TRISKEM INFOS
N°26
05/2026

SUMMARY

Edito :

Dear customers,

We hope that the new year has started well for you, despite the severe weather and political uncertainty that have marked these first few months. Your trust and loyalty remain a source of daily motivation for us.

We are delighted to share with you the latest developments at our company, which reflect our ongoing commitment to innovation, quality and support for your activities.

We are pleased to offer you solutions that are increasingly effective and tailored to your needs. Please find in this latest issue of our newsletter information about the TK227 Resin, which can be used to determine Sr-90 via Y-90 in large volumes of seawater (50 to 60 litres), and the TK-GA Discs, which are designed for the screening for actinides in water samples. After filtration, these discs enable effective measurement via alpha spectrometry.

As part of our Corporate Social Responsibility (CSR) approach, we have finalised our CSR brochure, which is now available on request. This document details our actions in favour of sustainable development, ethics and the continuous improvement of our practices. Please do not hesitate to contact us to obtain a copy.

The development of our employees and the arrival of new talent allow us to devote even more time to your technical support. Whether remotely or directly in your laboratories, we are at your side to respond to your needs.

TK Resins

We have received numerous questions about the naming of the "TK Resins". While there is no strict systematic behind the respective names, there are some guidelines!

Resins	Main domain of application
TK1NN	environmental monitoring
TK2NN	radiopharmaceutical
TK3NN	decommissioning
TK4NN	geochemistry
TK5NN	hydrometallurgy
TK6NN	*customized resins*

Further we try to regroup them by type of extractant used:

TK100/1/2 = extractant is a crown ether
TK211/2/3 = extractants are organo-phosphoric, -phosphonic or -phosphinic compounds
TK221/2/5/7 = resin contains *i.e.* DGA

New production equipment

To meet the growing demand for our resins, we have installed a new production equipment. While the production process itself remains unchanged, the new equipment enables us to produce batches of up to 8 kg of resin, compared to the previous maximum of 2 kg.

To validate the manufacturing process and ensure that the quality of our products remains unaffected by this scale-up, we have established the following quality criteria:

- Criterion 1: **Homogeneity of impregnation**
- Criterion 2: **Integrity of resin beads**
- Criterion 3: **Residual solvent content at 105°C**
- Criterion 4: **Separation of analytes, in accordance with standard product quality control**

The new equipment has been successfully validated according to these criteria. The validation report is available for consultation on-site.

We remain committed to delivering the highest quality service, and these improvements are part of our ongoing commitment to continuous improvement.

Triskem Infos / ISSN 2116-6145 / Publication Director: Michaela Langer; Editing: Steffen Happel; Graphic Design: Alice Soares

TK227 Resin

The TK227 Resin is based on a diglocylamide (TO-DGA) and small amounts of an ionic liquid and a long-chained alcohol. The ionic liquid is added to increase Y retention at lower HNO_3 concentrations.

Its main application is the determination of Sr-90 in seawater samples via Y-90 separation and measurement as described by Kim et al. [1 - 4]. The published method is a rapid procedure for the extraction and purification of Y-90 from large sea water samples (*e.g.* 60kg) that allows obtaining results in a few days (including measurement, the actual separation takes less than 4 h) instead of several weeks. It thus represents a potential gain of time that is very significant.

The TK227 Resin showed better performance than the originally employed DGA, N Resin and can thus replace the latter in the above-mentioned method. (*An overview over the method can be found below*).

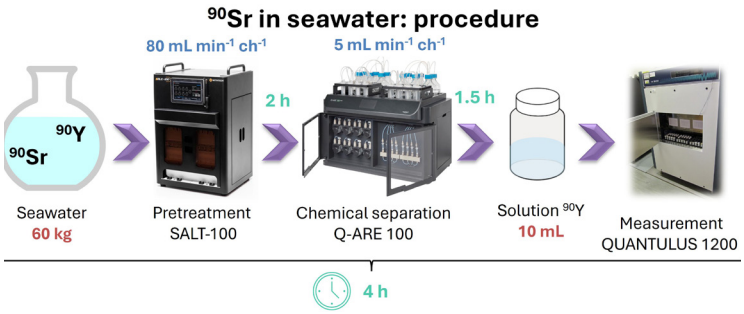

Figure 1: Workflow Sr-90 determination in seawater according to Kim et al. [1 – 4]

Typically, 60 kg seawater are pretreated (filtration, acidification to 3 M HNO_3, followed by the addition of 3 – 4 mg Y carrier).

Y is preconcentrated from sea water samples on an equipment specifically developed for this type of applications (SALT-100, WITHTEC Ltd, South Korea) at 80 mL/min per channel using a combination of two 1 mL DGA or TK227 Resin cartridges per channel (overall 16 cartridges). With eight channels being used the overall flow rate is in the order of 640 mL/min.

Once the Y has been concentrated on the cartridges the eight sets of stacked cartridges are moved into a Hidex Q-ARE 100 (Hidex Oy, Finland) system that allows for an automized multi-step purification of the Y.

The respective steps are shown in fig. 2, while fig. 3 gives an overview which impurity is eliminated in which step.

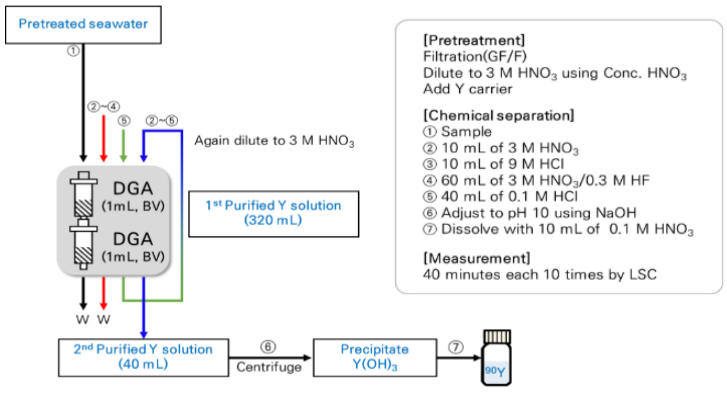

Figure 2: Scheme of the Y separation from seawater [1]

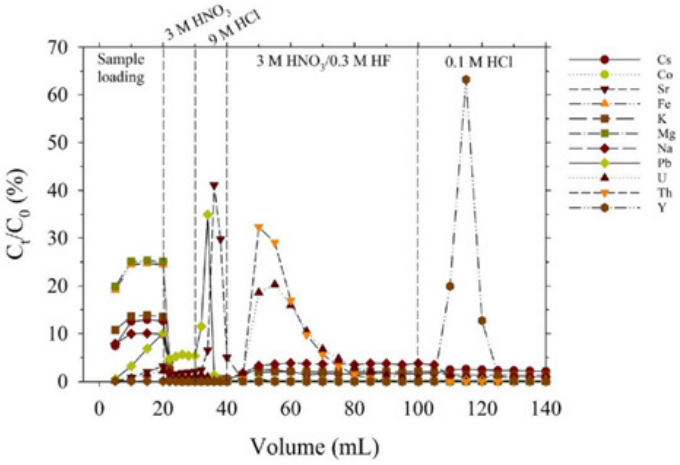

Figure 3: Separation of Y from interferences on DGA,N [1]

The separation on the Q-ARE 100 is performed at 5 mL/min. Y is eluted from the eight channels (16 cartridges) with 40 mL 0.1 M HCl per channel cartridges (overall 320 mL).

To lower the volume of the Y eluate, and to allow further purification, a set of two stacked cartridges is moved to the SALT-100 unit. The Y eluate (320 mL of 0.1 M HCl) is adjusted to 3 M HNO_3 and loaded onto the cartridges at 80 mL/min. The stacked cartridges that are now containing the Y are then moved back to the Q-ARE 100 unit to go through an additional purification cycle (see fig. 2) and finally elution in 40 mL 0.1 M HCl.

The Y-90 sample is prepared for counting by precipitation at pH 10 and redissolution in 10 mL 0.1 M HNO_3. An aliquot of the sample is taken and analysed by ICP-OES for Y yield determination. The remaining sample is analysed for 10x 40 minutes in Cerenkov mode.

For 50 L of seawater and the described counting modalities result in an MDA of 0.16 ± 0.1 mBq/m³ was reported [4]. Y yields were typically greater 90%.

Graphs 4 – 9 show the selectivity of the TK227 Resin for a wide range of elements in HCl and graphs 10 – 15 in HNO_3. All D_W values shown in

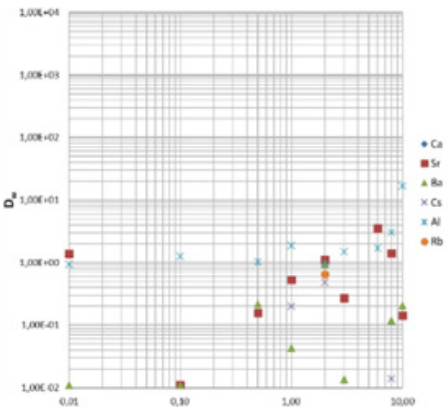

Figure 4 : D_W values, TK227, selected elements, HCl

None of the tested elements show significant retention on TK227 in HCl.

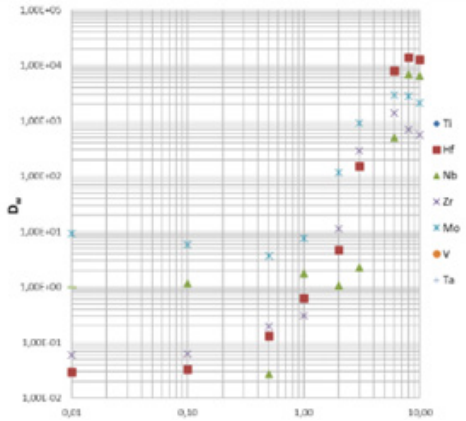

Figure 5 : D_w values, TK227, selected elements, HCl

Higher valent elements such as Hf, Zr, Mo and Nb are well retained at elevated HCl concentrations. At lower HCl concentrations the retention decreases quite steeply.

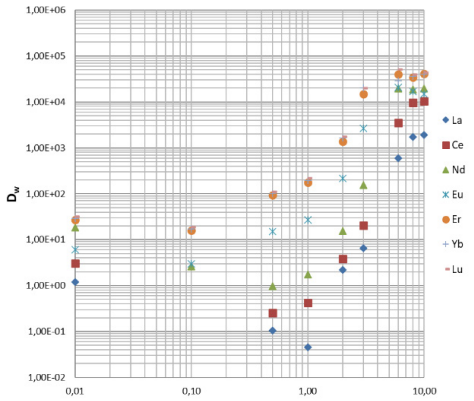

Figure 6 : D_w values, TK227, selected elements, HCl

All lanthanides are well retained at high HCl concentrations. To be noted, the retention of the heavy lanthanides is significantly higher than the retention of light lanthanides. In general, an elution of the lanthanides may be performed at low HCl concentrations.

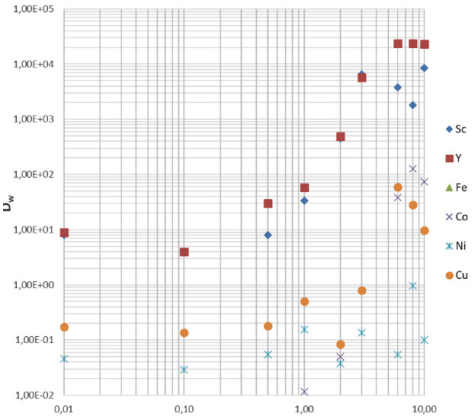

Figure 7 : D_w values, TK227, selected elements, HCl

Y and Sc show a behaviour similar to the lanthanides, high to very high retention in high HCl, elution in dilute HCl. Tested transition metals are generally not well retained, with the exception of Cu and Co which show some retention at 6-8 M HCl.

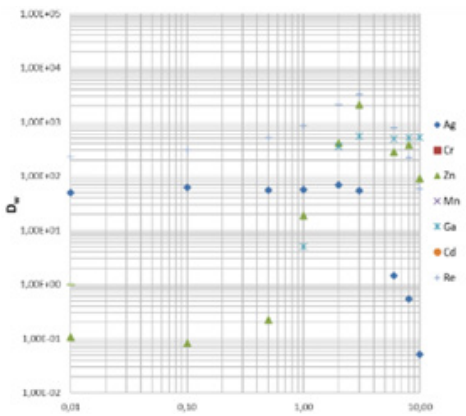

Figure 8 : D_w values, TK227, selected elements, HCl

Elements such as Zn and Ga show fairly high retention from 2 M HCl onwards. Ag is to a certain extent retained at lower HCl concentrations, while showing strong decrease at high HCl concentrations.

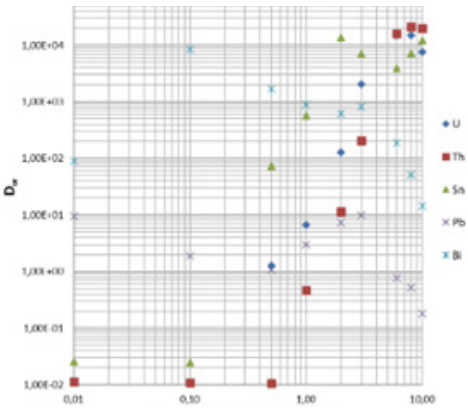

Figure 9 : D_w values, TK227, selected elements, HCl

U, Th and Sn show negligeable retention at less then 2 M HCl, above this HCl concentration though retention increases strongly. Bi shows contrary behaviour, strong retention at low HCl and decreased retention at high HCl concentration (*e.g.* 10 M).

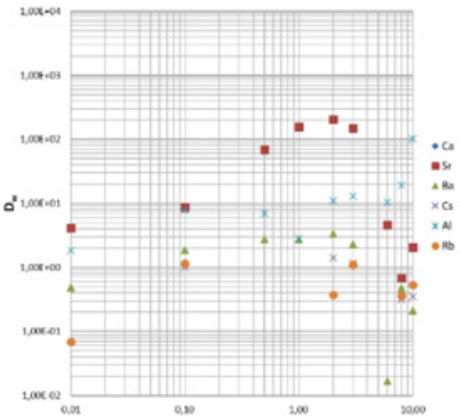

Figure 10 : D_w values, TK227, selected elements, HNO_3

Out of the tested elements only Sr is well retained on TK227 between 1 M and 3 M HNO_3.

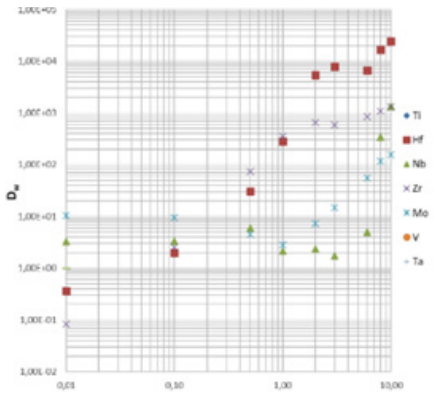

Figure 11 : D_W values, TK227, selected elements, HNO_3

Similar to HCl, higher valent elements such Hf, Zr, Nb and to a lesser extent Mo, are well retained at elevated HNO_3 concentrations.

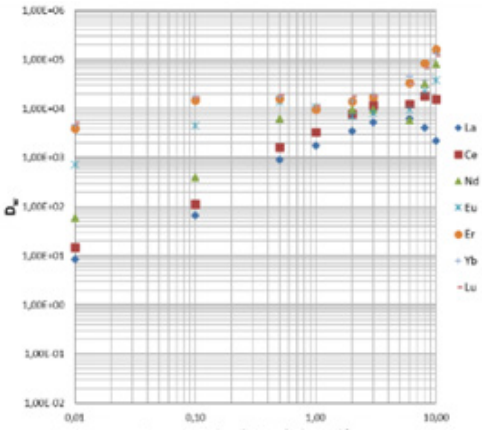

Figure 12 : D_W values, TK227, selected elements, HNO_3

All lanthanides are very well retained at elevated HNO_3 concentrations. Heavier lanthanides remain well retained even at low acid concentrations. Overall dilute HCl seems to represent the best option for lanthanide elution.

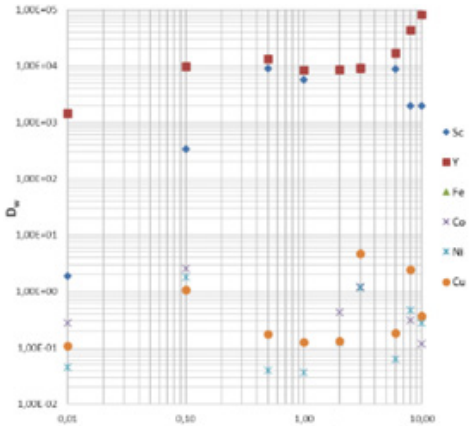

Figure 13 : D_W values, TK227, selected elements, HNO_3

Y and Sc are very well retained at high HNO_3 concentrations. While Sc retention decreases at low HNO_3 concentrations, the Y retention remains very high. Indeed, Y requires elution with dilute HCl, similar to the lanthanides. Tested transition metals showed no significant retention in HNO_3.

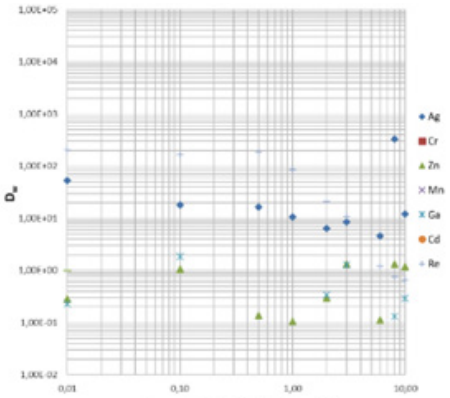

Figure 14 : D_W values, TK227, selected elements, HNO_3

None of the tested elements show strong retention on TK227 from HNO_3.

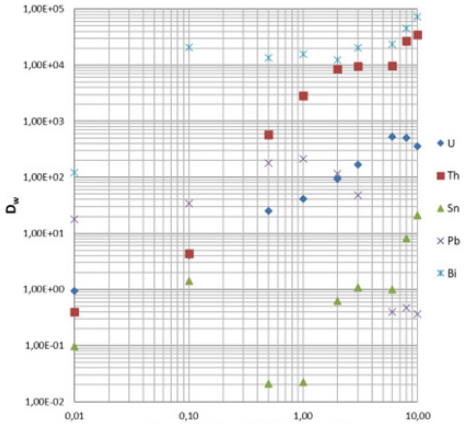

Figure 15 : D_W values, TK227, selected elements, HNO_3

U and Th show good to high retention on the TK227 from elevated HNO_3. Bi is overall well retained, even at rather low HNO_3 concentrations. Pb is quite well retained from 0.5 – 1 M HNO_3.

The following graphs show the results of elution studies with the aim of concentrating and separating Y from various types of water samples. In these tests 2 mL cartridges and 1 L water samples acidified to 0.1 – 0.2 M HNO_3 were employed. To show the effect of the ionic liquid added to the composition of the TK227 Resin results are compared to results obtained with DGA, N Resin. Important: it should be noted that Y needs to be present in mg amounts in such experiments, at trace concentrations Y will not be eluted quantitatively.

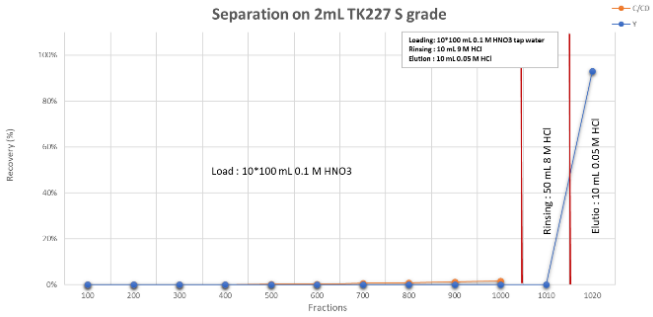

Figure 16 : Elution study, 1 L tap water, loading from 0.1 M HNO_3, Y separation, 2 mL TK227 Resin cartridge

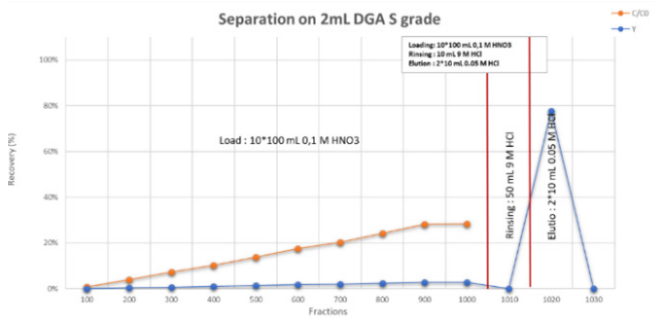

Figure 17 : Elution study, 1 L tap water, loading from 0.1 M HNO_3, Y separation, 2 mL DGA, N Resin cartridge

It can be seen that while TK227 Resin allows for quantitative retention of Y from 0.1 M HNO_3, DGA, N Resin shows significant breakthrough under these conditions.

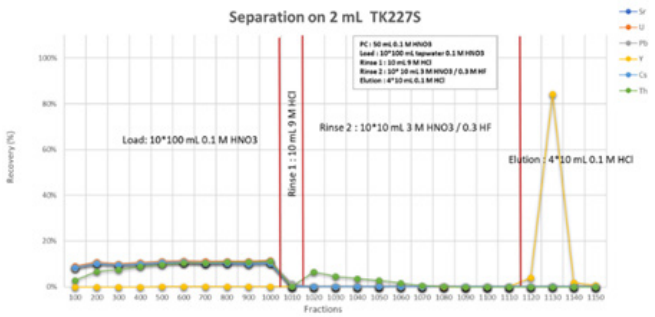

Figure 18: Elution study, 1 L tap water, loading from 0.1 M HNO_3, Y separation from selected elements, 2 mL TK227 Resin cartridge

Fig. 18 shows that Y can be preconcentrated from tap water (0.1 M HNO_3) and then purified. The shown separation scheme allows for the removal of all considered impurities.

- Bibliography

(1) Hyuncheol Kim and Gahyun Kim: "A simple and straightforward technique for analyzing radionuclides in sea water" presented at the Raddec/TrisKem Workshop (as part of the 2024 LSC conference) on April 18 in Portsmouth (UK). Available online: https://www.triskem-international.com/scripts/files/662fa5023ef284.68970177/raddec_tki-ws-2024_6_kim.pdf

(2) Video KAERI Method: "Simple and Straightforward technique for Sr-90 analysis in seawater". Available online: https://www.youtube.com/watch?v=i2R2b98oTCU

(3) Hyuncheol Kim, Yoo Gyum Kang, Yong-Jin Lee et al.: "Automated extraction chromatographic radionuclide separation system for analysis of 90Sr in sea water", Talanta 217 (2020) 121055. https://doi.org/10.1016/j.talanta.2020.121055

(4) Gahyun Kim, Sang-Do Choi, Jong-Myoung Lim, Hyuncheol Kim, Strontium-90 levels in seawater southeast of Jeju Island during 2021–2023, Marine Pollution Bulletin, Volume 193, 2023, 115258. https://doi.org/10.1016/j.marpolbul.2023.115258

Sea water samples show a similar trend to tap water samples. Due to the high matrix load these samples have to be acidified a more strongly (≥ 0.2 M HNO_3) to achieve elevated yields.

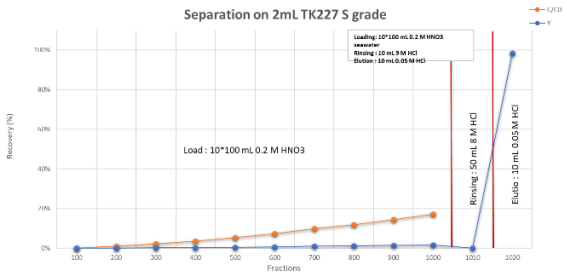

Figure 19 : Elution study, 1 L sea water, loading from 0.2 M HNO_3, Y separation, 2 mL TK227 Resin cartridge

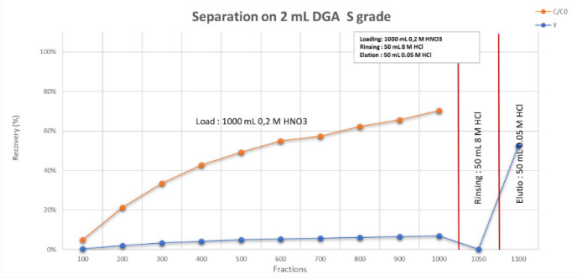

Figure 20 : Elution study, 1 L sea water, loading from 0.2 M HNO_3, Y separation, 2 mL DGA,N Resin cartridge

For sea water samples TK227 Resin shows some breakthrough, too – much less than DGA, N though. In order to obtain even higher Y yields for sea water samples the HNO_3 concentration needs to be increased further.

News

European Users Group Meeting

It has become one of our traditions to hold a European Users Group Meeting directly after the International Symposium on Nuclear and Environmental Radiochemical Analysis (ERA), and this year is no exception!

ERA 15 is taking place from September 7 to 10 in Portsmouth (UK), and we are very much looking forward to welcoming you to our European UGM, also in Portsmouth, on the 11th of September.

You will find further information on our web site soon.

We are very much looking forward to meeting you there!

Building extension

To better meet your needs and uphold the quality service you deserve, we are expanding our technical area. This growth will enable us to enhance our operations and serve you even more efficiently.

As we undertake this exciting project, we are committed to minimizing any disruption. You can count on us to maintain sufficient stock levels, ensuring your orders are fulfilled within our usual timeframes.

TK-GA Discs

The TK-GA (Gross Actinides) Discs are specialty membrane filters impregnated with an extractant system that shows very strong retention of actinides from acidified (pH 1 or 2, for some actinides even up to 3 M HNO_3) water samples. They are the first product of a new range of such impregnated membrane filters ('Discs'). It's main application is the screening for actinides in aqueous samples via alpha spectrometry [1, 2]. Other potential applications of such Discs include passive sampling [3, 4] or analyte preconcentration via filtration [5].

An outline for a typical actinide screening procedure in aqueous samples is shown in fig. 1.

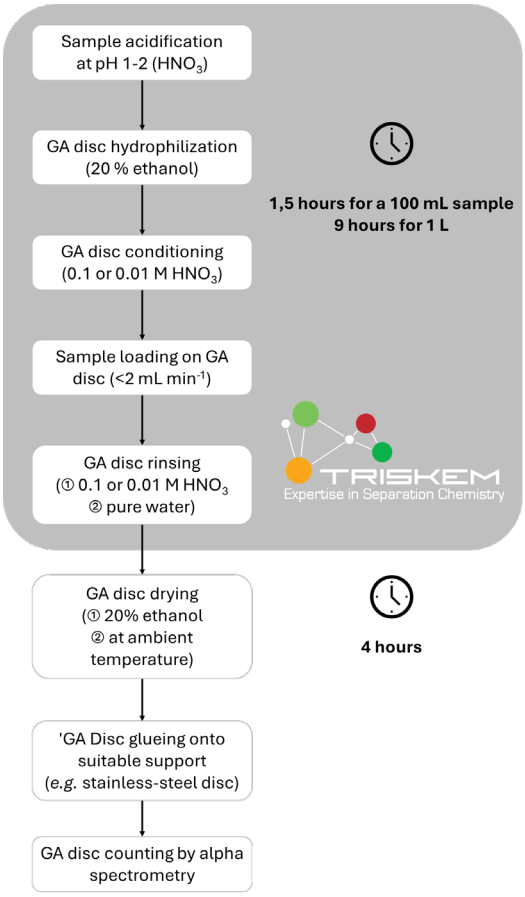

Figure 1: Sample preparation scheme TK-GA Discs for alpha spectrometry

The aqueous sample is first acidified to pH 1 or 2 and, in case this is necessary, filtered to remove fine particles that could interfere with the alpha spectrometric measurement. The TK-GA Disc is then preconditioned with 20% EtOH (hydrophilization step) followed by rinses with water and 0.01 M or 0.1 M HNO_3 (for Th *e.g.* it is preferable to work at pH 1).

The aqueous sample is then filtered through the TK-GA Disc, for best recovery and peak resolution of the alpha spectrum the filtration should ideally be performed at ≤2 mL/min.

It should be noted that the TK-GA Discs are available in two diameters: 25 mm and 47 mm. 25 mm discs are typically used for up to ~100 mL samples, the 47 mm discs for up to 1 L samples.

Once the sample has been completely passed through the Disc it is subsequently rinsed with dilute acid, water and 20% EtOH, and air dried.
The dried disc is then glued onto a suitable support (*e.g.* stainless steel disc), and is then introduced into an alpha spectrometry system for measurement.

The following graphs show some examples of alpha spectra obtained using the TK-GA Discs.
All shown spectra were obtained by Bailly et al. [1] as part of the LabCom 'TESMARAC' cooperation.

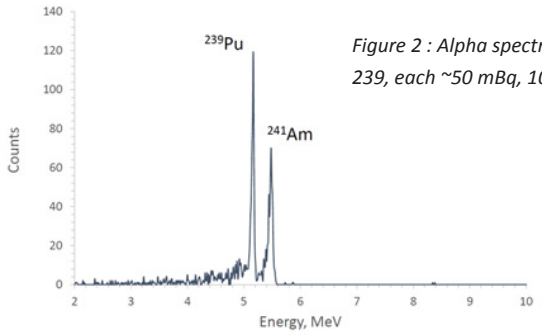

Figure 2 : Alpha spectrum, Am-241 & Pu-239, each ~50 mBq, 100 mL pH 2 HNO_3

As can be seen in fig. 2, the spectral resolution of the Am and Pu peaks are good to very good (30 – 100 keV) for a filtration based sample preparation. Typically 80 - >90% of the respective actinides are detected by alpha spectrometry, indicating that the actinides are to a very high extent fixed on the surface of the Discs.

Fig. 3 shows that Th is very well retained from acidified Pedras mineral water (acidified to ~0.1 M HNO_3), Ra on the other hand is not retained, and Po only weakly. Fig. 3 further shows the alpha spectrum of Pedras water obtained directly after filtration, and after 12 days of ingrowth of its daughters.

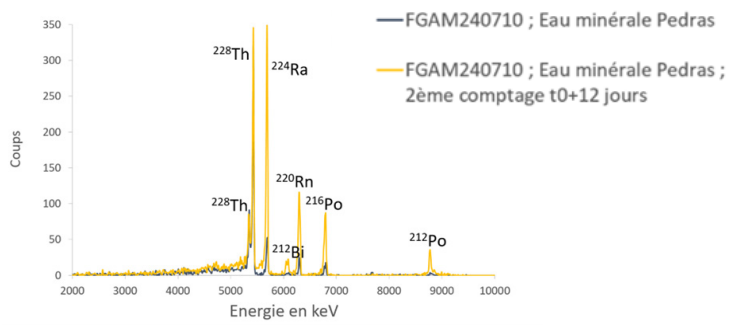

Figure 3 : Alpha spectrum, 47 mm TK-GA Disc, Pedras mineral water, 100 mL pH 1.25

Fig. 4 shows the alpha spectrum of a Ra-226 containing solution at 0.01 M HNO_3.

It could be confirmed that Ra-226 is not showing any signal in the alpha spectrum, it is indeed not retained as indicated in the Pedras water test (fig. 3). In an additional experiment at pH 4 it could be shown that while Ra is retained on the disc at this pH again no signal could be detected in the alpha spectrum, indicating that Ra is retained within the disc, and not on the surface.

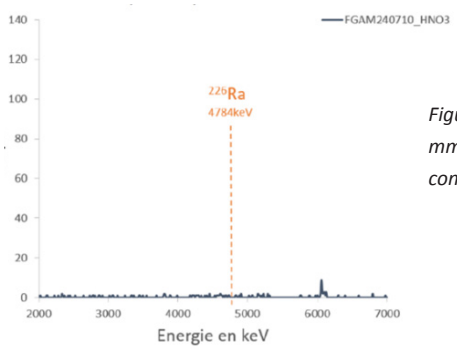

Figure 4 : Alpha spectrum, 47 mm TK-GA Disc, 100 mL Ra-226 containing solution, 0.01 M HNO_3

A similar test was performed with a solution containing U-238 and Po-209 in 0.01 M HNO_3. While U is very well retained, Po is only showing partial retention.

Here, the influence of Ca especially on the U retention was tested by running the test also at elevated Ca concentrations (0.1 g/L), no adverse effect was found to be induced by Ca.

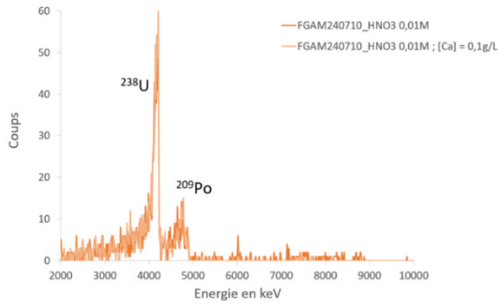

Figure 5 : Alpha spectra, 47 mm TK-GA Disc, 100 mL U-238 and Po-209 containing solutions, 0.01 M HNO_3

Pu is even strongly retained from high matrix samples such as sea water (fig. 6) and highly acidic samples such as 3 M HNO_3 (fig. 7). Under the same conditions Am is distinctively less well (sea water) or not retained (3 M HNO_3).

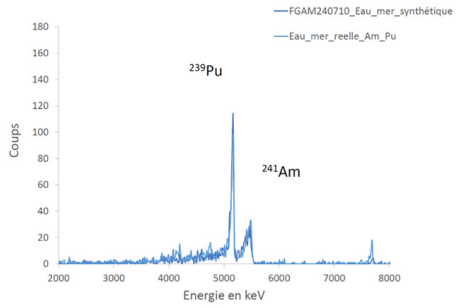

Figure 6 : Alpha spectrum, 47 mm TK-GA Disc, 100 mL natural and syntethic sea water samples containing Am and Pu, acidified to pH 2

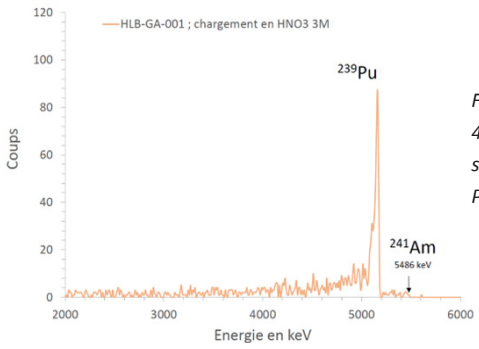

Figure 7 : Alpha spectrum, 47 mm TK-GA Disc, 100 mL solution containing Am and Pu, acidified to 3 M HNO_3

Th is also retained from 3 M HNO_3, not quite as well as from pH 1 or 2 though, and the peak resolution is distinctively less sharp.

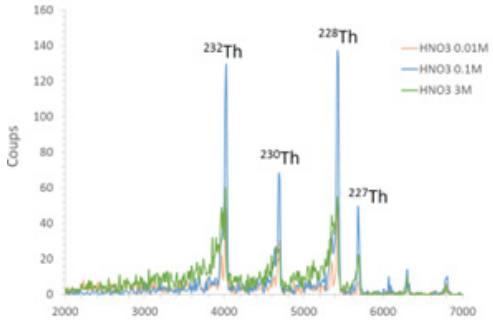

Figure 8 : Comparison of alpha spectra obtained with 47 mm TK-GA Discs for Th solutions of varying acid concentrations (0.01 M, 0.1 M and 3 M HNO_3)

- Bibliography

(1) C. Bailly et al. Selective impregnated Membrane Filters for Direct Alpha Spectrometric Analysis of Actinides; Applied Radiation and Isotopes, in preparation

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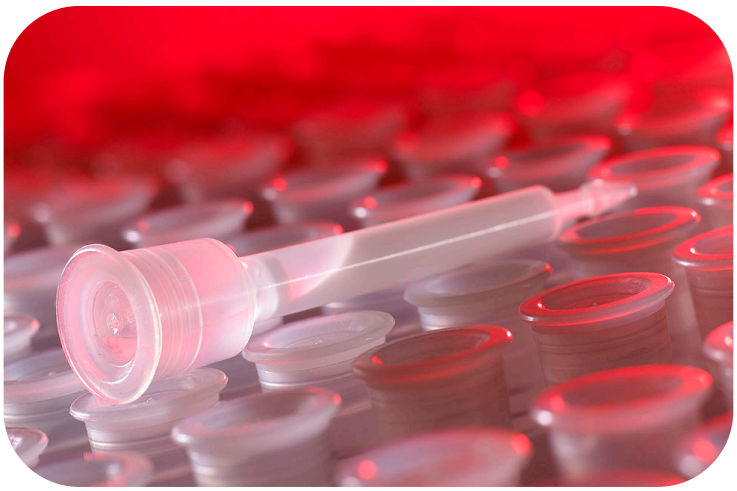
(3) S. Wagner, J. Santner, J. Irrgeher et al. Selective Diffusive Gradients in Thin Films (DGT) for the Simultaneous Assessment of Labile Sr and Pb Concentrations and Isotope Ratios in Soils. Anal Chem, 2022, 94, 16, 6338 - 6346. https://doi.org/10.1021/acs.analchem.2c00546

(4) Wagner, S., Santner, J., Puschenreiter, M. et al. Prediction of radiogenic Sr and Pb isotope signatures in plants using diffusive gradients in thin films. Anal Bioanal Chem 418, 1541–1555 (2026). https://doi.org/10.1007/s00216-026-06315-6

(5) M. Horstmann , C. Derrick Quarles Jr , S. Happel et al. : Quantification of technetium-99 in wastewater by means of automated on-line extraction chromatography – anion-exchange chromatography – inductively coupled plasma-mass spectrometry. J. Anal. At. Spectrom., 2024, 39, 2774-2782, https://doi.org/10.1039/D4JA00270A



Agenda

TrisKem will be participating in the following upcoming conferences and is very much looking forward to meeting and discussing with you there!

- **13th International Symposium of Targeted Alpha Therapy** (TAT 13), 14–16.04, Rio de Janeiro (Brasil) – meet us at our booth n°6
  https://www.tat13.com/

- **COGER 2026**, 14-16.04, Stirling (GB)
  https://www.coger.org.uk/our-conference

- **22nd European Symposium on Radiopharmacy and Radiochemistry** (ESRR'26), 16-19.05, Bergen (Norway) - Rencontrez-nous à notre stand n°2
  https://www.esrr.info/

- **International Radioisotope Supply Chain Meeting** – IRIS 2026, 20/21.04, Leiden (Netherlands)
  https://www.euronuclear.org/international-radioisotope-supply-chain-meeting-iris-2026/

- **180°N conference**
  28/29.04, Trondheim (Norway)
  https://www.ntnu.edu/180n/2026conference

- **20th Radiochemical Conference** (RadChem 2026), 10-15.05, Marianske Lazne (Czech Republic) - Meet us at our booth
  https://www.radchem.cz/

- **Canadian Radiotheranostics Leaders' Summit 2026**, 25/26.05, Toronto (Canada)
  Meet us at our booth n° 20
  https://www.canadianisotopes.ca/leaders-summit-2026/

- **SNMMI Annual Meeting 2026**,
  30.05 - 02.06, Los Angeles, CA (USA)
  Meet us at our booth n° 2258
  https://snmmi.org/AM/AM/Home.aspx

- **XIII Jornadas sobre la Calidad en el Control de la Radiactividad Ambiental**,
  02-05.06, Santander (Spain)
  Meet us at our booth
  https://xiiijornadasradiactividad.unican.es/

- **Procorad**, 17-19.06, Varsovie (Poland)
  https://www.procorad.org/discover-intercomparisons/annual-meeting/?lang=en

- **20th Workshop on Targetry and Target Chemistry** (WTTC20), 23-27.08, Nara (Japan)
  Meet us at our booth
  https://wttc20.ric.u-tokyo.ac.jp/

- **15th International Symposium on Nuclear and Environmental Radiochemical Analysis** (ERA15), 07-10.09, Portsmouth (UK)
  Meet us at our booth
  https://www.rsc.org/events/detail/82847/15th-international-symposium-on-nuclear-and-environmental-radiochemical-analysis-era15

- **TrisKem / Raddec European Users Group Meeting**, 11.09, Portsmouth (UK)
  https://www.triskem-international.com/users-group-meetings.php

- **5th International Symposium on Technetium and Other Radiometals in Chemistry and Medicine** (TERACHEM 2026), 23-26.09, Bressanone (Italy)
  Meet us at our booth
  https://www.srsweb.org/terachem2026

- **39th EANM Annual Congress** (EANM'26), 17-21.10, Vienne (Austria),
  Meet us at our booth in Halle X2
  https://eanm26.eanm.org/

- **69th Annual Radiobioassay and Radiochemical Measurements Conference** (RRMC), 08-13.11, Isle of Palms, SC (USA),
  Meet us at our booth and wokrshop
  https://www.rrmc.co/

You'll find an update on our participations to conferences on our website :
https://www.triskem-international.com/ma/events