From Resins to Discs: **Towards Faster Radiochemical Determination of Se, Actinides, Ra, and Sr-90**

Inés Llopart, Steffen Happel, Alex Blanco, Irati Rubio, Naji Abdallah, Alex Tarancón

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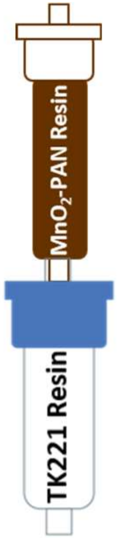
Expertise in Separation Chemistry

From Fast and Reproducible **Radiochemical Methods** to **Materials Development**

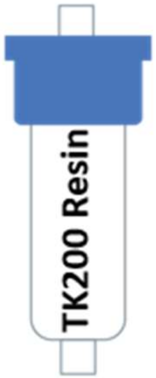
Commercially available

Under development

Ra determination



Actinides determination



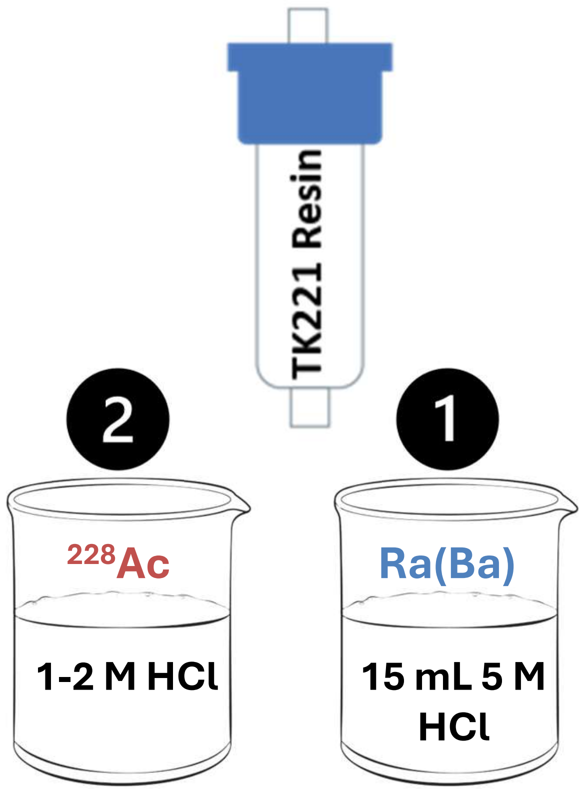
TK227 discs

SE Resin

Ra isotopes determination

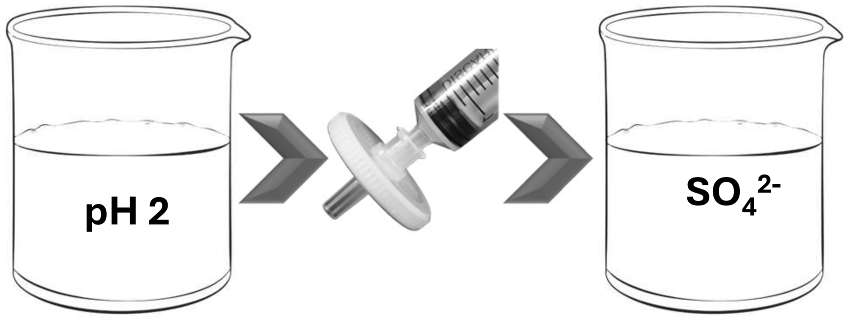
Preconcentration
(up to 1 L)

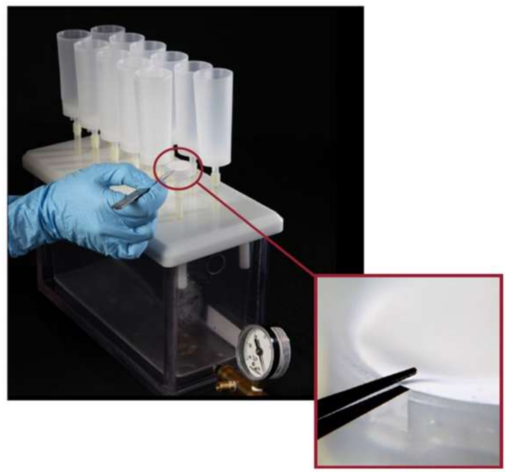
Interference removal
(actinides retention)



Based on Eichrom method RAW04 V1.0

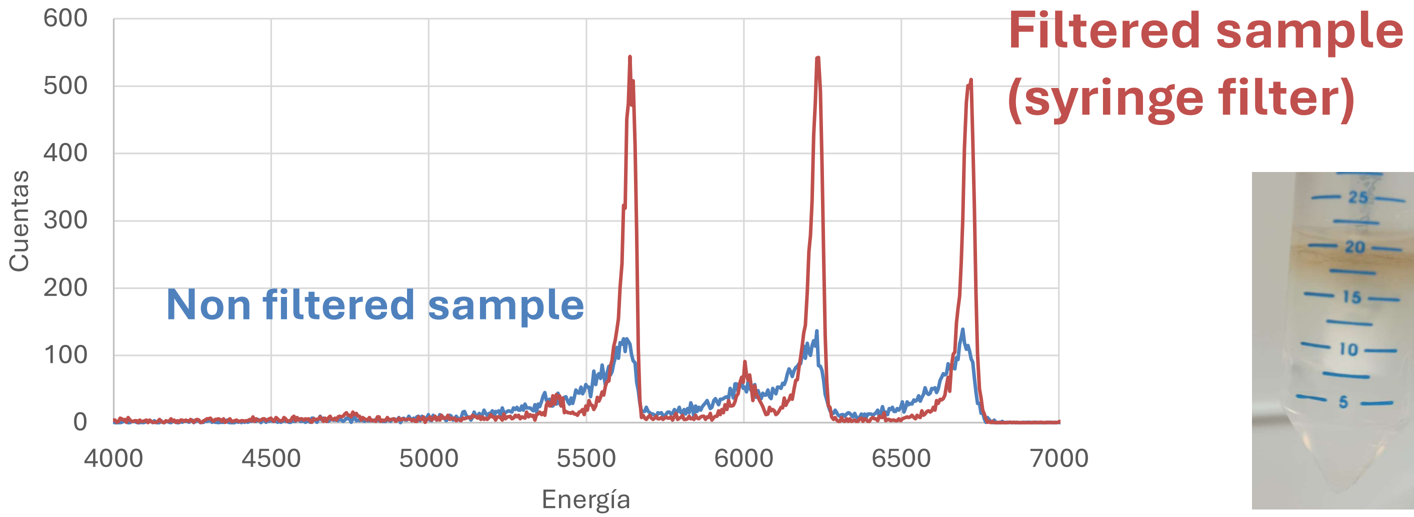
α source preparation

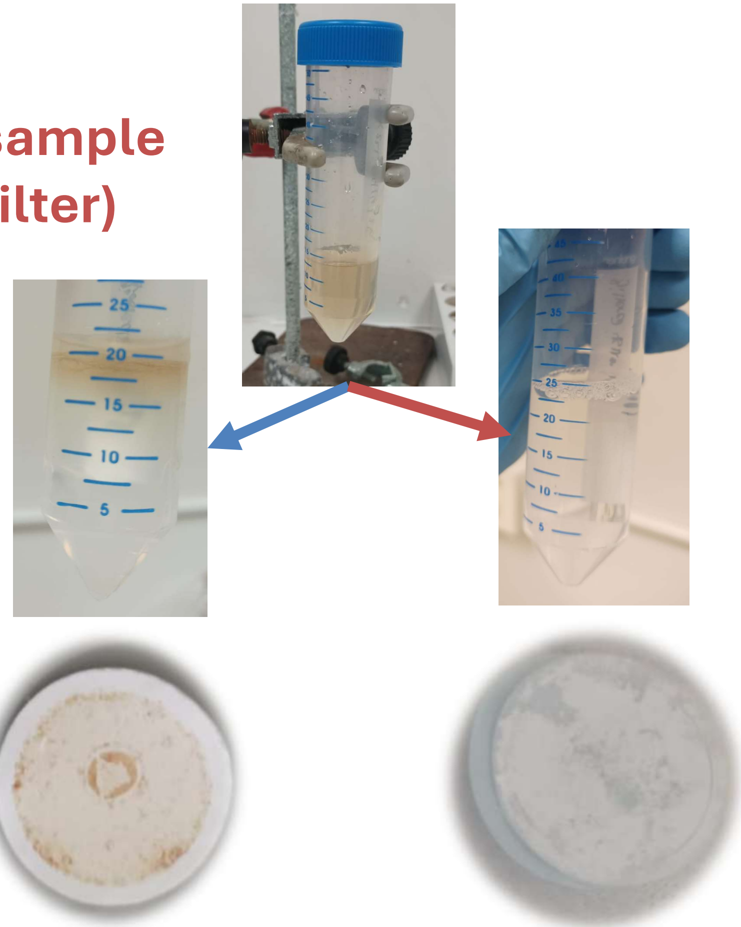




Ra

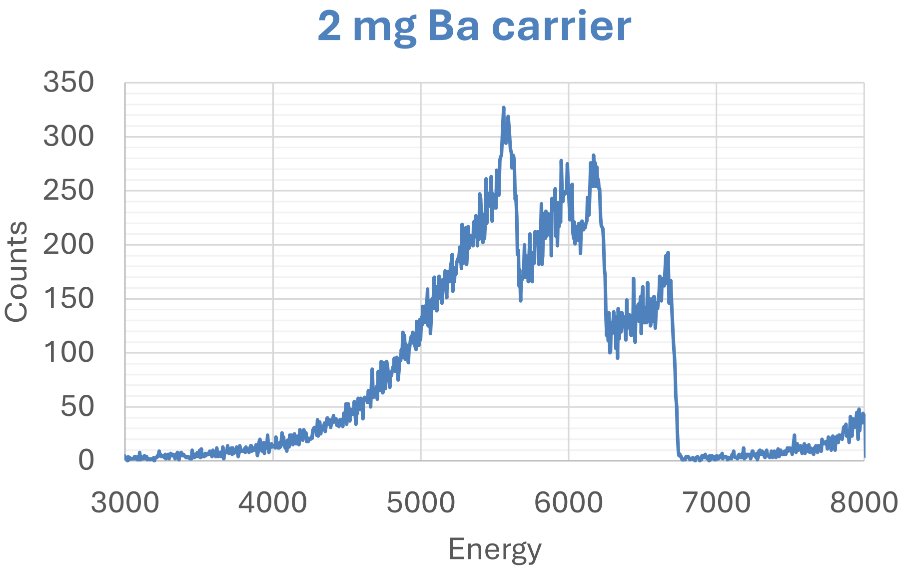
Filtering improves α-resolution

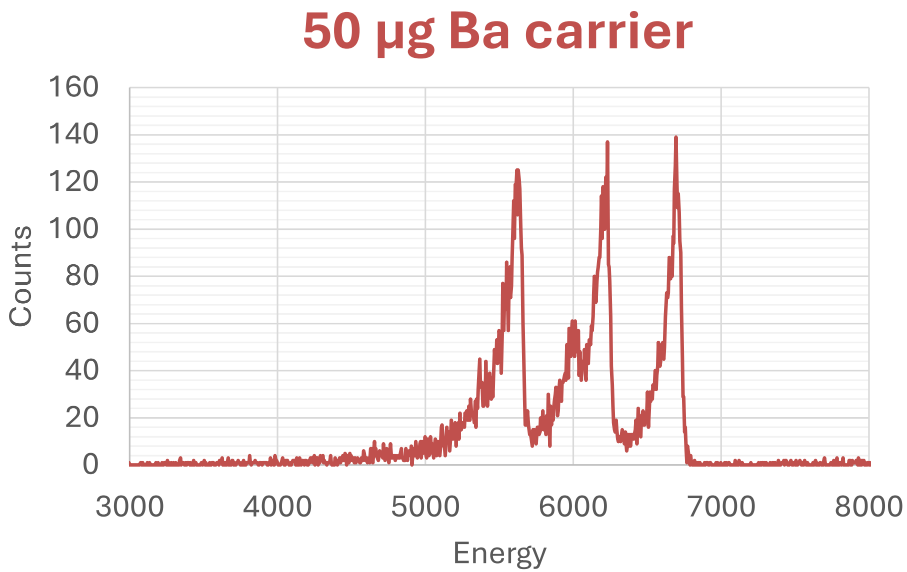




- Sharper peaks
- Lower Mn interference

Fewer carrier improves α-resolution

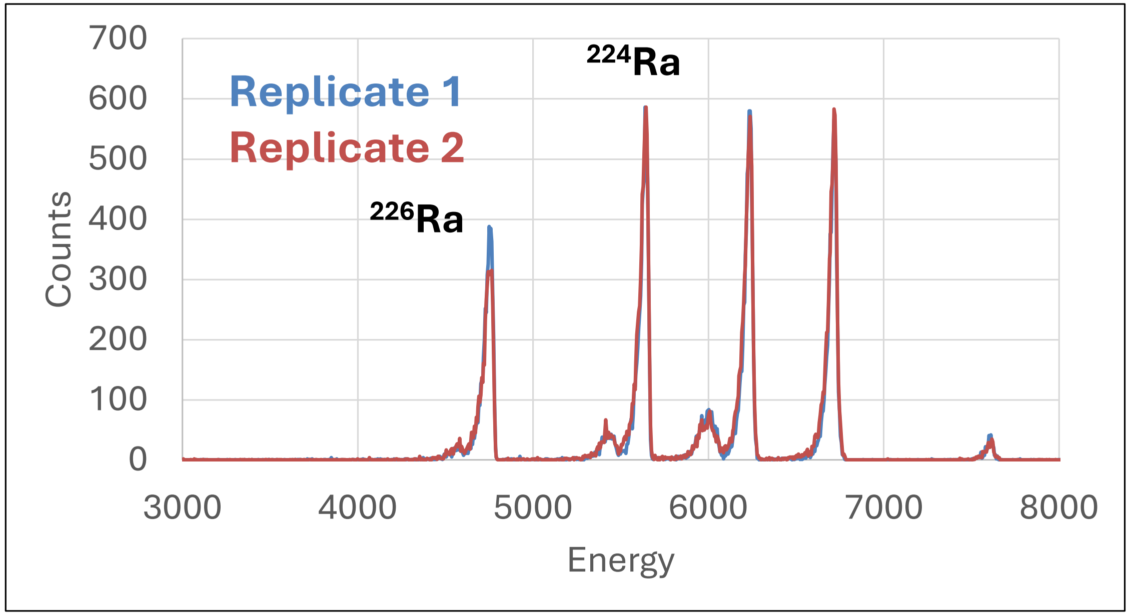


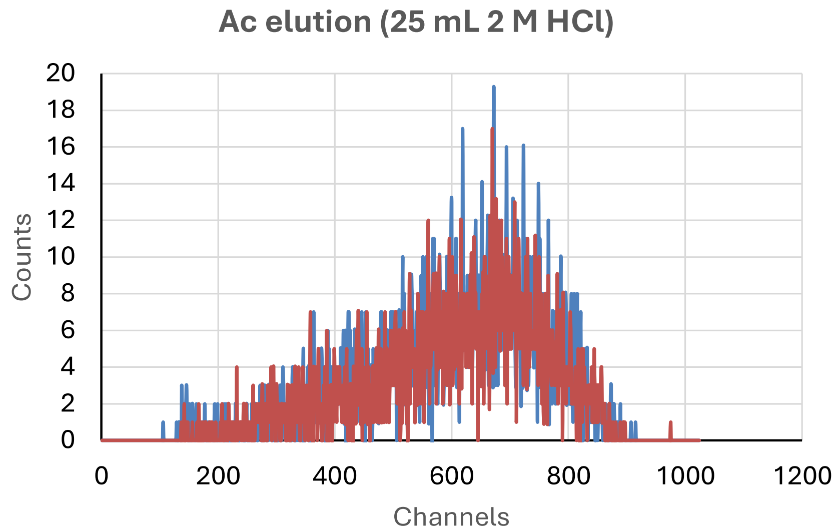


- Better alpha resolution by reducing Ba amount

Verification with spiked samples

Spiked water with 0.5 Bq ^{226}Ra y 200 µg $^{232/228}Th$





- Resolution
- Quantification

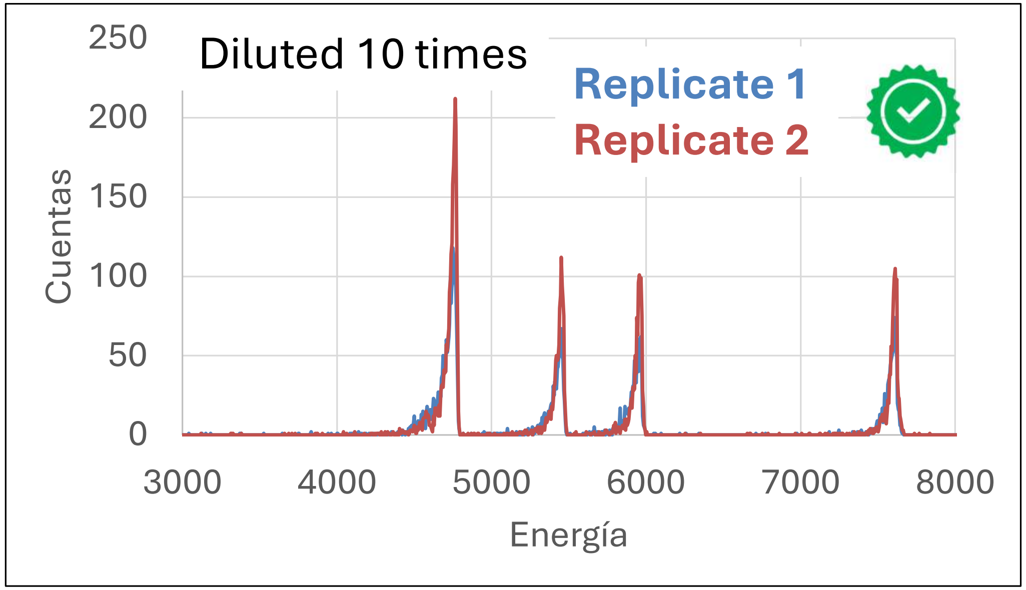
MDA ^{226}Ra~ 4-15 mBq/L (1L, 24h)

MDA ^{228}Ra~ 47 mBq/L (1L, 1h)

Ra

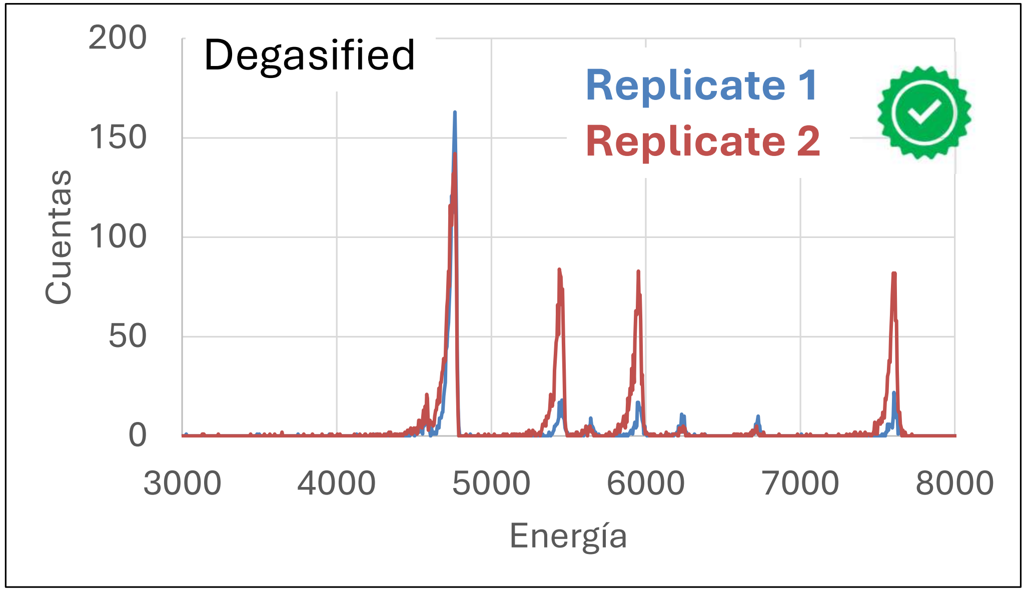
Method validated with real samples

Interlab sample: ^{152}Eu, ^{238}U, ^{210}Po, ^{3}H, ^{90}Sr



Sample	Ra-226 (Bq/L)	Ra-228
Measured	12,4 ± 0,3	-
Reference	13,0 ± 0,7	-

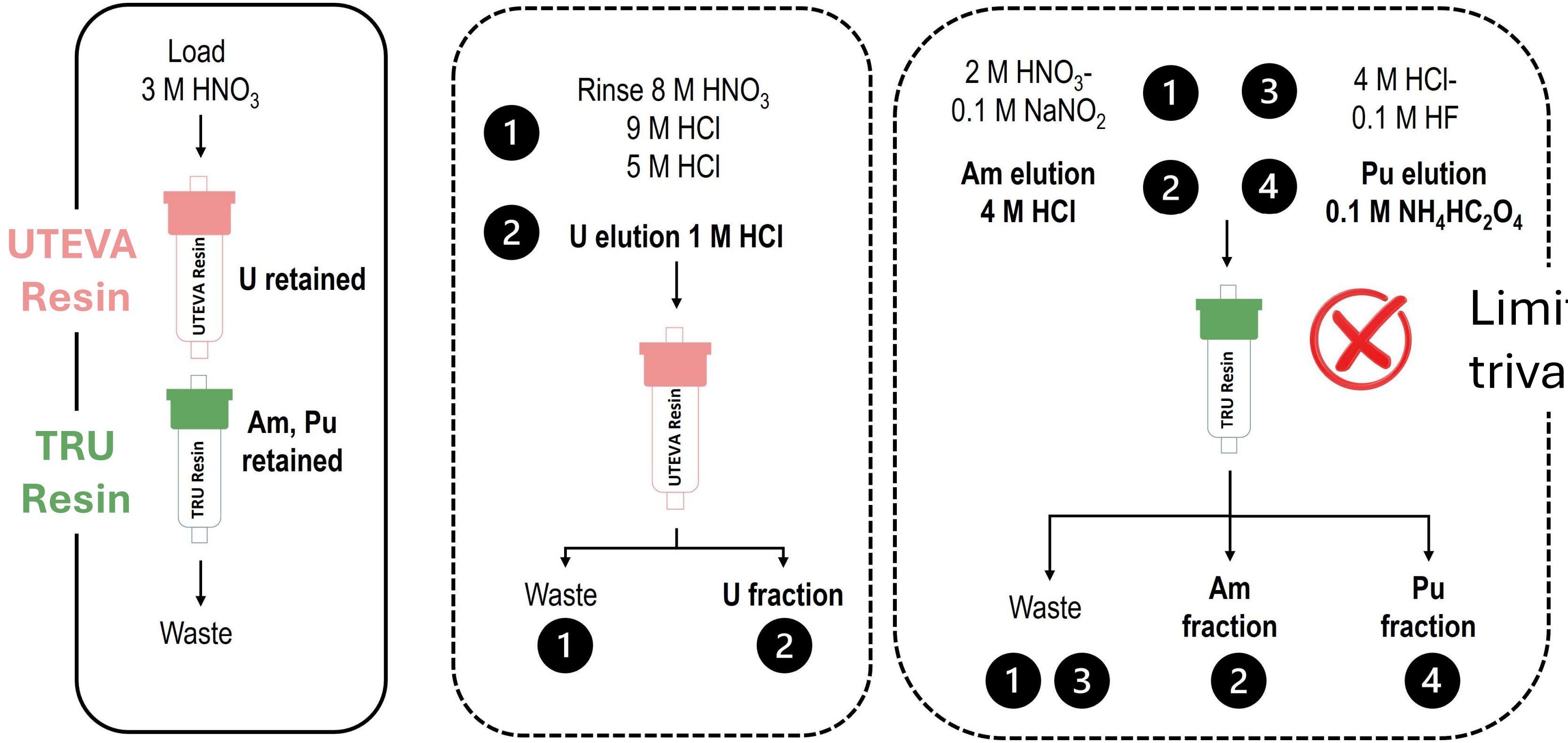
Pedras water



Sample	Ra-226 (Bq/L)	Ra-228 (Bq/L)
Measured	1,5 ± 0,2	1,8 ± 0,2
Reference	1,4 ± 0,4	1,6 ± 0,2

Zehringer, Markus. 2020. Radiological Investigation of a Portugese Mineral Water. 10.13140/RG.2.2.19650.81600.

Actinides sequential separation



Limited capacity of trivalent actinides

Th incomplete retention (UTEVA)
Use of HF

Eichrom Technologies, LLC (2014), *ACW03VBS: Americium, Plutonium, and Uranium in Water (with Vacuum Box System)*

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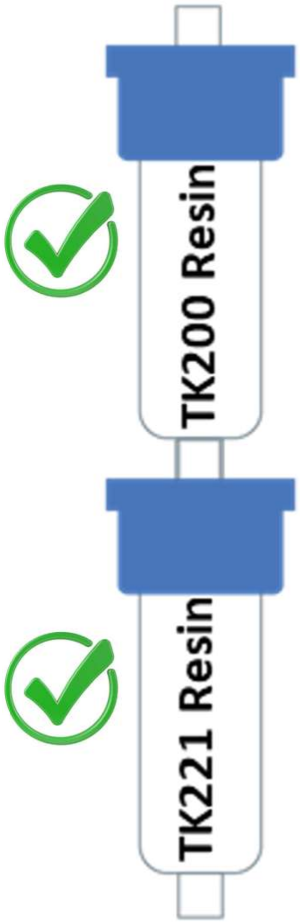
Actinides sequential separation

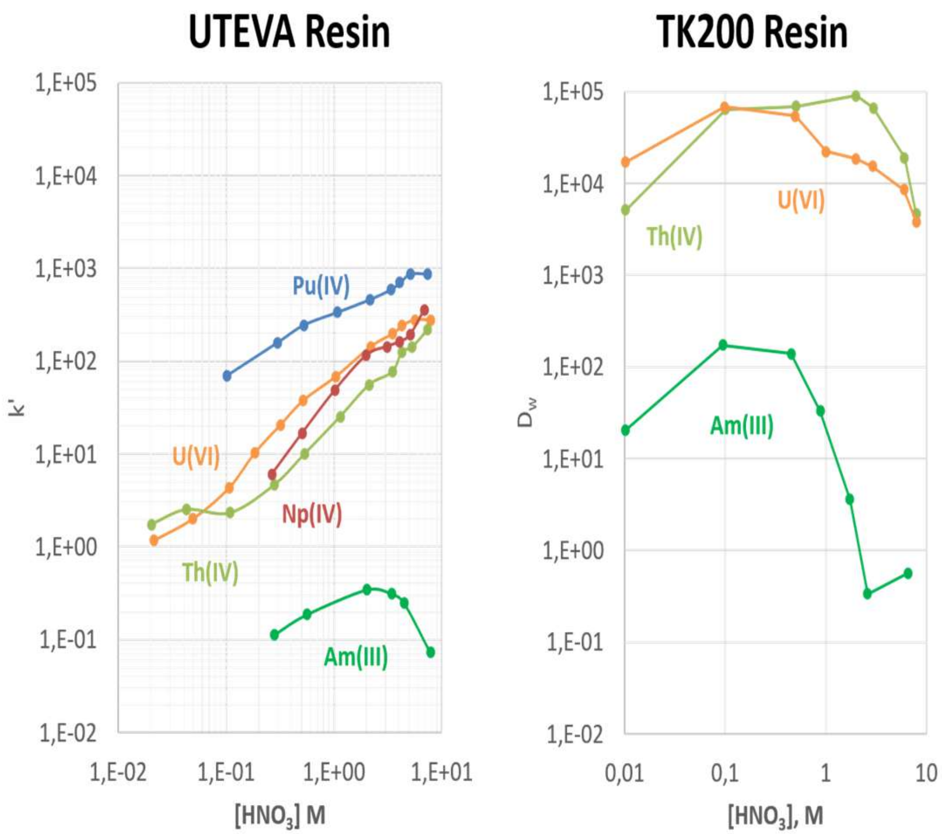
Better actinide retention
Removal of HF for elution

Retention of trivalent actinides



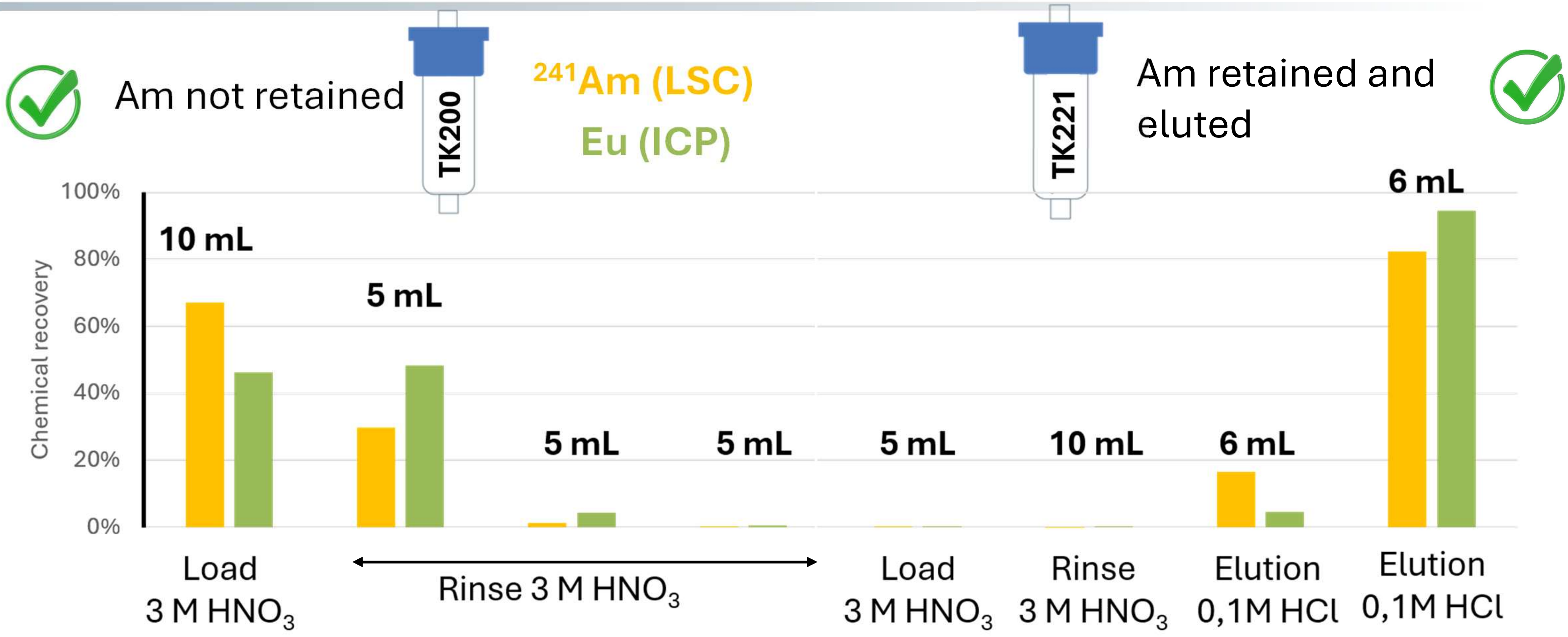
Pu, Th, U

Am (Eu)



Actinides sequential separation

Actinides

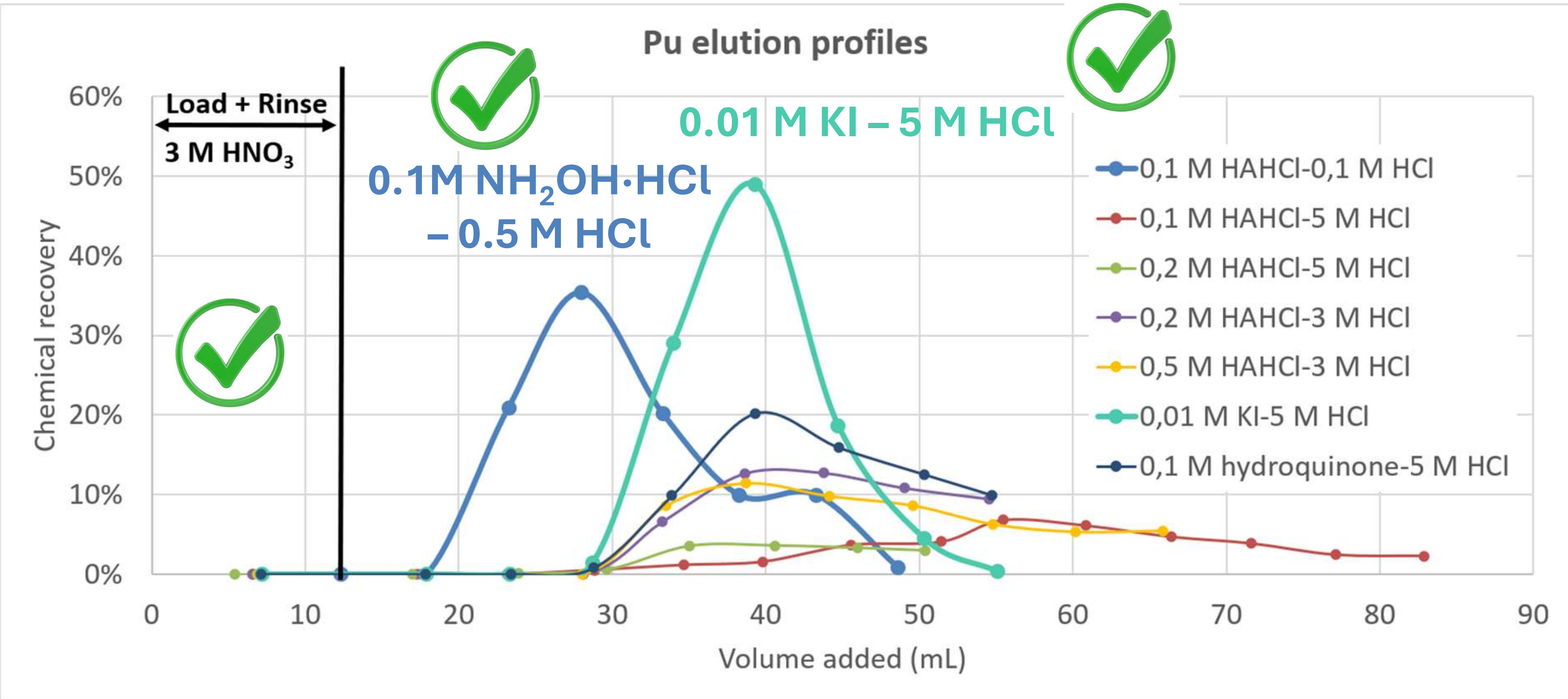


- 10 mL rinsing needed
- ^{241}Am elution with 12 mL 0.1 M HCl

Actinides sequential separation

Load: 3 M HNO_3
Rinse: 3 M HNO_3

1. Reduce to Pu (III) with iron sulfamate
2. Oxidize to Pu (IV) with $NaNO_2$



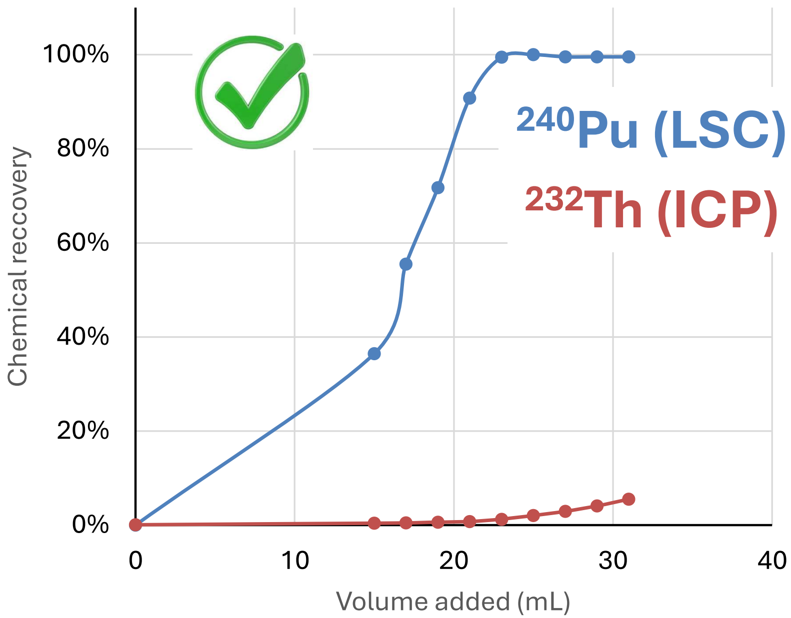
Pu retained

Elution with 20-30 mL

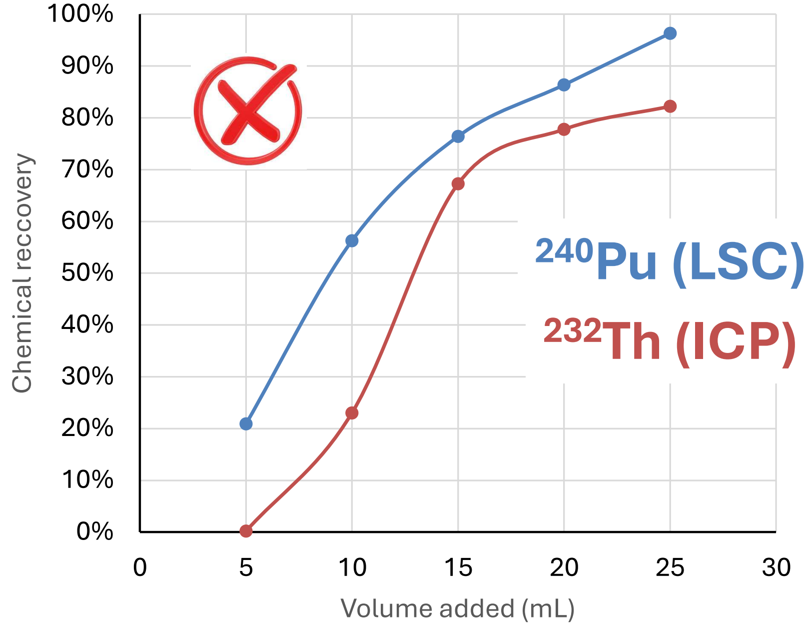
Actinides sequential separation

Pu
Th
U

Pu elution with 0.01 M KI -5 M HCl



Pu elution with 0.1M $NH_2OH \cdot HCl$ – 0.5 M HCl

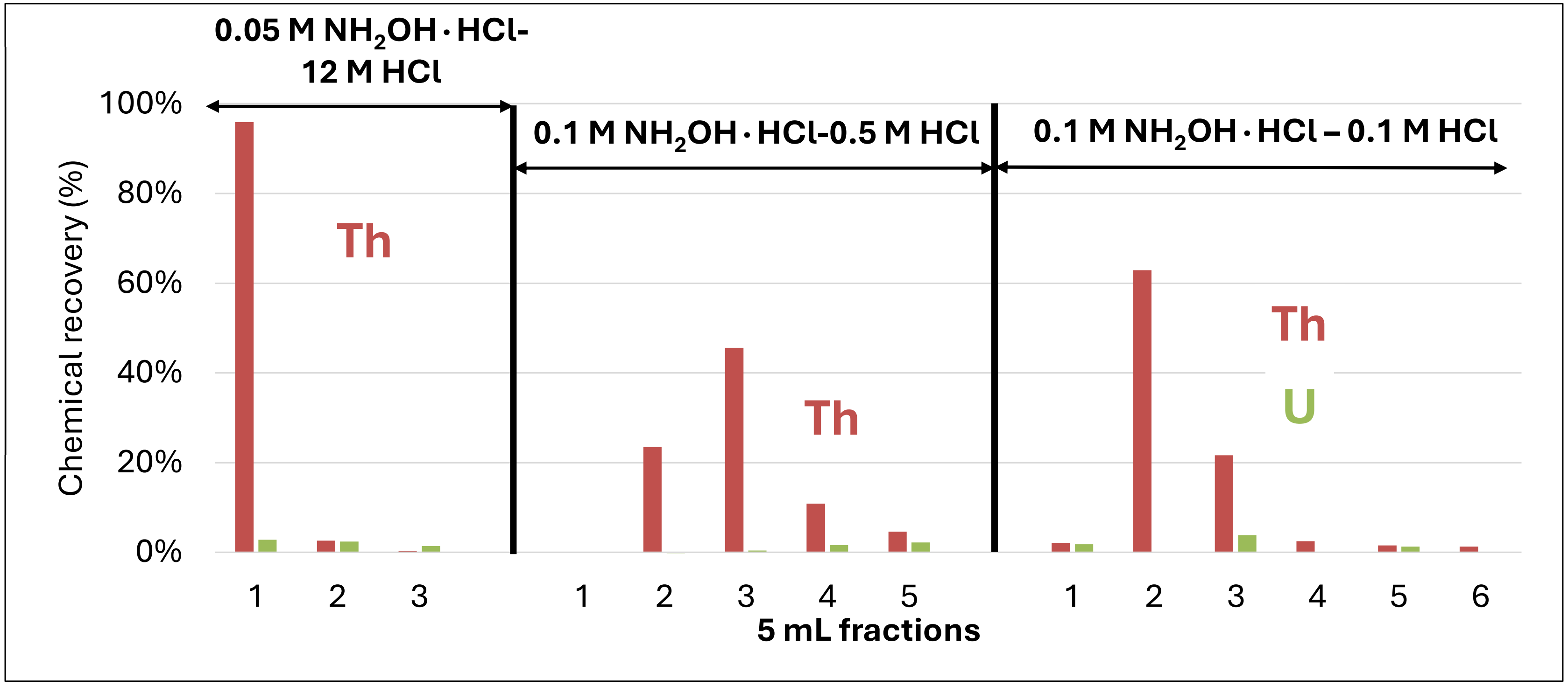


- **KI →** very few Th co-elution

- **Hydroxylamine →** Th co-elution

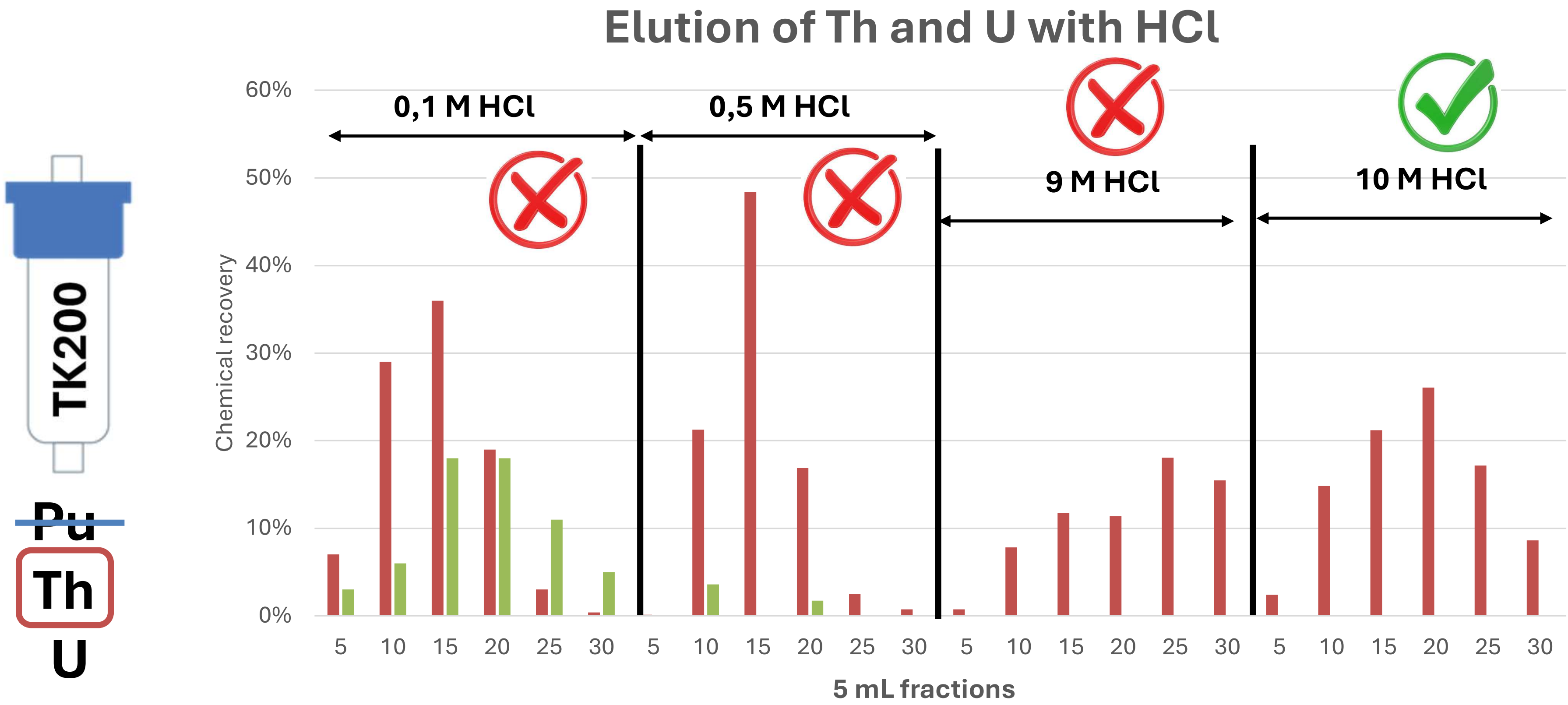
Actinides sequential separation

Elution of Th and U with hydroxylamine



- **Low elution volume** (15 mL) and no U co-elution

Actinides sequential separation



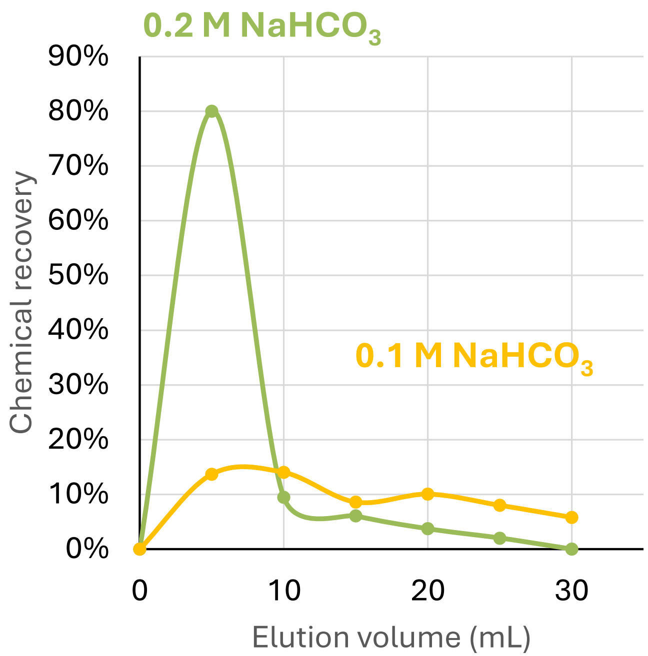
- ↑ **HCl** less U co-elution, but **larger volume** is required

Actinides sequential separation

~~Pu~~

~~Th~~

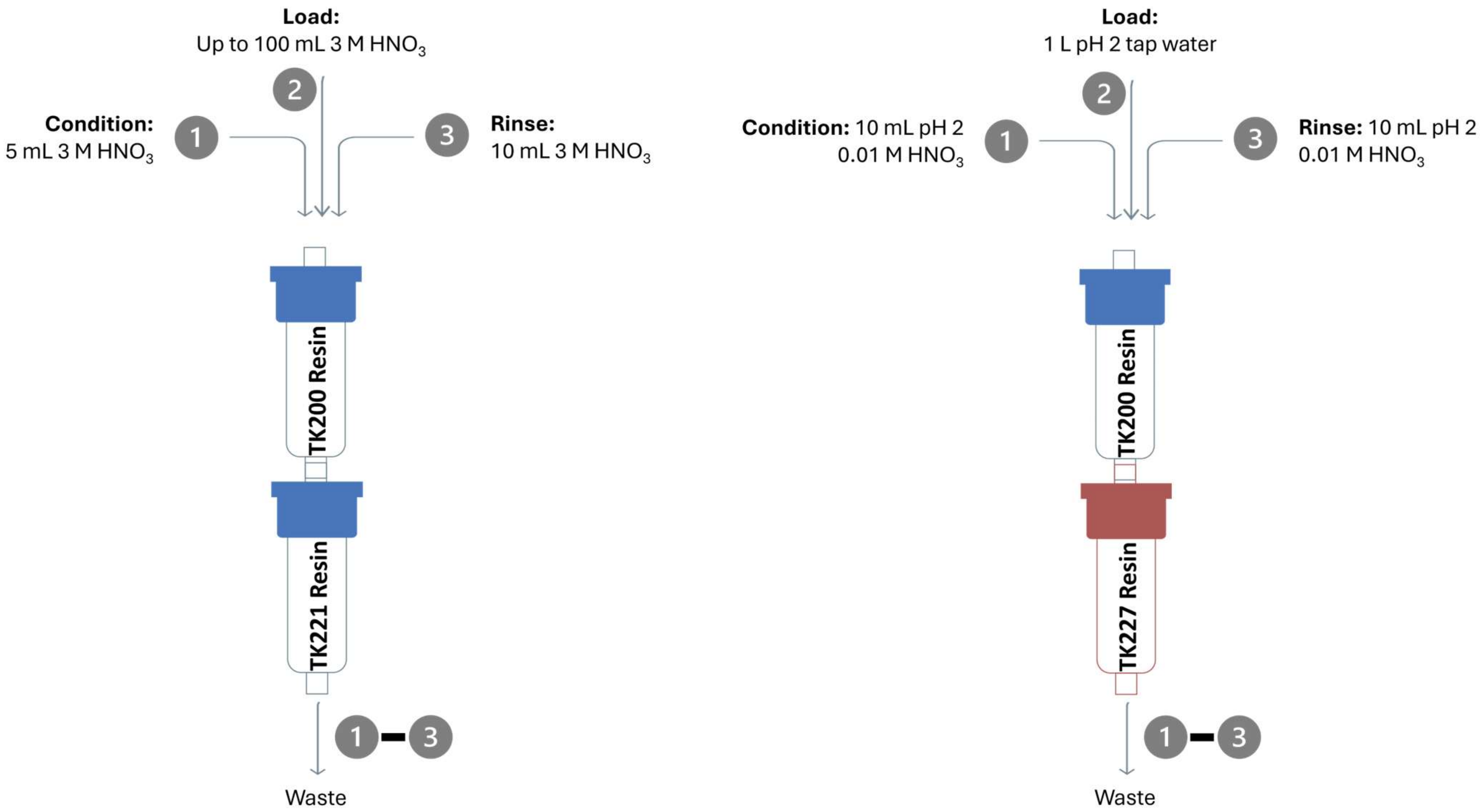
U



- **Faster U elution** ↑ $NaHCO_3$

- Redox conditions
- **Pu elution** – ↑ [KI]
- **Th elution** – temperature
- **U elution** – rinsing, ↑ [$NaHCO_3$]
- Application in large volume samples

Actinides sequential separation



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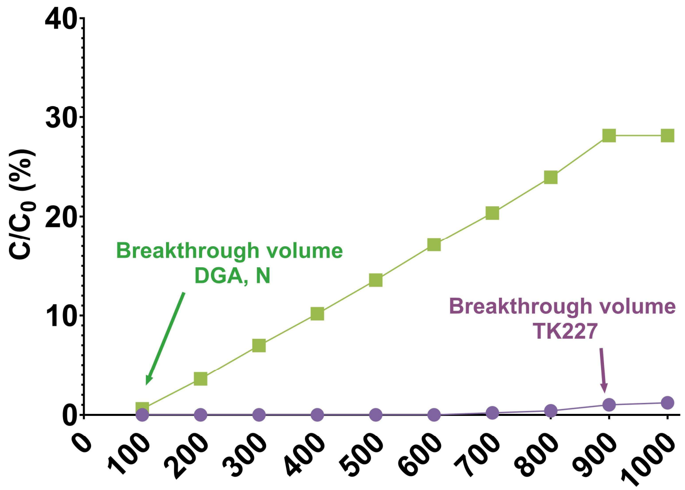
Y/Sr-90

Y-90 determination via Cerenkov

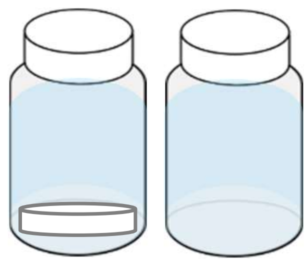


20 % EtOH
0.5 M HNO_3

1 L tap water
0.5 M HNO_3

0.5 M HNO_3
9 M HCl

Y elution
20 mL 0.1 M HCl



LSC + ICP

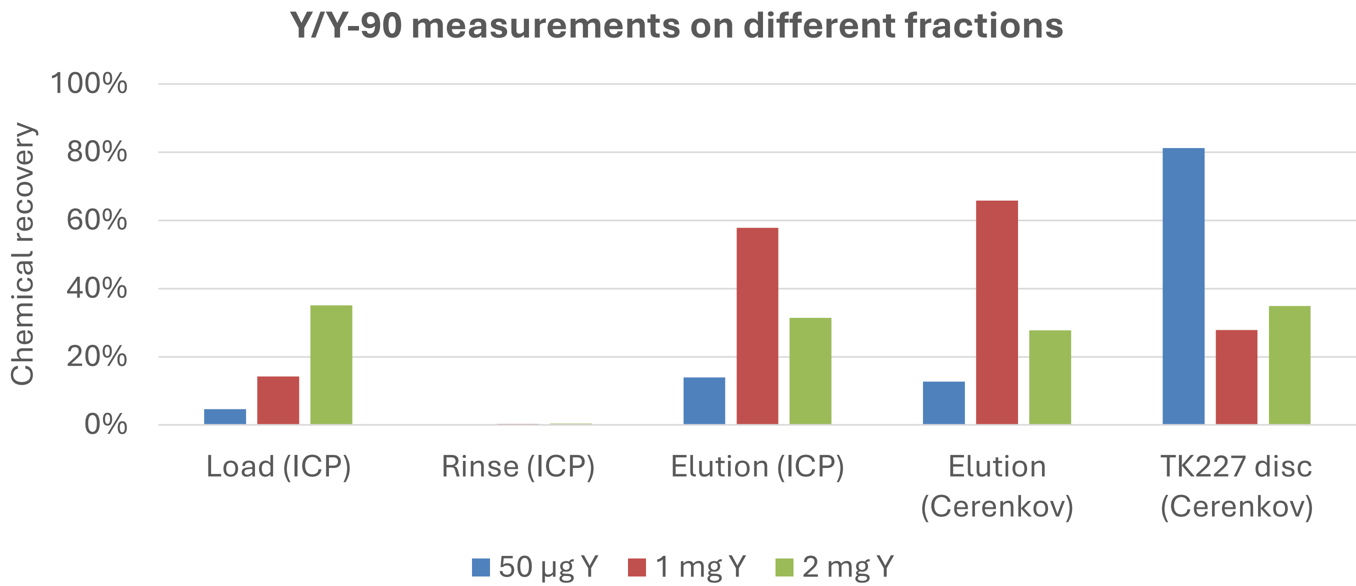
Y-90 determination via Cerenkov

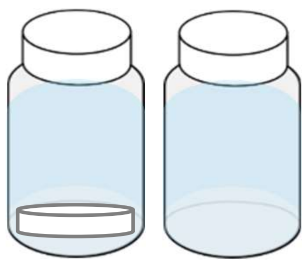
20 % EtOH
0.5 M HNO_3

1 L tap water
0.5 M HNO_3

0.5 M HNO_3
9 M HCl

Y elution
20 mL 0.1 M HCl





LSC + ICP

- For Y quantitative elution **minimum 1 mg** Y carrier
- Not enough **elution volume** (20 mL 0.1 M HCl) to collect all Y
- Cerenkov results comparable to ICP-OES

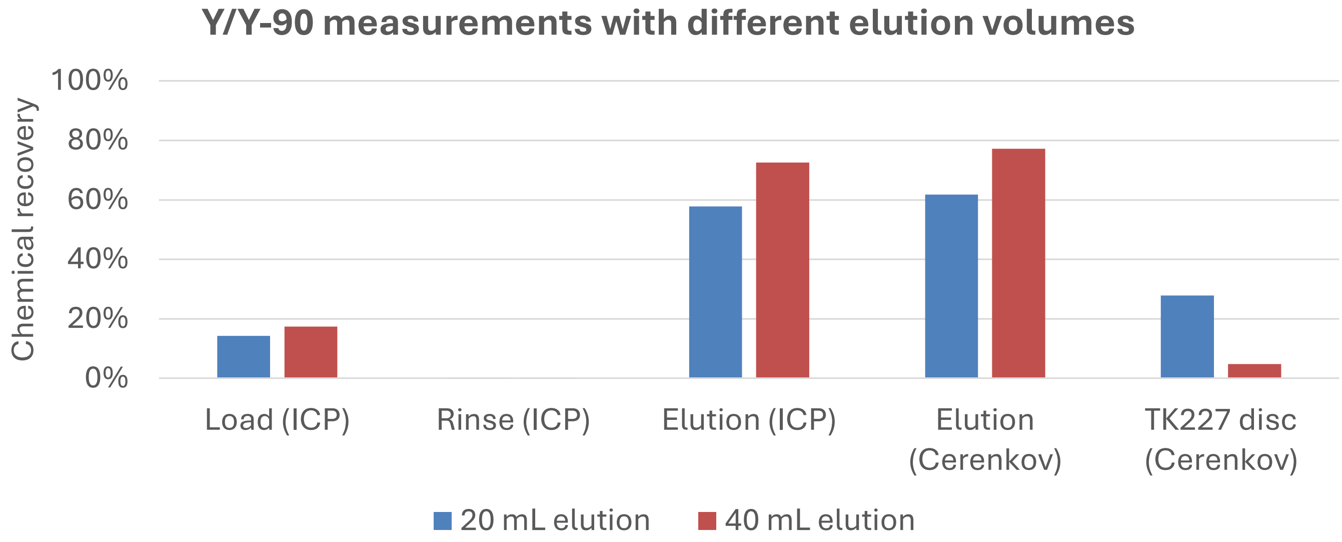
Y-90 determination via Cerenkov

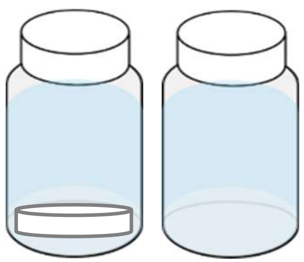
20 % EtOH
0.5 M HNO_3

1 L tap water
0.5 M HNO_3

0.5 M HNO_3
9 M HCl

Y elution
20 mL 0.1 M HCl





LSC + ICP

- A **40 mL elution** volume resulted in nearly complete Y elution

Y-90 determination via Cerenkov

	50 µg Y	1 mg Y	↑ volume 1 mg Y	2 mg Y
Load	5%	14%	17%	35%
Elution (LSC)	14%	58%	73%	31%
Elution (ICP)	13%	62%	77%	28%
TK227 disc (LSC)	81%	28%	5%	35%

Load

- 1 mg Y most suitable – 15% loses
- Sr collected on load fraction
- **Test higher/lower [HNO_3]**

Rinse

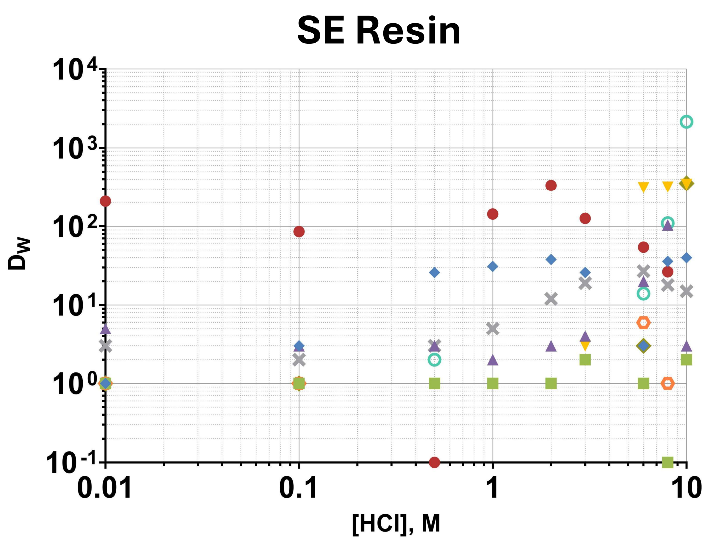
- Optimise rinse volume / medium

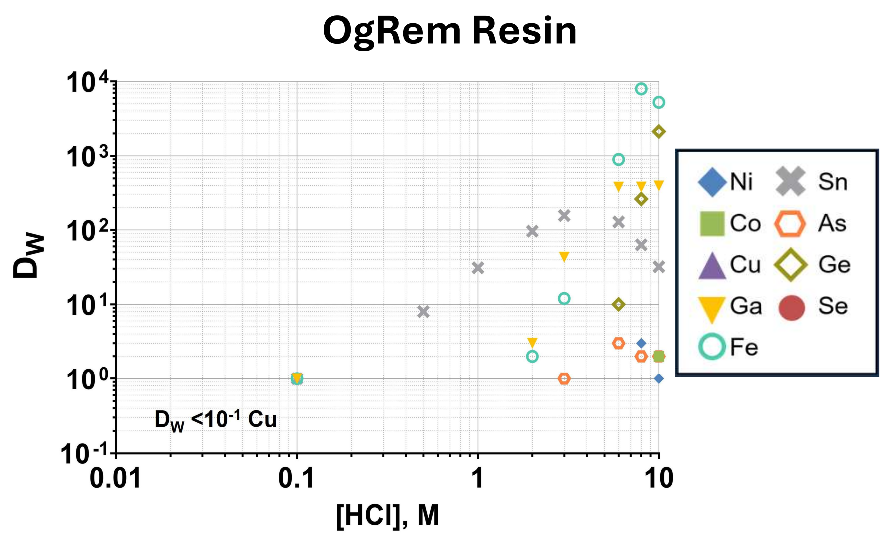
Y elution

- Optimise elution volume / medium

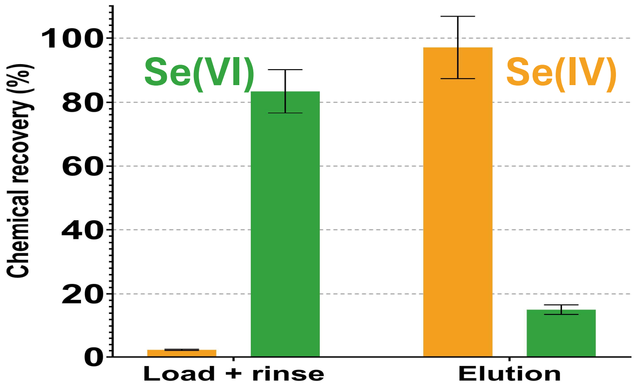
SE Resin characterization

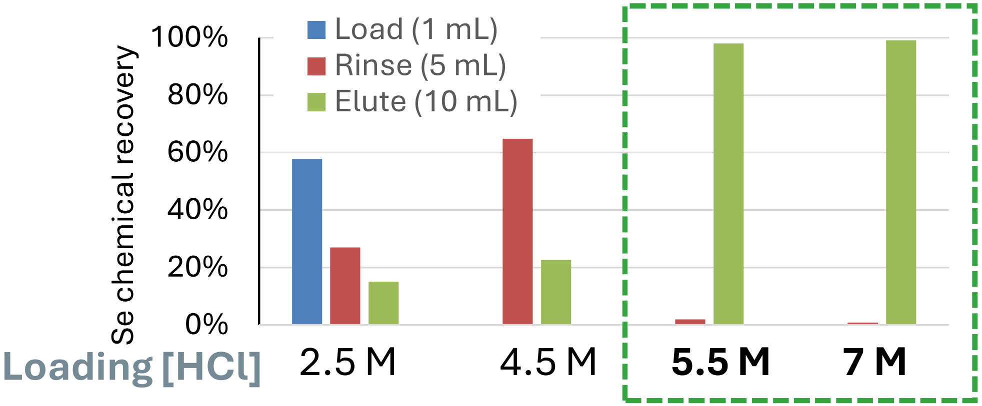
Se





Loading different Se oxidation states

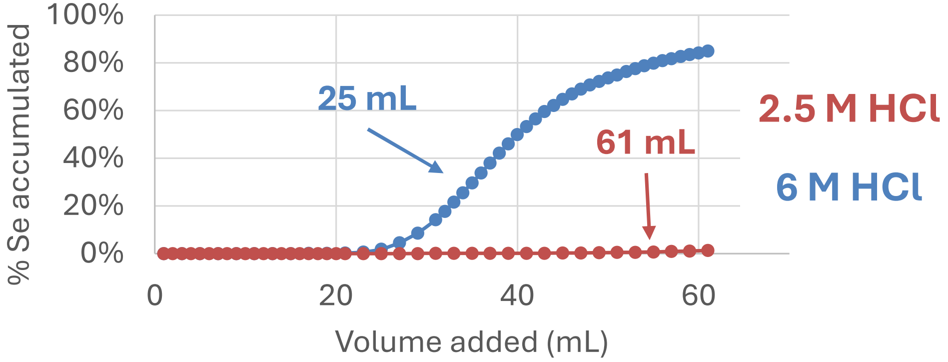




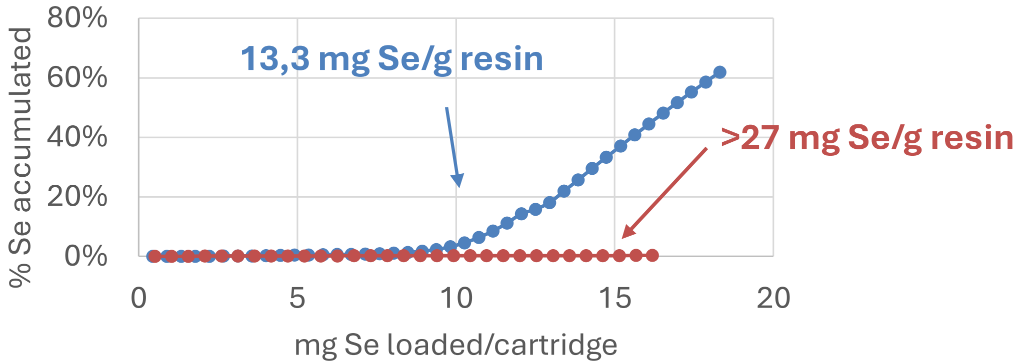
Se

SE Resin characterization

Breakthrough volume

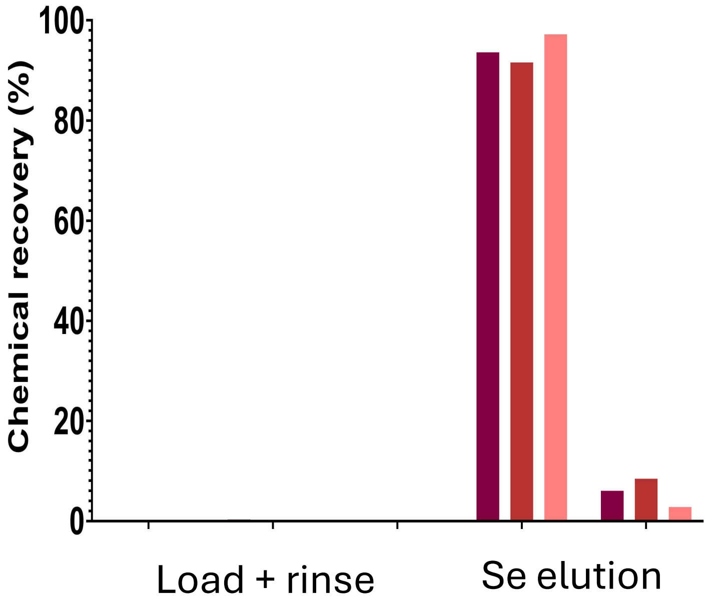


Capacity of SE Resin



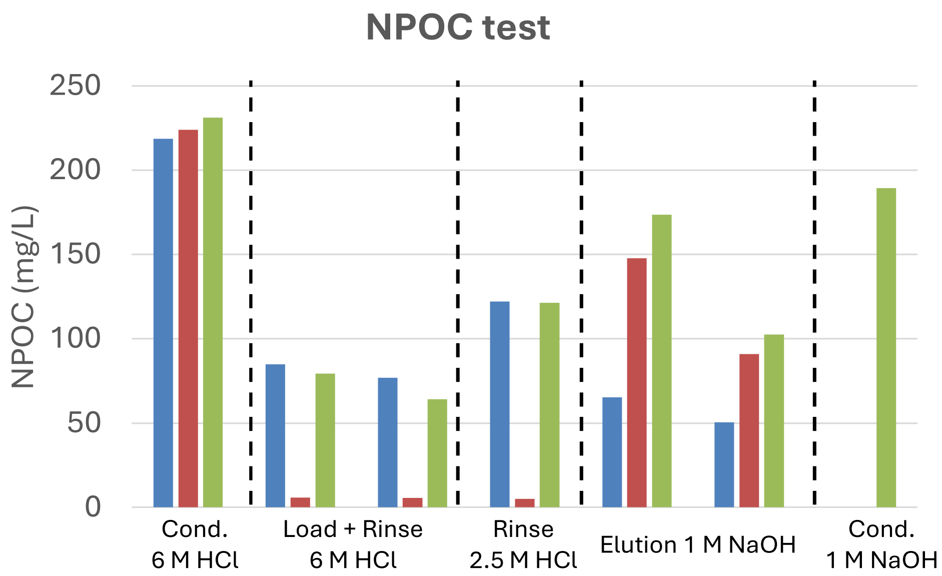
Ageing of the resin

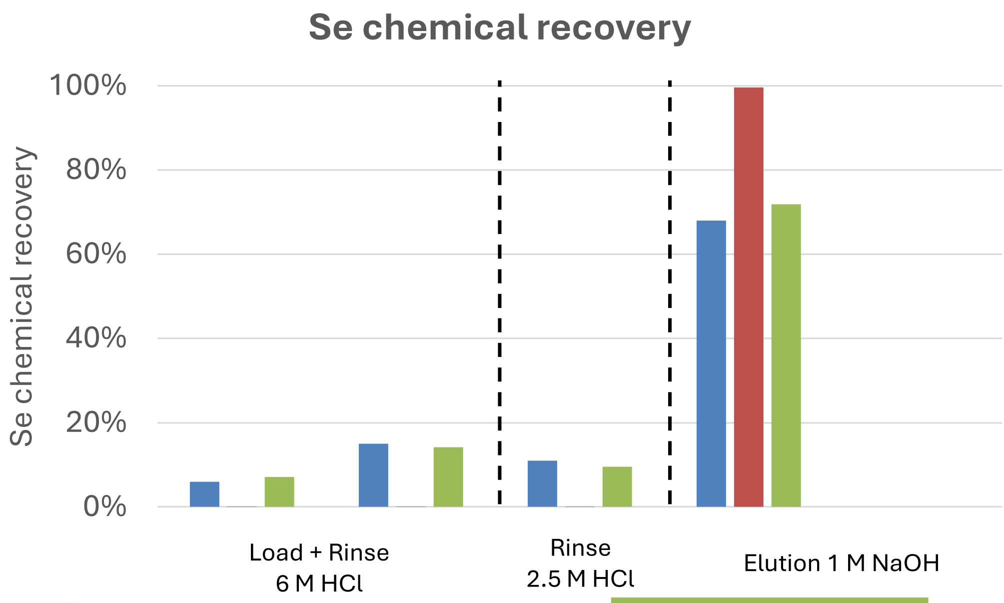
2022 → 2024 → 2025

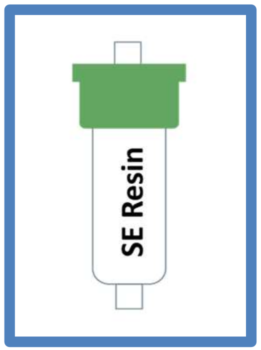


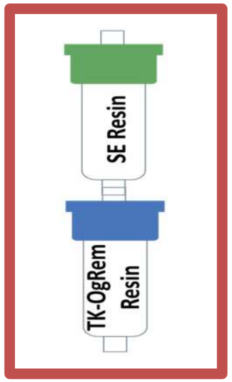
SE Resin characterization

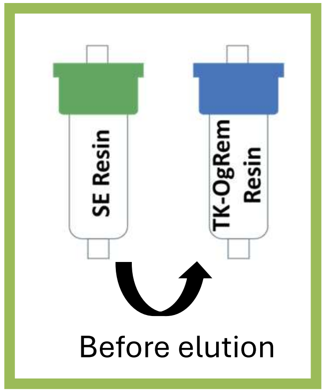
Se



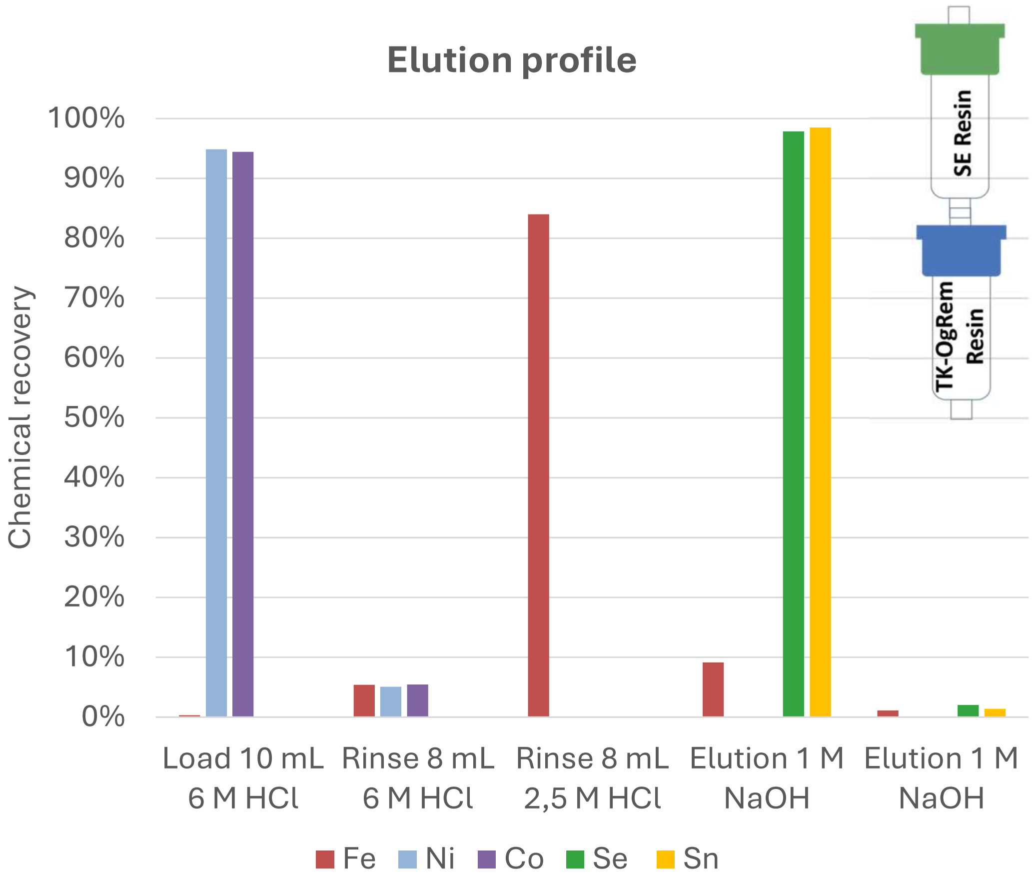




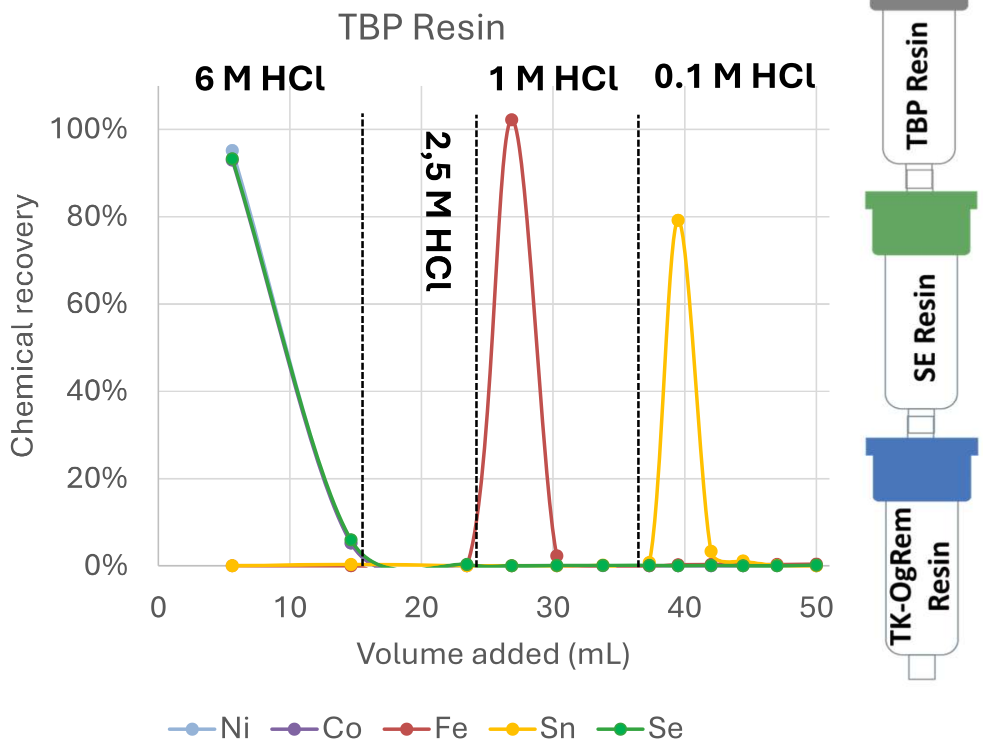




SE Resin interferences studies



TBP for Sn, Fe removal



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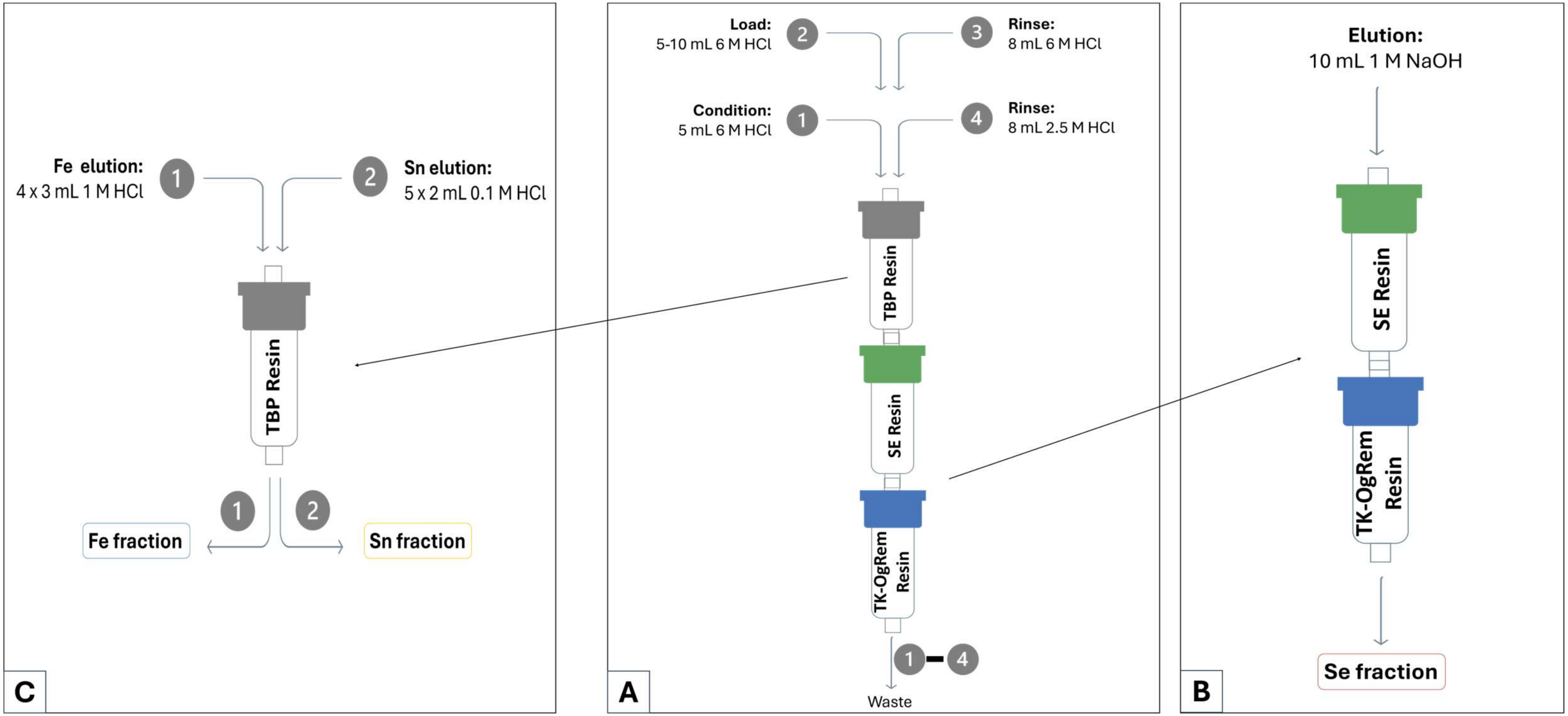
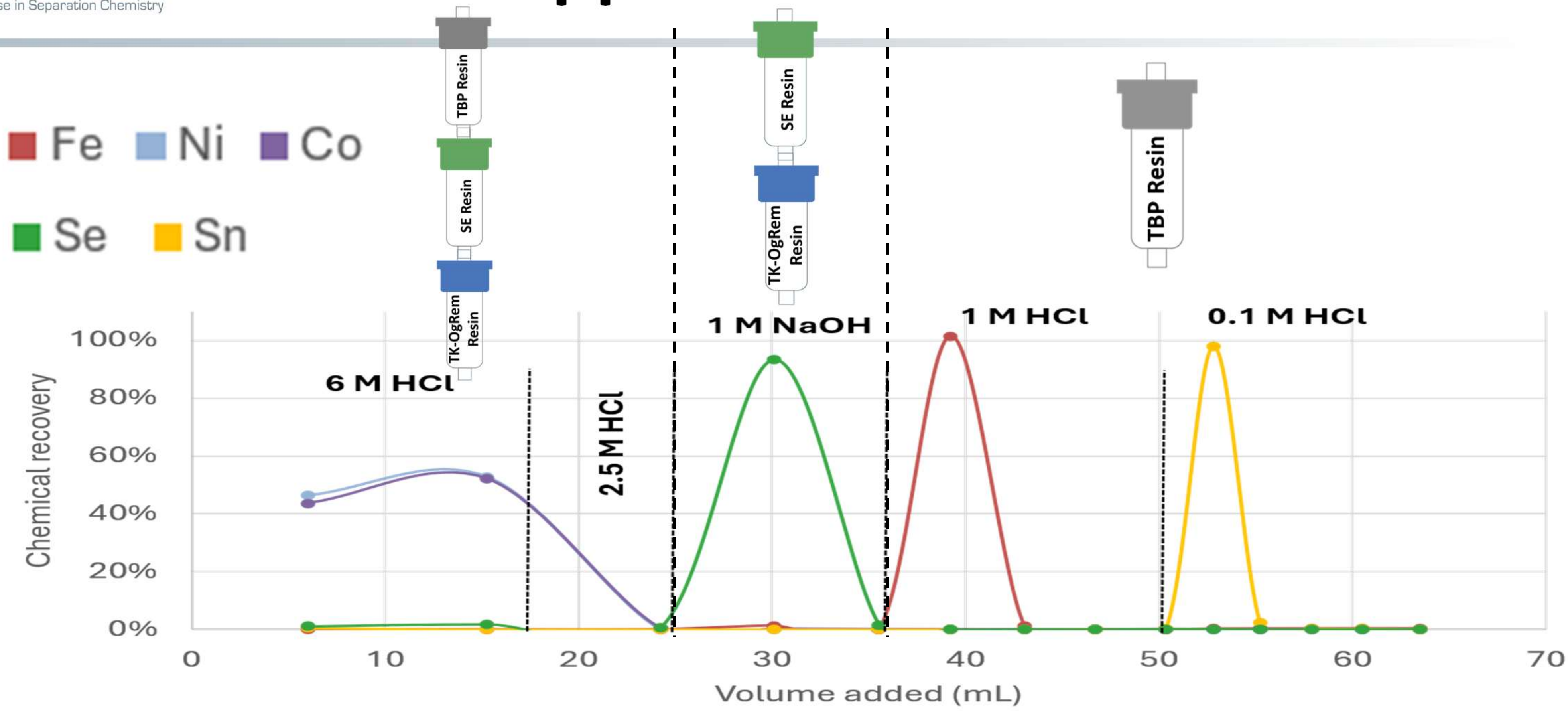
Method application



Se

Method application



Publication submitted to *ACA "Towards Effective Determination of Se-79 using Novel Extraction Chromatography: Selectivity and Stability Investigations"* Dokl et al.

Thank you for your attention!

illopart@triskem.fr

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