Research in the years of the economic crisis: A short review of the recent research activities of the Radiochemical Laboratory of the Aristotle University of Thessaloniki.

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THE RESEARCH ACTIVITIES:

1. Study of nuclear reactions of analytical interest (ca. 20%).

2. Application of Ion-Beam Analysis techniques to the characterization and study of near-surface layers of materials (ca. 30%).

3. Investigation of the interactions of radionuclides and heavy metals with natural and synthetic sorbents - Environmental radiochemistry (ca.30%).

4. Radio-analytical Chemistry & Natural radioactivity measurements using alpha- and gamma-spectroscopy (ca. 20%).

Study of nuclear reactions of analytical interest (collaboration with NTUA and NCSR Demokritos)

Nuclear Reaction Analysis (NRA) is well established, in parallel with RBS and NRS, as one of the primary methods in ion beam analysis of light elements in near-surface layers of complex matrices.

Main NRA advantages: (a) high isotopic selectivity, (b) good sensitivity for many nuclides (c) almost non-destructive depth profiling, (d) accurate quantitative analysis and (e) possible simultaneous analysis of multiple light elements.

The application of NRA to the determination of the concentration and the depth distribution of light elements in near-surface layers of materials is frequently impeded by the lack of adequate and/or reliable experimental differential cross section data.

For this reason,

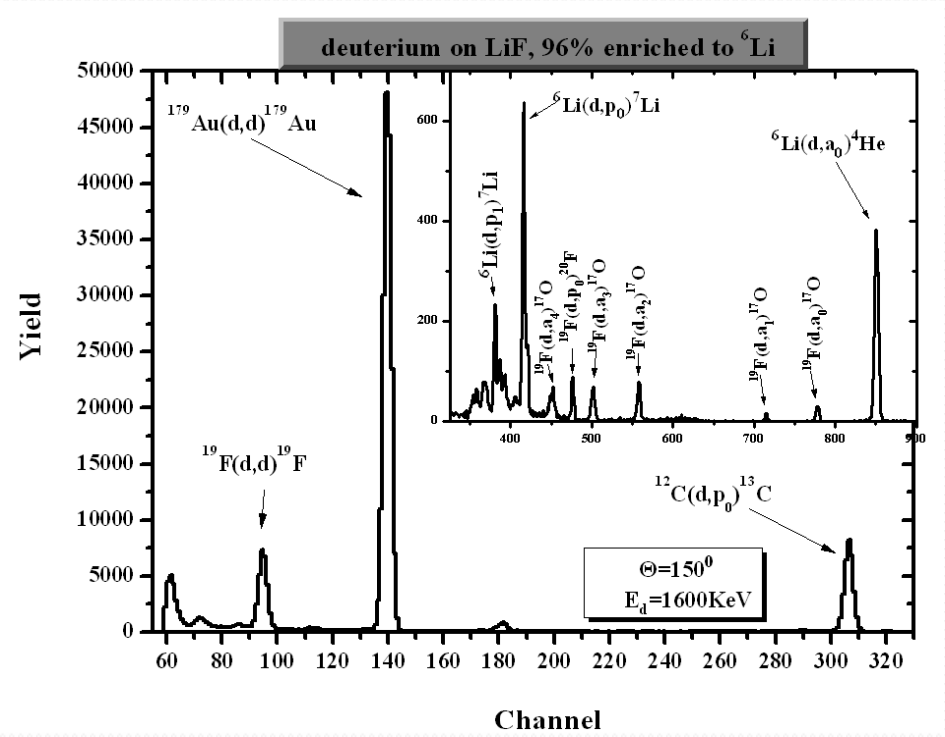
We measured in energy steps of 10 to 25 keV differential cross-sections of d-induced reactions on ^{12}C, ^{10}B, ^{11}B, ^{32}S, ^{14}N, ^{28}Si and ^{6}Li at several backward detector angles (4 to 8 angles between 135 to 170º). In addition, the cross-sections of some p-induced reactions (e.g. K (natural and ^{39}K), ^{11}B, ^{45}Sc) were also measured.

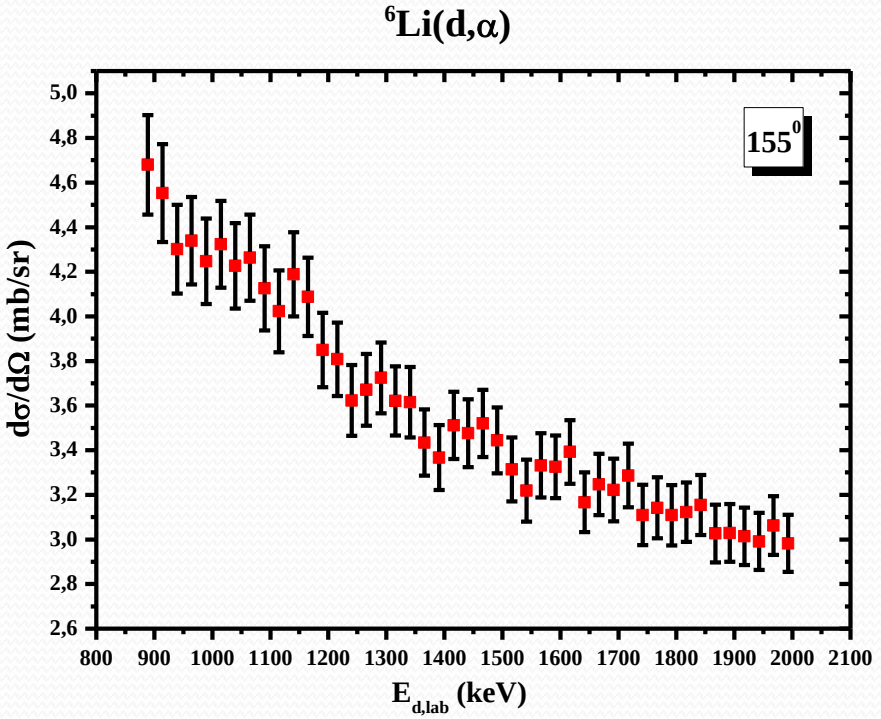
Several thousands new differential cross-section values were obtained, which were, after evaluation, included in the IAEA IBANDL database (http:www.nds.iaea.org/ibandl).

This activity is our contribution to the IAEA CRPs
"Development of a reference database for Ion Beam Analysis"

A Few Recent Publications

RESULTS FOR ^{6}Li(d,α)



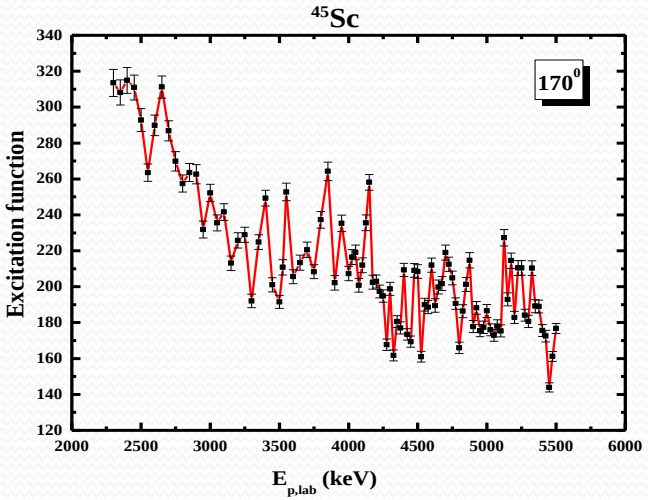


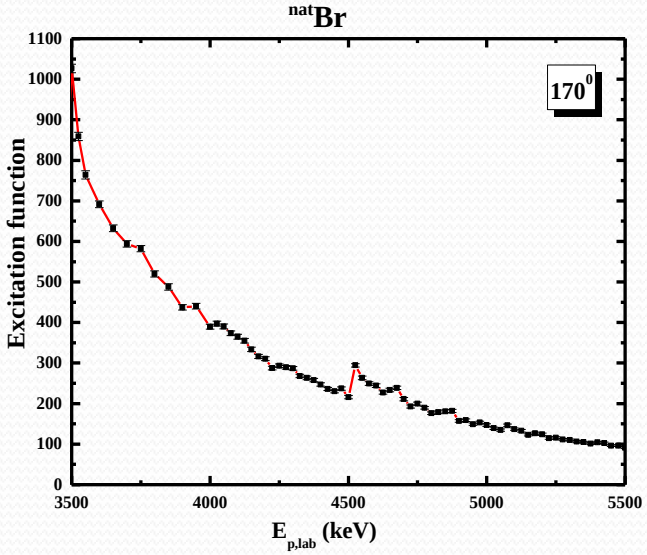
- E$_d$=0.9-2 MeV steps of 25 keV, 8 angles from 135^{o} to 170^{o} steps of 5^{o}

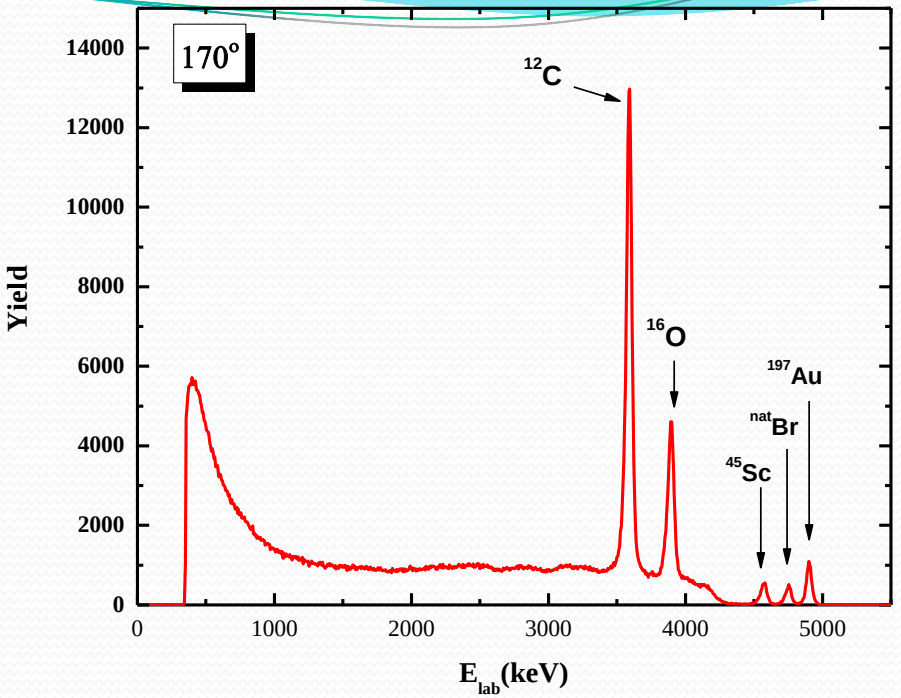
Cross section measurements of the ^{6}Li(d,α$_0$)^{4}He reaction.

V. Foteinou et al., *Nucl. Instr. and Meth. in Phys. Res. B 269 (2011) 2990*

RESULTS FOR p+^{45}Sc:







- **4 angles 140°-170°, steps of 10°**

The same for ^{nat}Br

- **E_p=2-5.5 MeV in steps of 25 keV**

Proton elastic scattering differential cross section measurements of ^{45}Sc.

G. Provatas et al., *Nucl. Instr. and Meth. in Phys. Res. B 269(2011) 2994*

In continuation of the above project we recently started the measurement of the differential cross sections of the ^{9}Be(p,γ), ^{13}C(p,γ) and ^{32}S(p,p') reactions.

Participation in the IAEA CRP:

"Development of a Reference Database for Particle-Induced Gamma-ray Emission".

Application of Ion-Beam Analysis techniques to the characterization and study of near-surface layers of materials (Collaboration with the University of Poitiers and NCSR Demokritos).

The characterization and study of the properties of a variety of metallic materials surface-modified by ion-implantation and by the application of corrosion- or oxidation-resistant coatings.

The most recently investigated materials:

Y-implanted stainless steels and titanium alloys modified by deposition of SiC-, DLC-, Al_2O_3-coatings using different techniques. The preparation of the samples usually takes places in our collaborating laboratories (e.g. PHYMAT, Sumy Institute for Surface Modification), the investigation of their corrosion/ oxidation properties at the University of Thessaloniki and the characterization of the materials prior and after the corrosion or thermal treatment by the Thessaloniki group at the 5.5 MV Tandem van de Graaff accelerator of the NCSR Demokritos.

Characterization and investigation techniques:

Electrochemical techniques, SEM/EDS, TEM, Nuclear Reaction Analysis, ^{12}C- and d-Rutherford Backscattering Spectrometry and proton induced gamma-ray emission (PIGE).

SOME RECENT PUBLICATIONS:

Application of ion beam analysis techniques for the investigation of the oxidation and corrosion resistance of low-energy high-flux nitrogen-implanted stainless steel.
F. Noli, P. Misaelides, E. Pavlidou, A. Lagoyannis, *Nucl. Instr. and Meth. in Phys. Res. B 270 (2012) 1*

Characterisation and corrosion resistance of TiN-Ni nanocomposite coatings using RBS and NRA.
F. Noli, P. Misaelides, A. Lagoyannis, A. Akbari, C. Templier, J.-P. Rivière, Nucl. Instr. and Meth. in Phys. Res. B 269 (2011) 3226

The beneficial role of Y-implantation on the aqueous corrosion of stainless steel.
F. Noli, P. Misaelides, E. Pavlidou, Surface & Coatings Technology 205 (2011) 3506

Oxidation resistance of Y-implanted steel using accelerator based techniques.
F. Noli, A. Lagoyannis and P. Misaelides, *Nucl. Instr. and Meth. in Phys. Res. B 266 (2008)2437*

Investigation of the interactions of radionuclides and heavy metals with natural and synthetic sorbents.

The objective of this activity is

the investigation of the interactions of aqueous solutions of radionuclides (e.g. U, Th, Cs, Sr, Eu (analogue to trivalent actinides), Re (analogue to Tc(VII), I) and heavy metals (e.g. Pb, Cd, Hg, Cr, As) with natural-, synthetic- and bio-sorbents.

The natural materials investigated include natural zeolites, clay minerals, metal oxides, carbonates (e.g. marble, limestone), granites, while the synthetic ones Ti- and Zr- phosphates and silicates, synthetic zeolites and organic resins. The biosorbents include several microorganisms (e.g. fungi) by-products or wastes of the food industry.

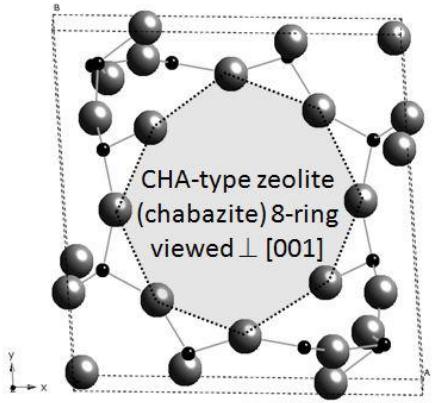
The applied techniques:

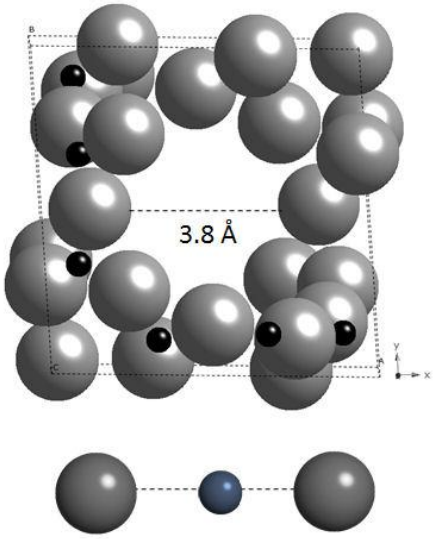
For the measurement of the uptake capacity: Radioactive tracers and nuclear spectroscopic techniques, Atomic Absorption Spectroscopy, UV-Vis spectroscopy.

For the determination of the depth distribution of the sorbed species in near-surface layers of the materials: IBA – techniques (e.g. RBS, NRA, PIGE).

For the determination of the binding mechanism: XPS, EXAFS

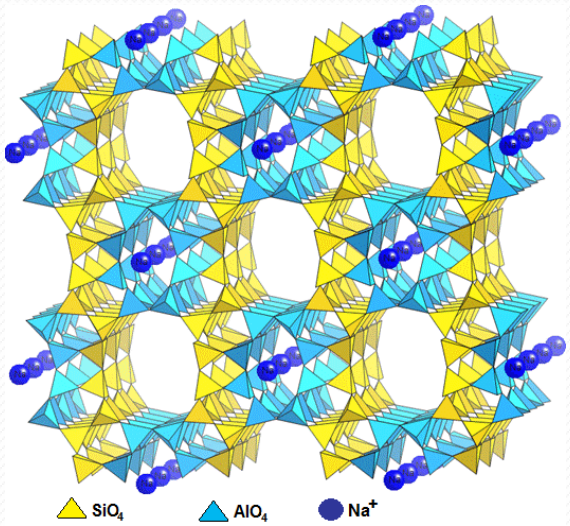
Interaction of U^{VI}_{aq} with CHA-type zeolitic materials. (J. Warchol et al., Micropor. Mesopor. Mater. 153(2012)63)

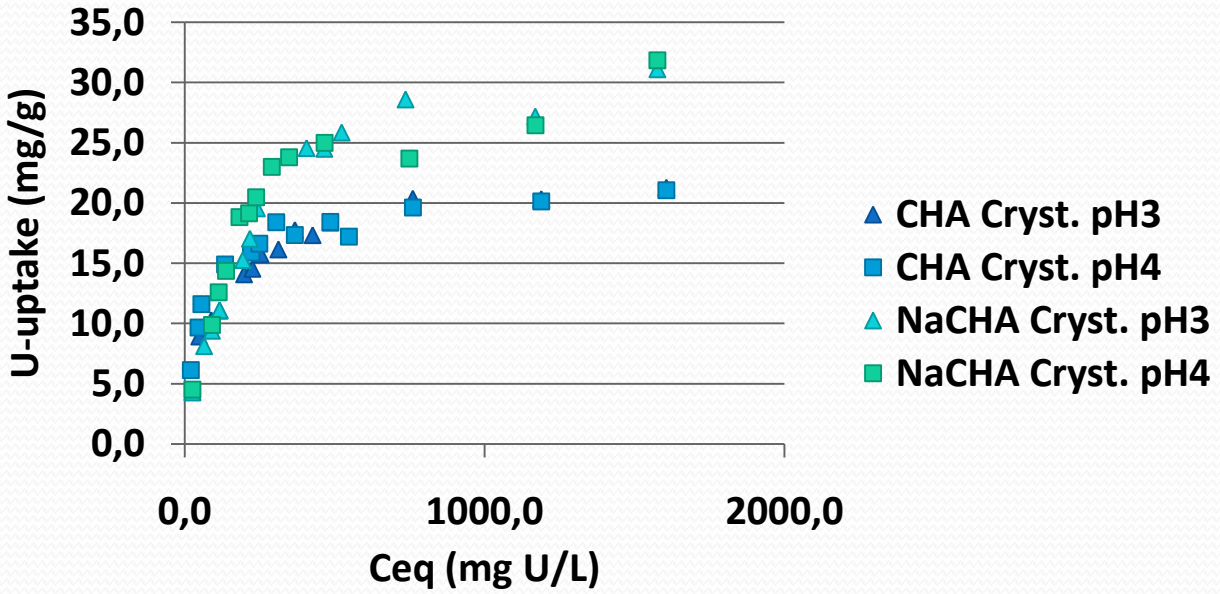




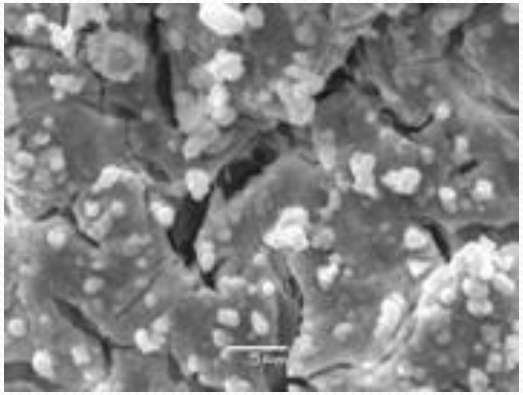
$^{[2]}r_{U^{6+}}$=0.45 Å ($r_{O^{2-}}$=1.4 Å)

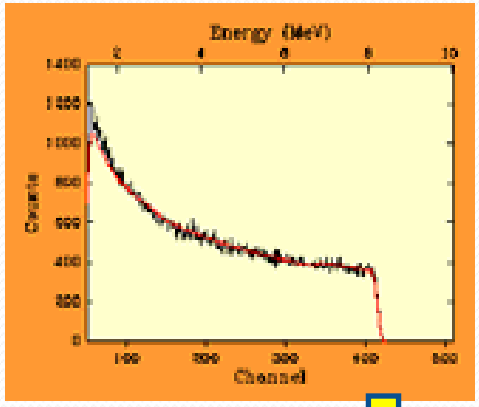
$\left[O \equiv U \equiv O \right]^{2+}$

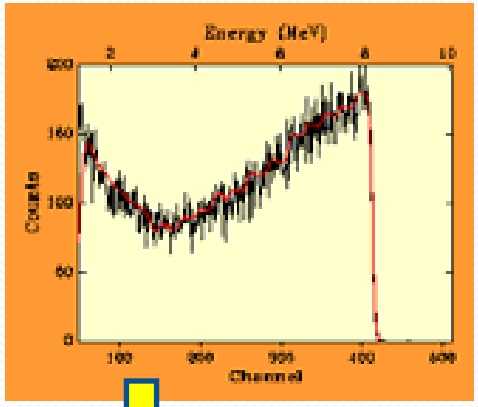


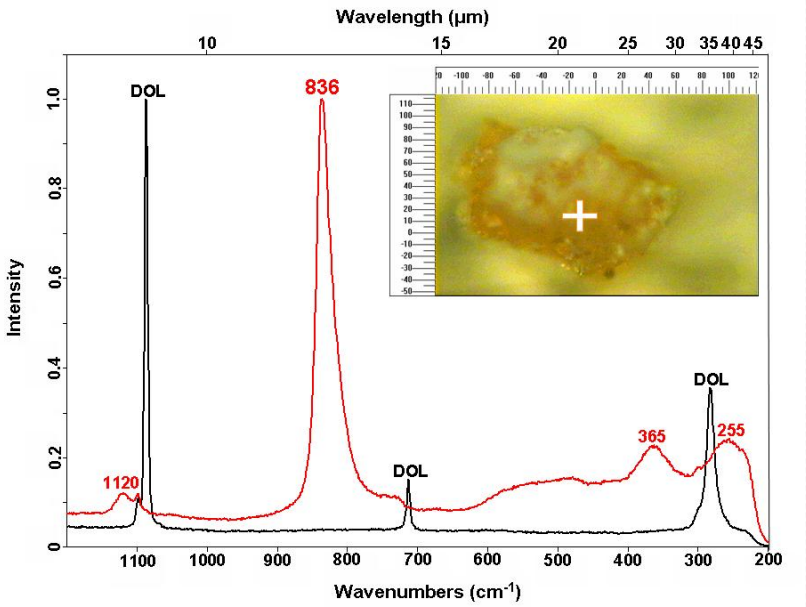


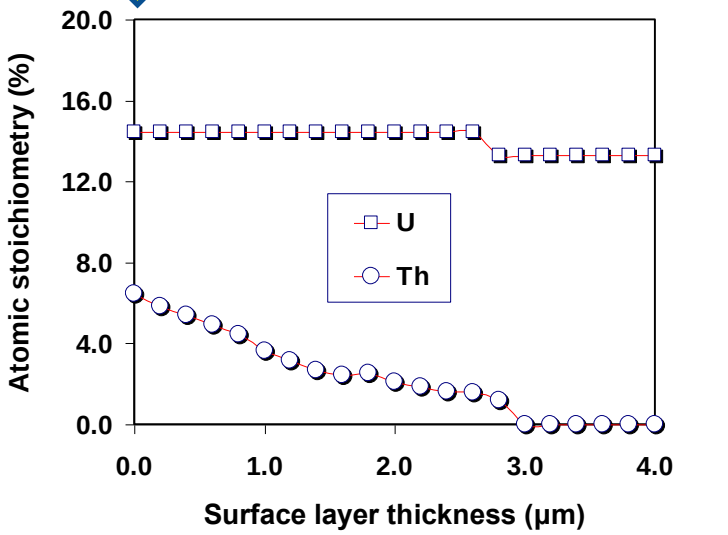
CHARACTERIZATION OF GREEK DOLOMITIC MARBLE SURFACES INTERACTED WITH URANIUM AND THORIUM AQUEOUS SOLUTIONS USING ^{12}C-RBS AND LASER μ-RAMAN SPECTROSCOPY (A. Godelitsas et al., NIM B266(2008)2363)





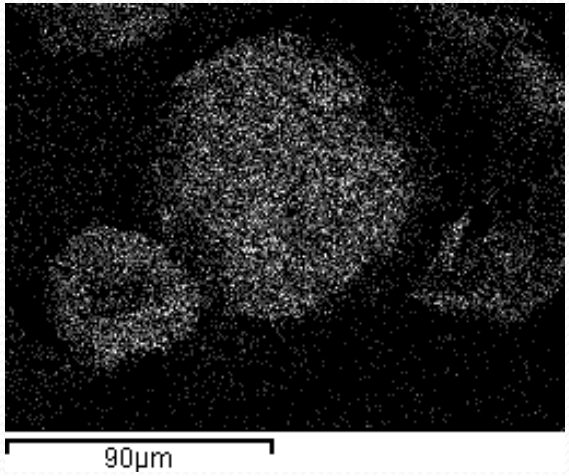


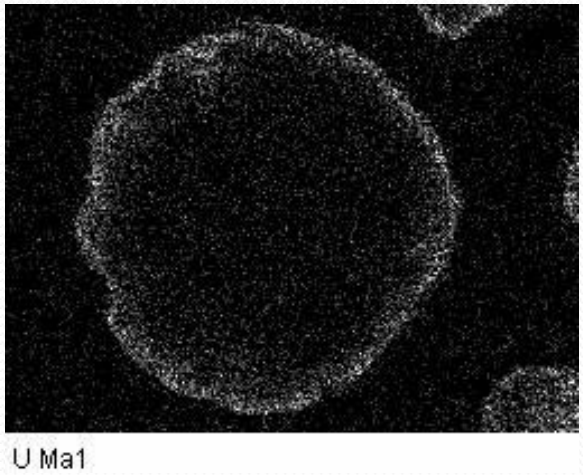


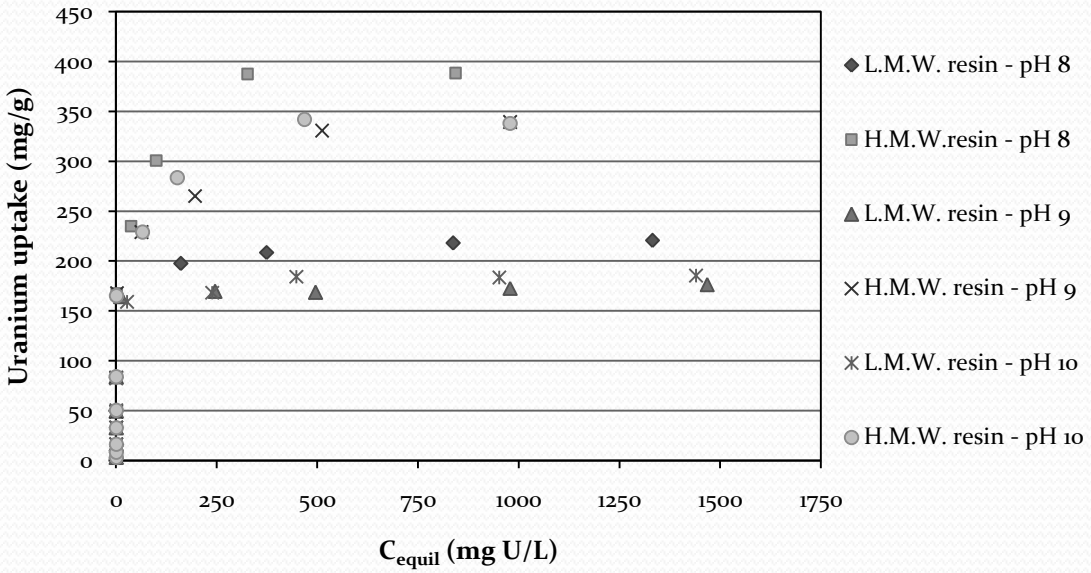


Removal of uranium anionic species from aqueous solutions by polyethylenimine – epichlorohydrin resins.

S. Sarri et al. (in press *J. Radioanal. Nucl. Chem., 2012*).







Radioanalytical Chemistry & Natural radioactivity measurements using alpha- and gamma-spectroscopy.

Neutron Activation Analysis

Measurement of the concentration of uranium in soils and waters.

Attempts to determine radium in waters (in progress)

Thank you very much for your attention!