On the development of a rapid method for the concentration and separation of radiostrontium from water samples based on a modified Sr resin

Jake Surman [a], Carina Dirks [b], Lena Kuhne [b], Steffen Happel [c], Jackie Pates [a] and Hao Zhang [a]

[a] Lancaster Environment Centre, Lancaster University, LA1 4YQ, UK
[a] Radiochemistry, Department of Chemistry, Philipps University Marburg ,35043 Marburg, Germany
[c] Triskem International, 35170 Bruz, France

Context

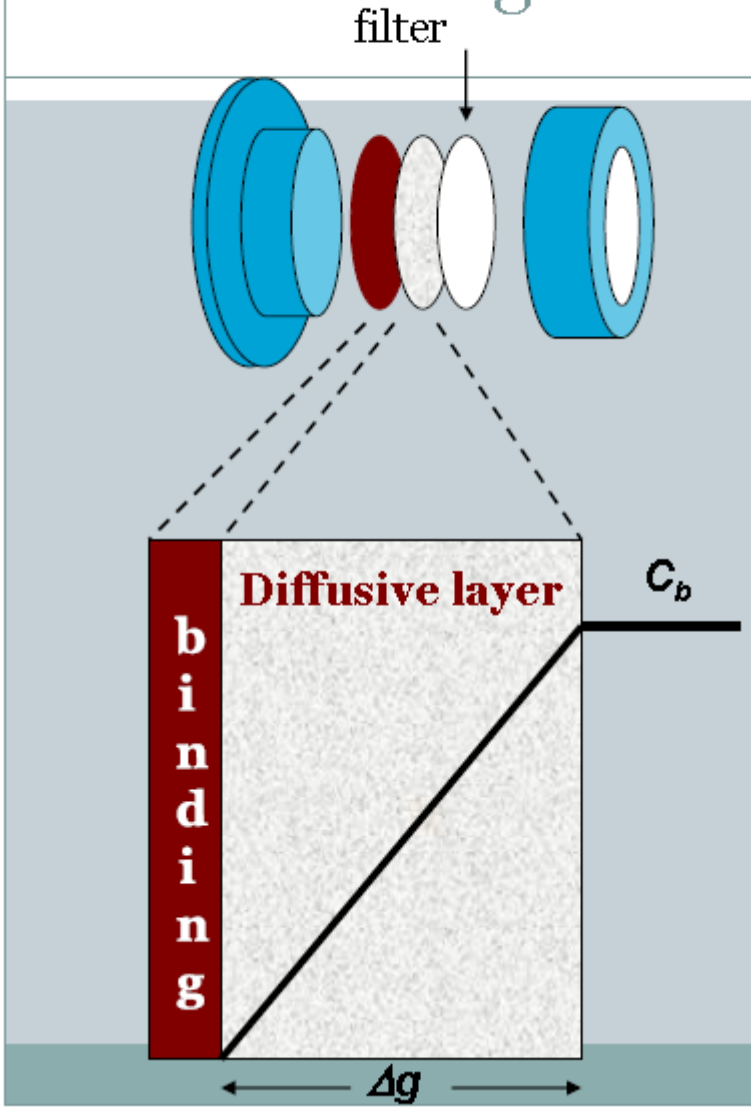
- Rapid extraction and separation of Sr from water samples (pH5–8)
- « Passive sampling »
  - Use in DGT (Diffusive gradients in thin-films) units
  - Monitoring e.g. of ground waters and wells
- Rapid method
  - Direct load of Sr from 100 – 1000 mL
  - Separation on same resin/column
  - Batch or column approach

TRISKEM INTERNATIONAL

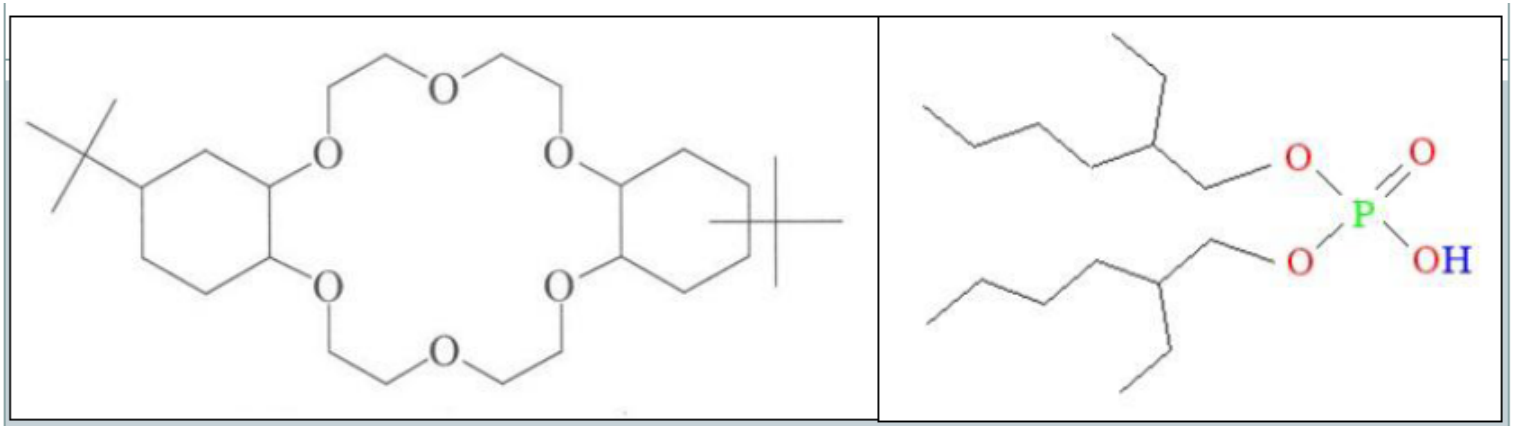
The Lancaster
Environment Centre

LANCASTER UNIVERSITY

Diffusive gradients in thin-films (DGT)



Modified Sr Resin



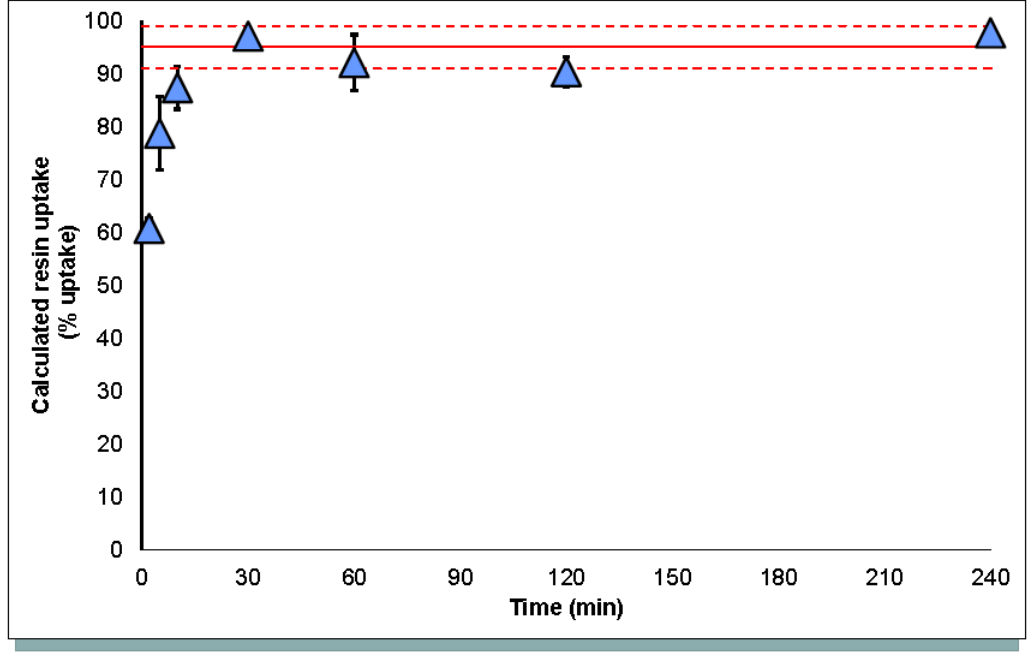
- Keep Sr Resin selectivity (crown ether), increase pH range
- 1st approach: Replace 1-Octanol by HDEHP
- Screening of several test resins (varying HDEHP contents)
- Characterisation of best suited resin prototype
- Elution studies and first tests

TRISKEM INTERNATIONAL

The Lancaster Environment Centre

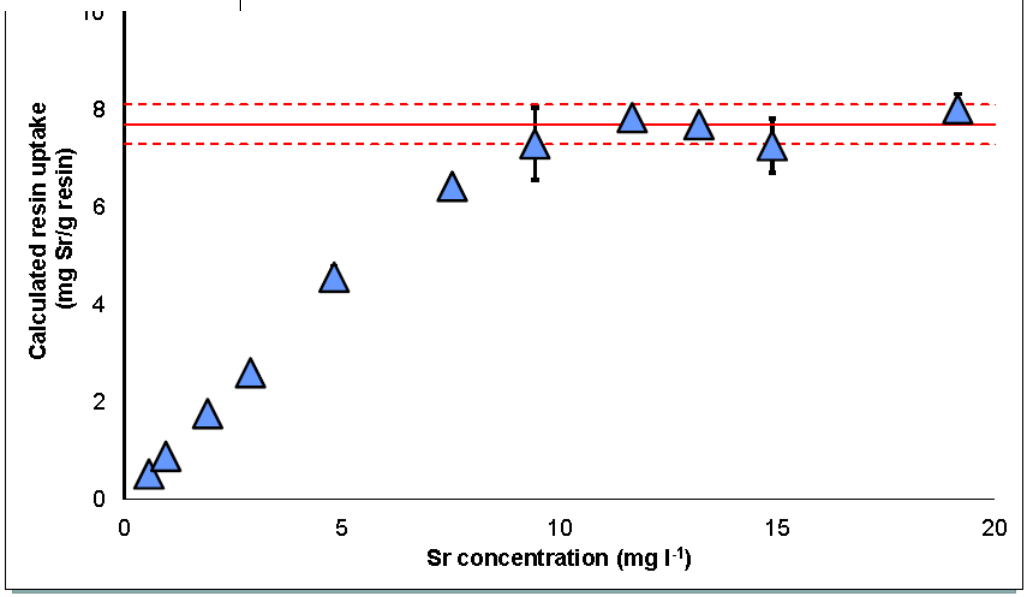
LANCASTER UNIVERSITY

Uptake kinetics



- pH 7
- Batch experiments

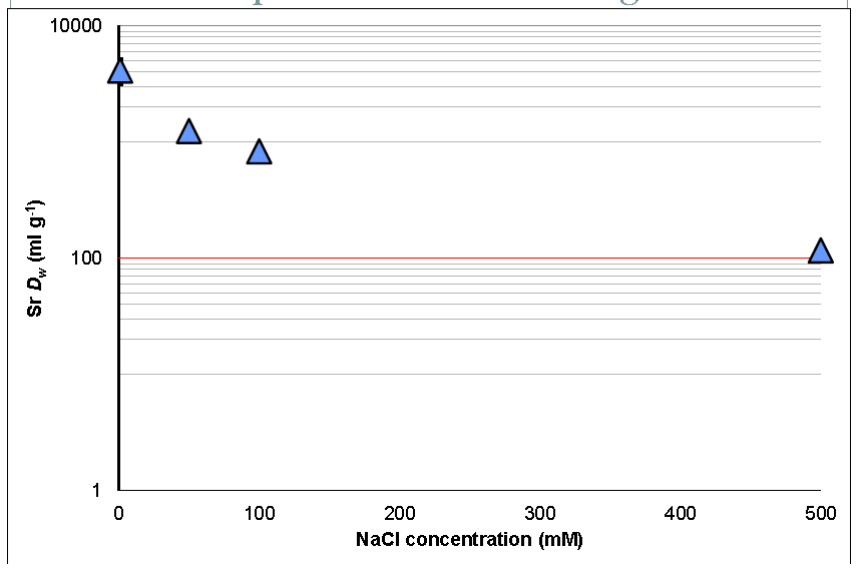
Capacity



The Lancaster Environment Centre

LANCASTER UNIVERSITY

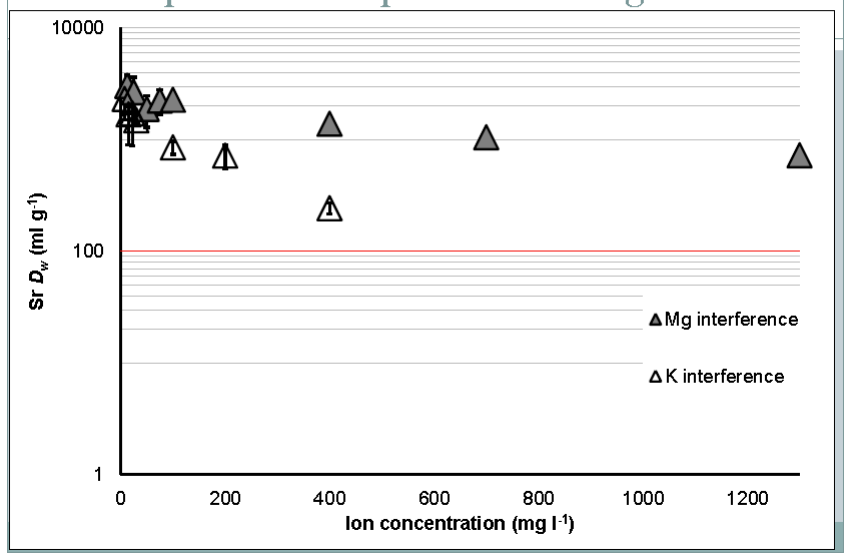
Sr uptake and ionic strength



The Lancaster Environment Centre

LANCASTER UNIVERSITY

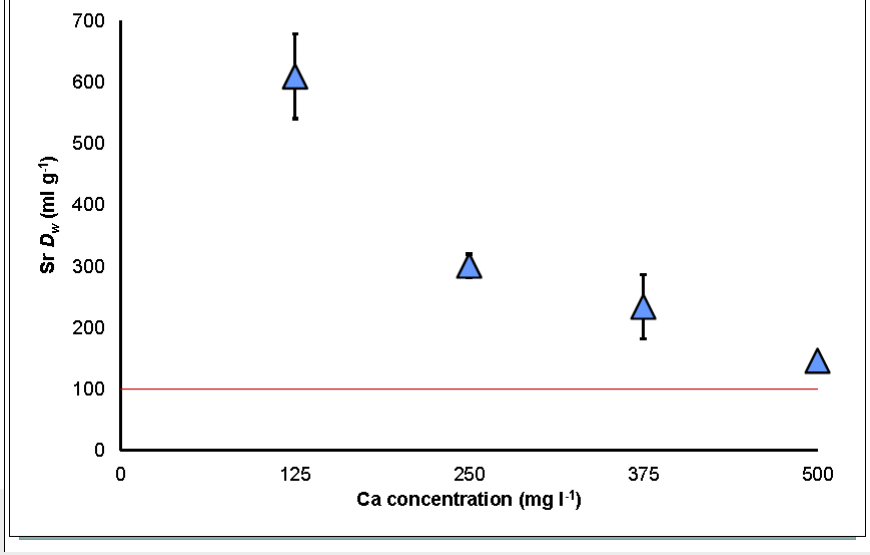
Sr uptake in the presence of Mg and K



The Lancaster Environment Centre

LANCASTER UNIVERSITY

Sr uptake in the presence of Ca



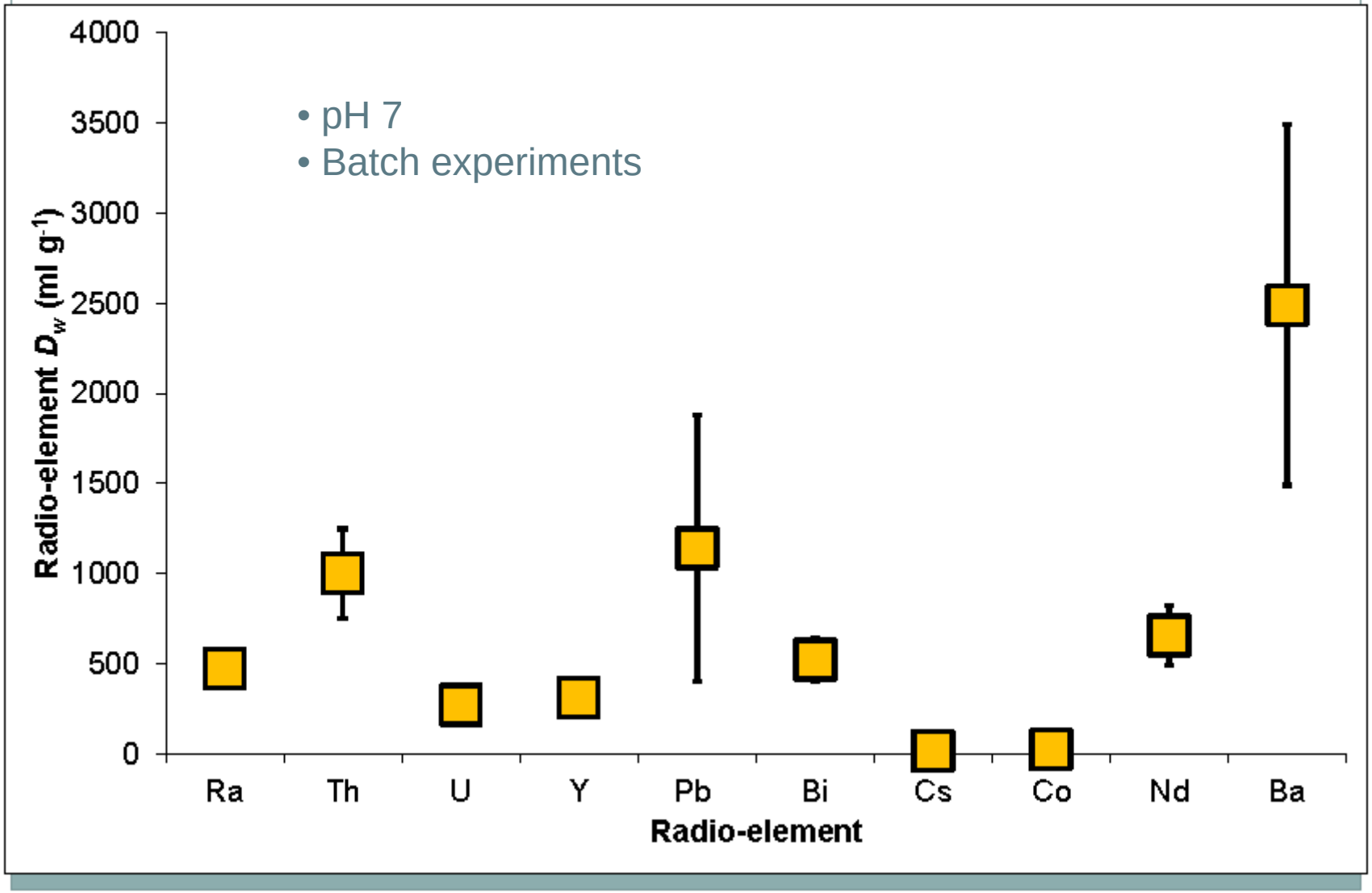
- pH 7
- Batch experiments

TRISKEM INTERNATIONAL

LANCASTER UNIVERSITY

Radio-elements interference

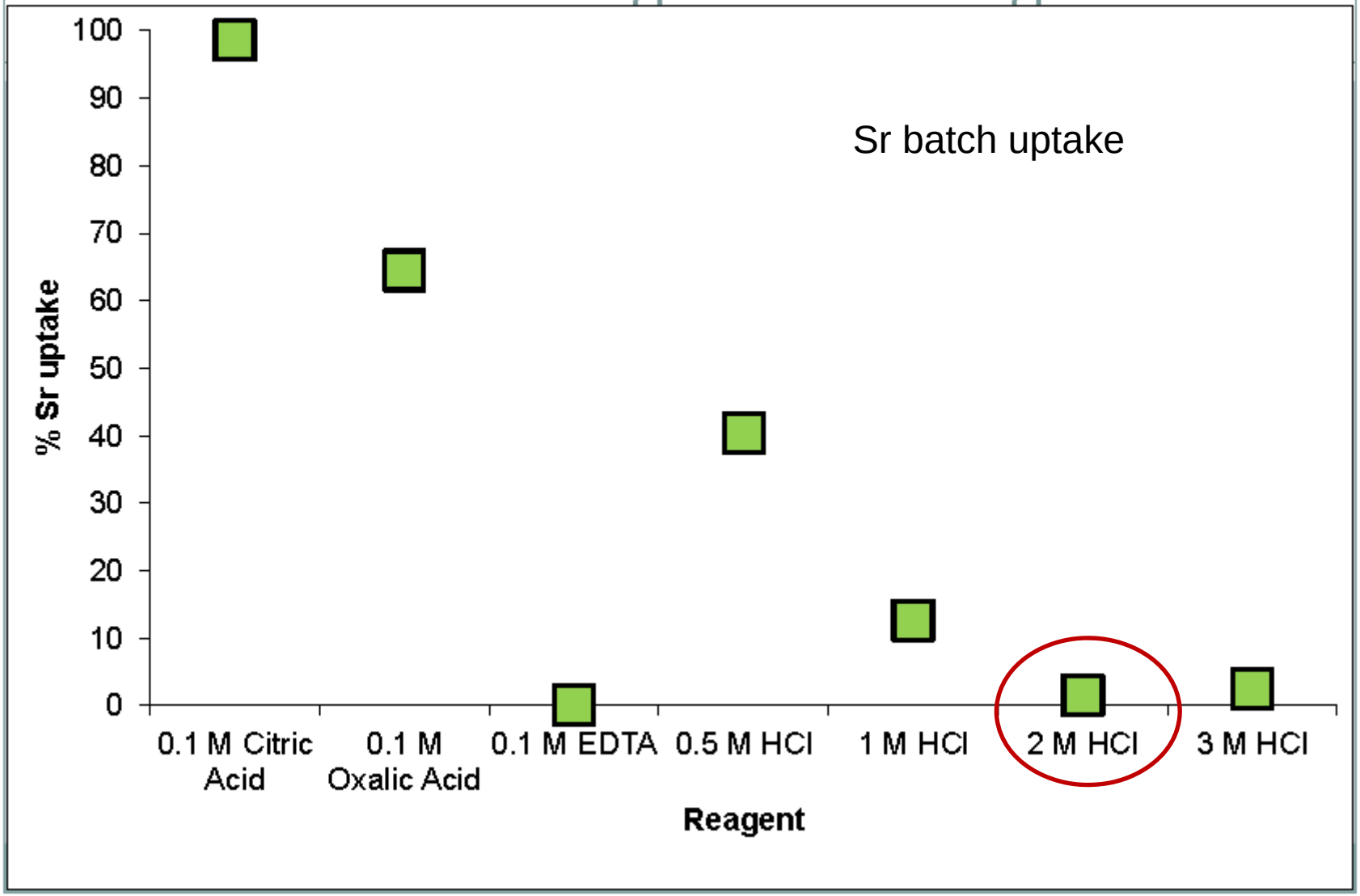
- pH 7
- Batch experiments



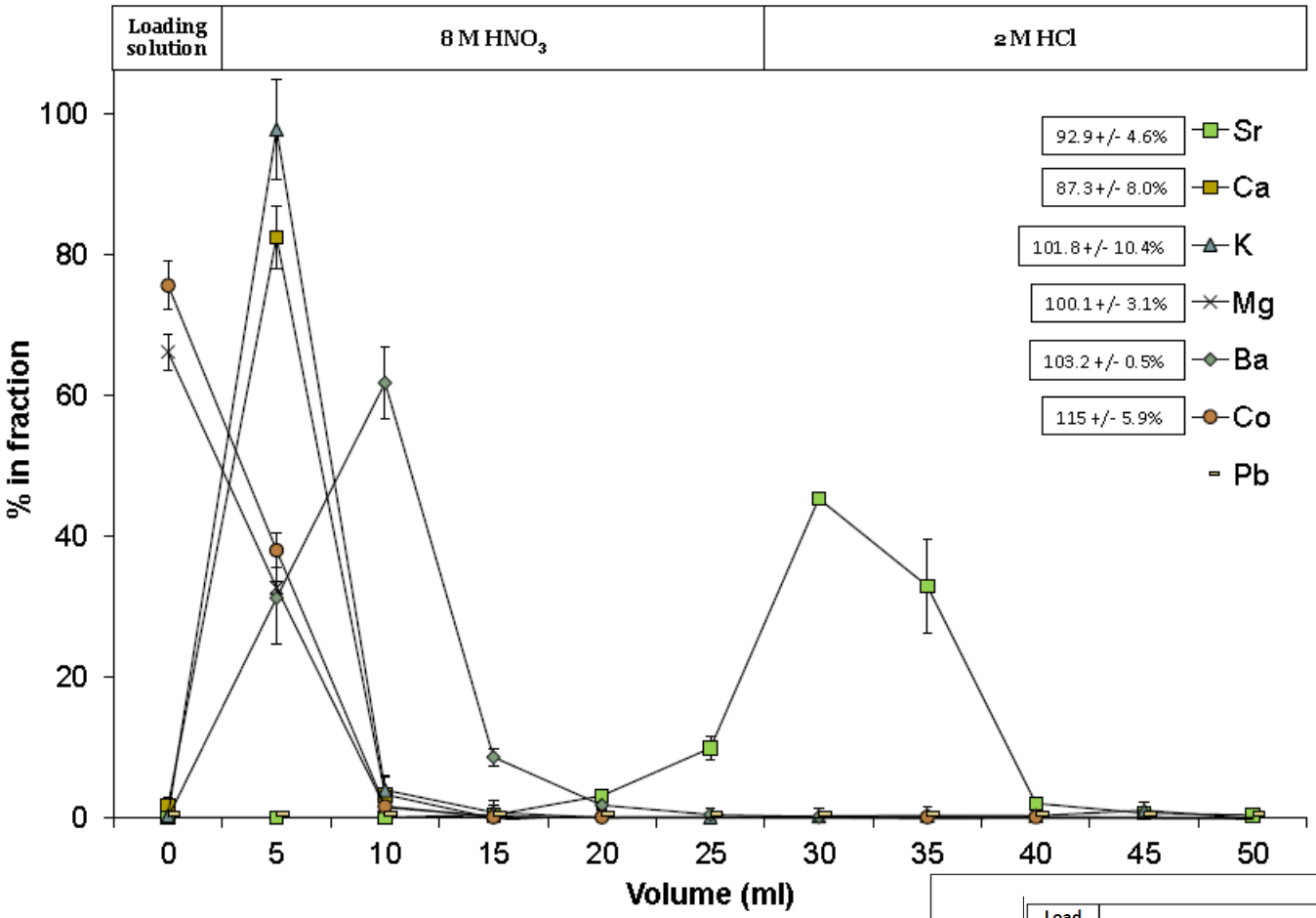
The Lancaster Environment Centre

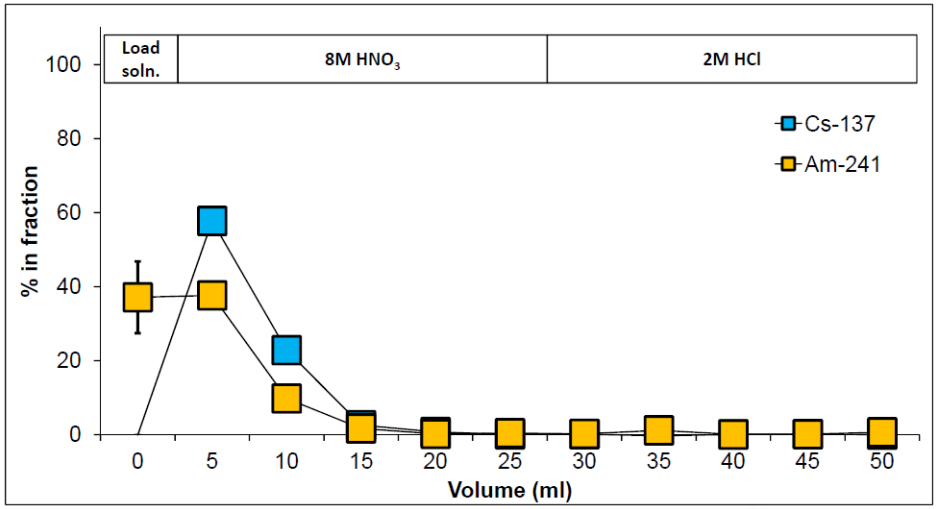
LANCASTER UNIVERSITY

Elution reagent screening



INTERNATIONAL


Loading solution
8 M HNO3
2 M HCl
% in fraction
Volume (ml)
92.9+/- 4.6%
Sr
87.3+/- 8.0%
Ca
101.8+/- 10.4%
K
100.1+/- 3.1%
Mg
103.2+/- 0.5%
Ba
115+/- 5.9%
Co
Pb


Load soln.
8M HNO3
2M HCl
% in fraction
Volume (ml)
Cs-137
Am-241

Application tests

- First experiments
  - Batch
    - Sr-90 spiked water sample, pH 7, 1L
    - 1h extraction, vortex
    - Transfert to column, separation/elution
    - LSC measurement
  - Elution study (column experiment)
    - pH7, 1 mg Sr, 100 mg Ca, 5 mg K, 0.1 mg Pb, Y, U
    - 1L sample, 100 mL aliquots
    - Vacuum supported separation, 5 mL/min
    - ICP-MS measurement

TRISKEM INTERNATIONAL

Batch experiments - I

- 0.7 g of resin added to 1 litre of DI water spiked with ^{90}Sr, shaken for **1** hour
- Supernatant and resin separated, resin loaded onto a column
- Column washed with 15 ml 8M HNO_3 and 20 ml 2M HCl
- Fractions dried down, redissolved in 3 ml 1M HCl and counted by LSC
- Rapid method but Sr yield only 43%

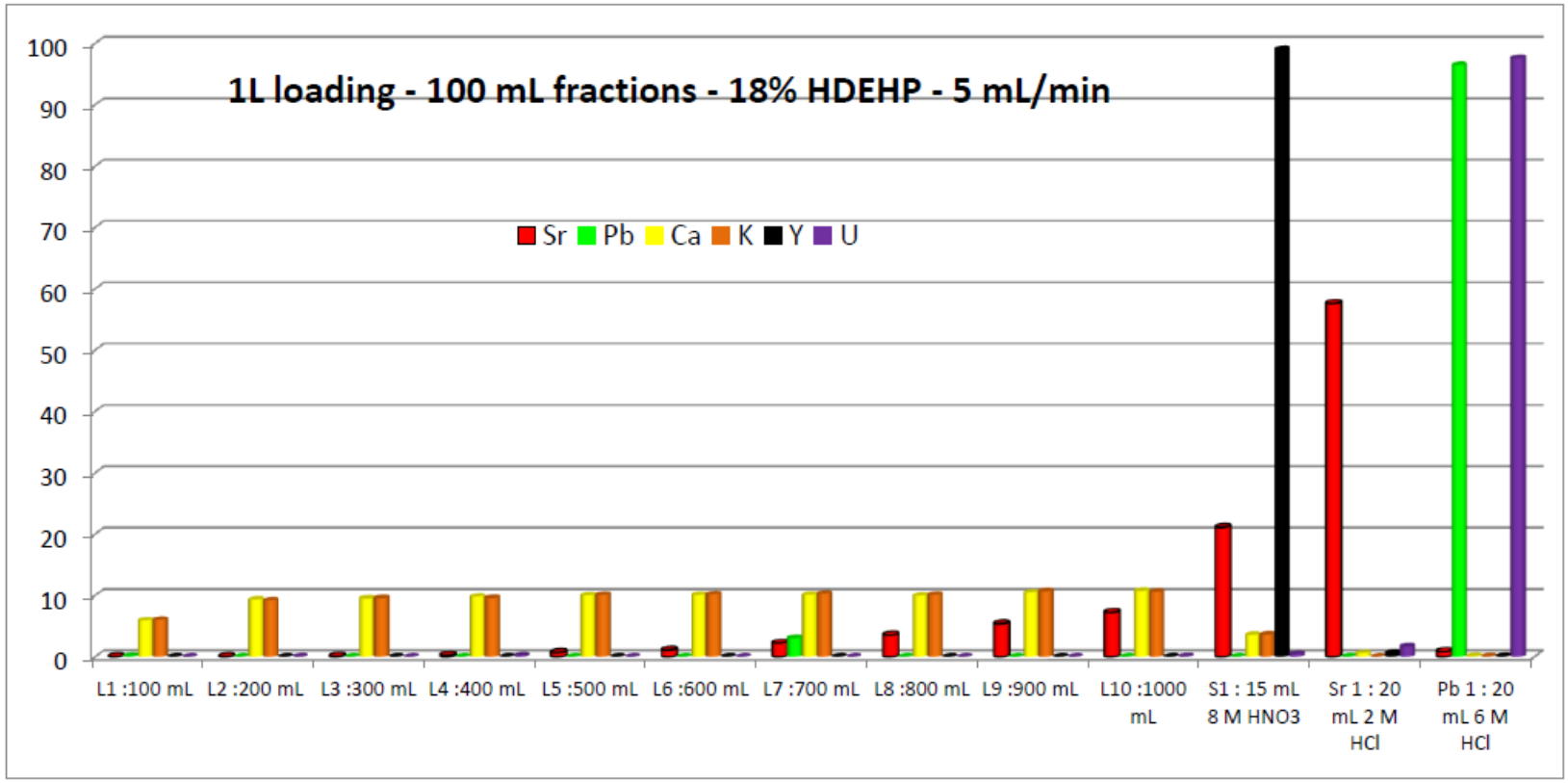
TRISKEM INTERNATIONAL

Batch experiments - II

- 0.5 g of resin added to 1 litre of DI water spiked with ^{90}Sr, shaken for **1** hour
- Supernatant and resin separated, resin loaded onto a column with a 0.4 g ‘guard layer’ of fresh resin to lower Sr breakthrough
- Column washed with 15 ml 8M HNO_3 and 20 ml 2M HCl
- Fractions collected and counted by LSC
- Sr yield improved to 73%

TRISKEM INTERNATIONAL

Column breakthrough study – direct load

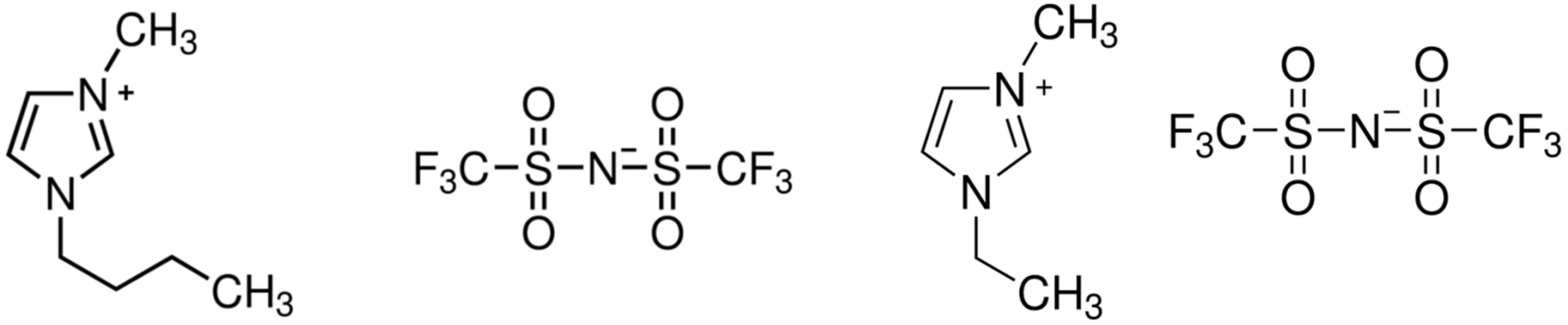


- 2 mL column
- 1L water samples, pH 7, 1 mg Sr, 100 mg Ca, 5 mg K, 0.1 mg Pb, Y, U 5 mL/min
- 100 mL fractions
- Sr breakthrough starts at 600 mL
- For 1L sample volume Sr yield ~58%
- Pb fraction also contains U

TRISKEM INTERNATIONAL

2nd Option: RTILs

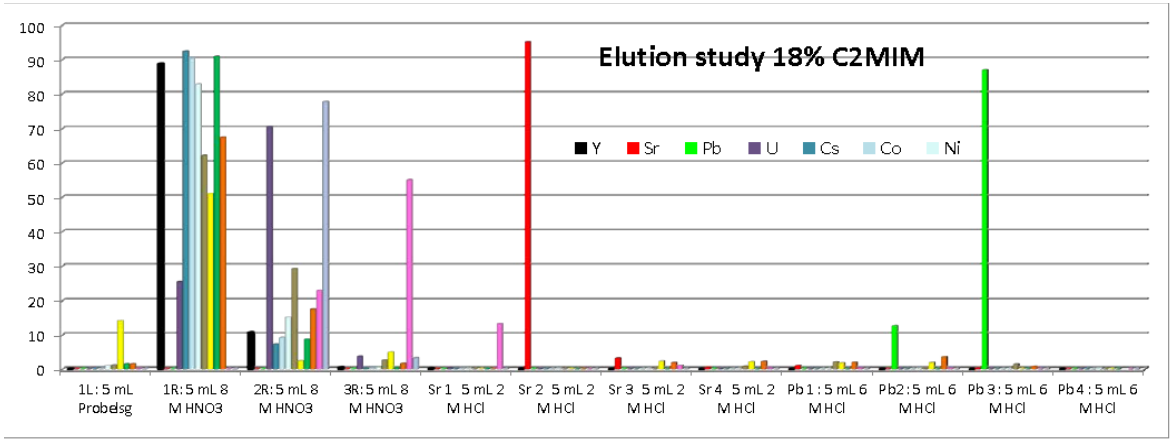
- Use of room temperature liquids (RTILs) instead of HDEHP

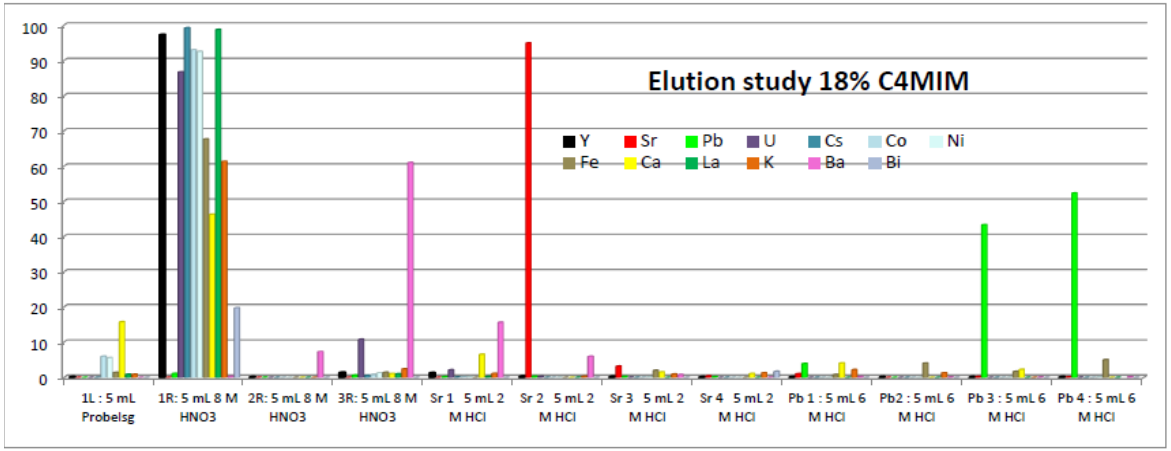


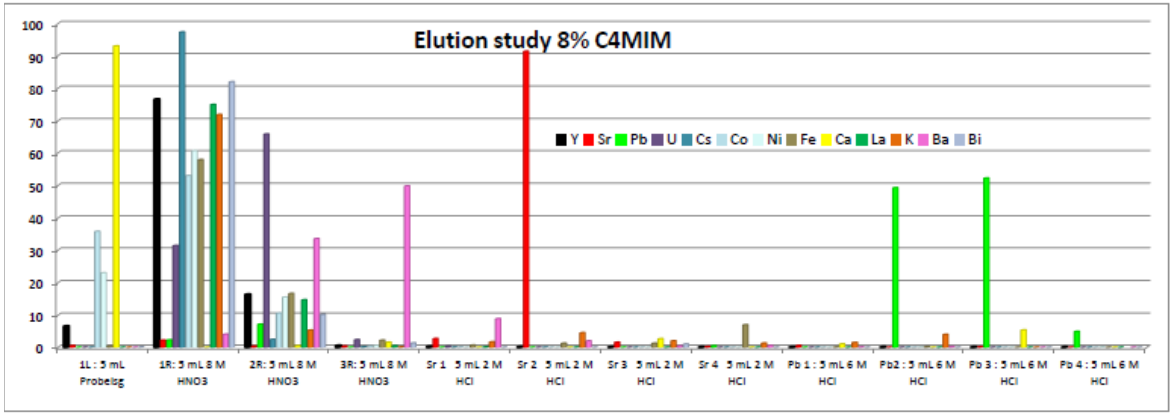
1-Butyl-3-methylimidazolium bis(trifluoromethylsulfonyl)imide (**BMIM**)

1-Ethyl-3-methylimidazolium bis(trifluoromethylsulfonyl)imide (**EMIM**)

TRISKEM INTERNATIONAL







- Load: 5 mL pH 7, multi-element solution
- Rinse with 3x5 mL 8M HNO_3,
- Sr elution with 4x5 mL 2M HCl
- Pb elution with 4x5 mL 6M HCl

- Similar elution characteristics
- Improved purity of Pb fraction

- Breakthrough experiments on-going
- Additional extractants (synergistic systems)

TRISKEM INTERNATIONAL

Conclusion

- On-going work
- Modified Sr resin
  - ➢ Use of HDEHP and RTILs results in extended uptake pH range (pH 8 to high nitric acid)
- Sr selectivity remains good, Sr separation possible
- Very good potential for Pb separation
- First batch and column tests on 1L samples
  - Improvement necessary

- Discs for increased flow
- DGT tests

TRISKEM INTERNATIONAL

Thank you for your attention!

TRISKEM

SHARING INNOVATION

TRISKEM INTERNATIONAL

Parc de Lormandière Bât. C - Rue Maryse Bastié - Campus de Ker Lann - 35170 Bruz - FRANCE

Tel +33 (0)2.99.05.00.09 - Fax +33 (0)2.99.05.07.27 - www.triskem-international.com - email : contact@triskem.fr