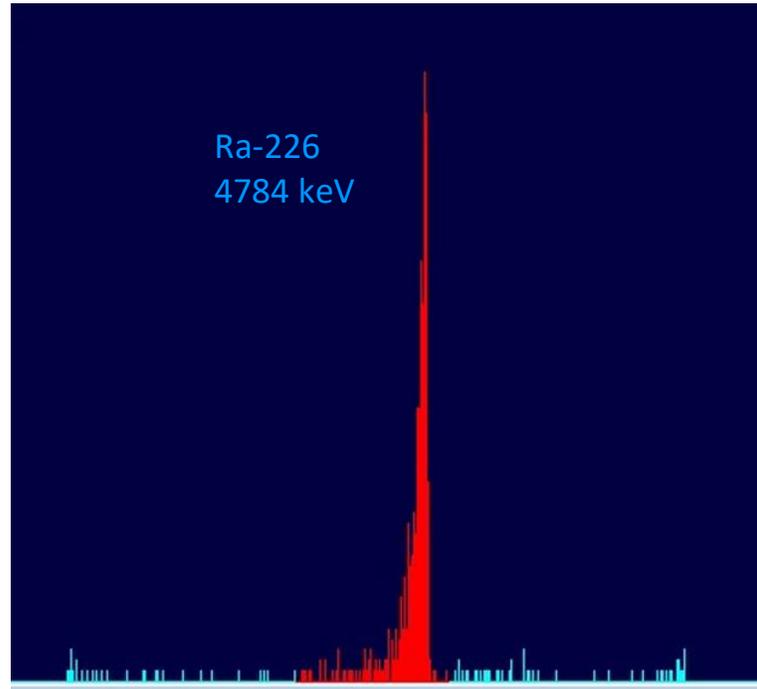
It was also followed for the PT 2 (2 duplicated samples).



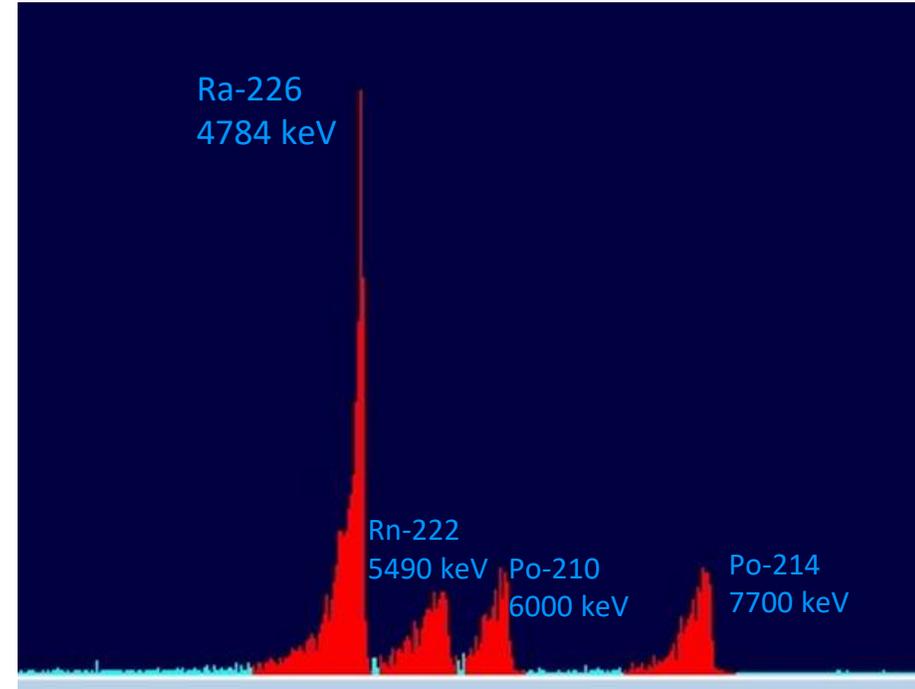
Blank spike

4. Methodology (cont)

Optimization using MnO₂ resin (Cont.)



Blank spike



PT 2 unknown sample

5. Quality Assurance

Evaluation Table for Sample 2

TABLE 4. Evaluation Results for Sample 2

Analyte	Technique	Reported value [Bq/kg]	Reported uncertainty ($k = 1$) [Bq/kg]	Relative bias [%]	P-Test [%]	Trueness evaluation	Precision evaluation	Final Score
Sb-125	gamma	72.81	1.7	-0.3	5.46	A	A	A
Cs-134	gamma	39.87	1.23	-0.3	5.88	A	A	A
Cs-137	gamma	44.31	2.25	0.5	7.12	A	A	A
Pb-210	gamma	5.07	1.32	-3.1	26.51	A	A	A
Pb-210	beta	5.38	1	2.9	19.24	A	A	A
Ra-226	alpha	7.34	0.5	16.1	8.49	A	A	A

5. Quality Assurance

Target Values for activity concentration of radionuclides in Sample 2

TABLE 3. Target values

Sample	Analyte	Technique	Target Value	Uncertainty ($k = 1$)	Unit	MARB [%]
2	Sr-90	beta	14.2	0.7	Bq/kg	30.00
2	Sb-125	gamma	73.0	3.6	Bq/kg	20.00
2	Cs-134	gamma	40.0	2.0	Bq/kg	20.00
2	Cs-137	gamma	44.1	2.2	Bq/kg	20.00
2	Pb-210	gamma	5.23	0.26	Bq/kg	30.00
2	Pb-210	beta	5.23	0.26	Bq/kg	30.00
2	Po-210	alpha	5.21	0.26	Bq/kg	30.00
2	Ra-226	alpha	6.32	0.32	Bq/kg	30.00
2	Ra-226	gamma	6.32	0.32	Bq/kg	30.00



Gamma measurements

VS

Weak emission probabilities of several potentially emission lines. and the relatively poor efficiency of HPGe detectors over a wide range of energy.

Difficulties in precisely calibrating the efficiency of the detector.

LSC measurements

VS

Quenching, poor energy resolution and relatively high background

Alpha measurements

High energy resolution and relatively low background
Low detection limit

5. Results and Discussion

- ^{226}Ra was successfully and competently assessed in the unknown PT sample, and it was found to be 7.34 ± 0.5 Bq/kg, whereas the certified reference value was 6.32 ± 0.32
- CR% for the procedure based on blank sample was found to be 95%.

5. Conclusion

The newly developed radium analysis procedure is more efficient for water samples than other radio-analytical techniques due to the low detection limit of alpha spectrometry compared to other techniques.