

Radioprotection and Radioactive Waste

Romão Trindade

The Radioprotection and Radioactive Waste Group (GRRR) has pursued its involvement in KADRWASTE (FCT), ACSPET (FP7) and PETRUS II (FP7) projects.

Concerning Education & Training, a PhD degree in the field of radioactive waste management in collaboration with Sciences Faculty of Lisbon (Dpt. Geology) is ongoing. Members of the GRRR have participated as lecturers and invited professors in **13** Advanced and Post-Graduation Studies (DFA, Master) at IST, FCUL and ESTSL in the field of radiological protection, radioactive waste management, transport of radioactive materials and radiological emergencies. They have also participated in **9** professional training courses on radiological protection and safety, through the Training Centre and upon external request.

Members of the Group were also involved in several national and international committees, working groups and task forces related to radwaste management, transport of radioactive materials, radiological protection and monitoring, decommissioning of radioactive and nuclear facilities, surveillance of contaminated scrap metal and radiological emergencies.

Considering the activities related to legal obligations such as licensing of sealed sources for medical, industrial, teaching and research applications the Group has issued **440** licensing requested for analysis and authorization during 2010. This year, **555** gamma spectrometry analysis for research, radiological protection and monitoring purposes were carried out in the Radioactive Samples Measurement Laboratory (LMAA/GRRR).

Also during the last year and still considering legal obligations, **186** requests for collecting and storing radioactive waste, from medical, industrial and

research applications, were received and processed. To do this work GRRR has only one person.

ITN's radioactive wastes discharges compliance with Art° 35° of Euratom Treaty recommendations was pursued in 2010 with the renewal and improvement of the new ITN's Treatment Station, the ECoDELiR. This has been another step into the direction of assuring a more efficiently controlled released into the outside sewer and the application of the Best Available Technology (BAT).

The *Campus* environmental gamma radiation dose continued to be assessed through the gamma monitoring network, GAMMANET, and the data reported in compliance of Art° 35 of Euratom Treaty.

Detection of radioactive materials in scrap metal is still continued as happening in other EU MS and this year **8** events were reported to ITN.

Radiological surveillance was carried out by GRRR during the stay of **5** military nuclear vessels in the Lisboa Harbour and also **10** verifications and monitoring on radiological facilities and equipment.

The Monitoring Programme of the radioactive liquid discharges into the public sewage of Lisbon as well as the monitoring of the four ETAR'S (waste water treatment facilities) was continued in 2010, in collaboration with Lisboa Council Borough and public and private nuclear medicine facilities

During 2010, GRRR has organized **4** Workshops and Meetings.

In 2010, were published **15** internal reports related to the activities carry out by the GRRR.

Research Team

Researchers

R. TRINDADE, Aux., Group Leader
M.I. PAIVA, Aux.

Fellow

A. BAPTISTA

Technical Personnel

L.M. PORTUGAL
J. VENÂNCIO

KADRWASTE – Study of the Adsorption Mechanisms and Kinetics in Geomaterials and Their Structural Characterisation: Implications for Processes of Natural Attenuation of Heavy Metal Contamination and Radioactive Wastes Confinement

M. Abel¹, A. Mateus¹, I. Bobos², I. Paiva, R. Trindade, P. Duarte, M. Reis, M. F. Araújo, M. J. Madruga, J. Mirão³ et al.

The project (PTDC/CTE-GEX/82678/2006) has pursued in 2010 with the continuation of its tasks and the beginning of the submission and publication of the first papers related to it. The data concerned the radiometric surveys obtained from *in-situ* gamma spectrometry with NaI (TI) 3''x 3'' e 5''x 5'' probes was analyzed in terms of the geological settings. Safety assessment of low and intermediate level waste repositories requires the understanding of radionuclides sorption-desorption mechanisms, mainly the degree of interaction between radionuclides and mineral surfaces. Among the different radionuclides that are part of the Portuguese radwastes' inventory ¹³⁷Cs is one of the most important from the radiological point of view due to its high radiotoxicity. The adsorption studies using ¹³⁷Cs and the characterization of geomaterial samples (soils and *rañas*) collected in the framework of the KADRWaste project, using both Instrumental Neutron Activation Analysis (INAA) and gamma spectrometry for chemical elemental composition and radionuclides content respectively have been pursued. The geomaterial samples that were collected were of two kinds: soils, that are basically peridotites and gabbros and are part of the Iberian Hercynian Massif located in most of the Western half of the Iberian Peninsula, and *rañas* that are sedimentary deposits originated from the same area. The clay components of natural geomaterials named *rañas*, has been studied for their potential as effective liner/backfilling/buffer barriers for Low and Intermediate Level Wastes (LILW) repositories. Characterization of geomaterials and the capacity adsorption of the *rañas* have also been carried out by using two different but complementary techniques: *k₀*-based Instrumental Neutron Activation Analysis and Gamma Spectrometry Methods. Batch mode experiments studies related to the adsorption/desorption of different ¹³⁷Cs concentrations at different pH values and flow rate for different *rañas* samples were supposed to be carried out at ITN with Teflon continuous flux reactors. These were constructed at ITN workshop according to a FCUL model and expected to be used at ITN, FCUL and FCUP for adsorption/desorption studies of radioactive and non-radioactive elements in solutions containing clay minerals. Samples were

analysed by the THERMO ICP-MS existent at Environmental Agency at the market price.

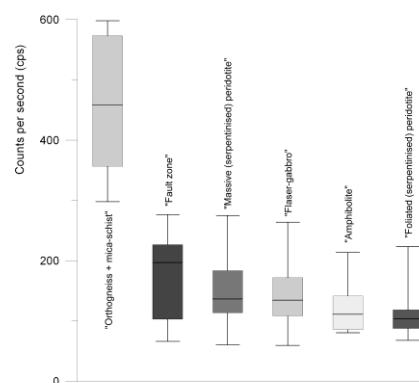


Fig- Box-whisker diagrams of the main distributions of gamma-ray values assigned to the "lithological" and "structural" sub-groups for the Morais area.

¹(FFC/Geology/Creminer/FC/UL);

²(ADFC/Geology/FC/UP); ³(U. Évora)

Published work

E. Andrade, M.J. Madruga, I. Bobos, I. Paiva, F. Maia, A. Mateus, R. Trindade, M.C. Freitas, M.A. Gonçalves. Characterization of Portuguese geomaterials, the clay component of *rañas*, as potential liners for low and intermediate radioactive disposal sites. *J. Radioanalytical & Nuclear Chemistry*, (2010) 286:777-783.

M. Reis, M.C. Freitas, A. Mateus, I. Paiva, L. Silva, I. Dionisio, H.M. Dung, M.J. Madruga, P. Duarte, M.A. Gonçalves. *Characterization of Geomaterials from NE Portugal using Instrumental Neutron Activation Analysis (INAA) and Gamma Spectrometry*, Fourth International Symposium on Nuclear Analytical Chemistry (NAC-IV), Bhabha Atomic Research Centre, Mumbai, India, 15-19 November 2010 (Poster).

ACSEPT-Actinide reCycling by SEParation and Transmutation (7th Programme EURATOM- FP7-Fission 2007)*I. Paiva, J. Marçalo, C. Lourenço, R. Trindade, P. Vaz*

ITN (UPSR/GRRR/GDR and UCQR/QIO) organized the Second Annual ACSEPT Project Meeting, the First ACSEPT International Workshop on *Innovative Solutions for Sustainable Nuclear Energy* in collaboration with EURATOM FP7, CEA, IAEA, ENS and the First Meeting on *Pyro-Metallurgy*, with Russia, in a total of 120 participants. Speakers from Khlopin and RRC-KI, Russia; IGCAR, India; WSU and INL, USA; CEA and ANDRA, France; PSI, Switzerland; Titech, Japan; KTH, Sweden; CEA and ANDRA, France and SKB, Sweden were invited to participate in the workshop. ITN's five progress reports were already presented in Domain 1, WP1.2, M 1.2.2, M1.2.4, D1.2.1. A new ligand (C5-BTBP) from CEA was delivered to ITN to carry out studies on gas-phase reactions of Ln(III) and An(III) using FTICR/MS. Complexation studies of C5-BTBP with $GdCl_2^{2+}$ and $CmCl_2^{2+}$, where formation of $MCl_2(C5-BTBP)^+$ ions was observed but kinetics of association could not be measured due to the low volatility of C5-BTBP. ITN also reported the experimental study, by FTICR/MS, of the association reactions of MCl_2^+ ($M = Cm$ and Gd) with pyridine, a building block of the C5-BTBP ligand. Related studies were performed by ESI-QIT/MS to probe the relative affinity of several N-donor bases (building blocks of the ACSEPT ligands), in solution and in the gas phase, towards several LnX_2^+ ions ($X = NO_3, Cl$). The ACSEPT grantee has been to Marcoule on a short visit to prepare for an experimental visit of 2 months working at ATALANTE Facility, being supported by the ACTINET-I3 Network where UCQR/QIO has now a project in collaboration with CEA-ATALANTE and LBNL/USA.

PETRUS II—Towards an European training market and professional qualification in Geological Disposal*I. Paiva, P. Vaz, R. Trindade.*

PETRUS II has pursuing activities to identifying existing EU training and education actions in radioactive waste management/geological disposal E&T and setting-up the recognition of European training programs on geological disposal. Audiovisual and in-house Pilot E&T sessions, shared by different partners, have already been in place. In 2010, the First Annual PETRUS II Meeting was organized by ITN. Ten international organizations, including independent regulatory bodies, representatives of ECFP7 and ENEN, were present in a total of almost 40 participants. PETRUS II results have shown the importance of end-users, courses' providers and EU experts working together to develop and sustain a qualified, mobile workforce with transferable skills that will allow career progression in the newly strategic rebirth of the nuclear industry. Also it will produce future skilled technical and scientific experts. Priority Activities to support a lifelong learning system, increasing mobility of European learners and flexibility of learning pathways to achieve the required qualifications using the *European Credit system for Vocational Education and Training* (ECVET), are being launched. PETRUS II members will also extending their input to the ECNET project to reinforce collaboration with China.

Characterization of Suitable Areas for a Long-Term Radioactive Waste Repository Facility in Portugal*P. Duarte¹, I. Paiva, A. Mateus², R. Trindade*

The Ph.D. work supervised by FCUL and ITN, related to some of the tasks of the FCT project KADRWaste has suffered several corrections and setbacks within the last year. There were many reasons for that including the leaving of the Ph.D student, without completing all the tasks of 2010. Despite this setback, a paper was produced and accepted for publication due to the efforts of both Institutions. During this year, there was collaboration with National Research Center of Materials Science, Borj Cedria Technopark, Tunisia, through FCUL/Geological Department. Portuguese soil and clay samples prepared by FCUL and ITN were sent to Tunisia to carry out adsorption/desorption experiments with different metals to compare results with the Tunisian samples. Further cooperation with Tunisia Group and with FCUL, it is envisaged through a Tunisian Pos-Doc student.

¹- Left ITN in December 2009²- Dep. Geologia, FCUL.**Radioactive Liquid Discharges from Hospitals in Public Sewage of Lisboa Borough Council (CML)***R. Trindade, I. Paiva, L. Portugal, A. Baptista, J. Venâncio, F. Gomes, L. Silva, M. Reis*

Radioactive liquid discharges from public and private nuclear medicine facilities in Lisbon public sewage as well as residual effluents from Lisboa four Water Treatment Plants (ETARs) have been monitored by UPSR/ITN in 2010. The Project was divided in 4 different programmes related to the sites where the samples were collected. Programme I involved sequential collection of discrete samples in sampling points from nuclear medicine facilities. In Programme II, discrete samples were taken at one single discharge point of each Lisboa's ETARs. The Programme III has involved the affluent to ETAR's and their effluents. Finally, the Programme IV was related to sewage of the municipality neighbours of Lisboa. Sampling was carried out in order to identify the radionuclides present and their activities. About 254 samples of liquid effluents were collected and analysed by quantitative and qualitative gamma spectrometry. During this year there were no changes to this Project that has been collaboration with the Lisbon Borough Council.

SERVICES

1. Radioactive waste management

During 2010, **186** requests for radioactive waste collection were received, collected, segregated, and transported for the interim storage facility “Pavilhão de Armazenamento Interino de Resíduos Radioactivos”, (PAIRR) at ITN *Campus*. Concerning radwaste, it is very important and urgent to define and to establish a national plan related to radioactive wastes produced in Portugal. In the last years only one technician is working at PAIRR, which is not enough to carry out all duties.

2. Sealed sources licensing

According Decree-Law n° 38/2007 and Decree-Law n° 165/2002, **440** sealed sources licensing were issued: national territory introduction licences (**128**), transfer licences (**60**), transport licences (**89**) and ownership licences (**163**). Only one person is related with this activity. It was developed a data base for radioactive sealed sources.

3. Gamma Monitoring Network (GAMMANET) of Instituto Tecnológico e Nuclear (ITN)

The environmental dose gamma radiation at ITN *Campus* is continuously being measured by the gamma network, GAMMANET. The data are collected, analysed and reported to the EU, according to articles 35° and 36° of the Euratom Treaty and also to the National Report “Programas de Monitorização Radiológica Ambiental”.

4. Radioactive liquid discharges from Instituto Tecnológico e Nuclear (ITN)

Radioactive liquid wastes originated at ITN are analysed and measured at “Estação de Controlo das Descargas dos Efluentes Líquidos Radioactivos” (ECoDELiR) before being discharged into Estação de Águas Residuais (ETAR). The data are reported to the EU according Articles 35° and 36° of Euratom Treaty and to the Radioactive Substances Committee of OSPAR Convention and also to the National Report “Programas de Monitorização Radiológica Ambiental”. In 2010 the work to repair and to improve ECoDELiR was pursued.

5. Radioactive liquid discharges from Instituto Português de Oncologia (IPO), Coimbra

In 2010 and as requested by IPO-CROC, EPE, Coimbra, the radiological survey of radioactive liquid effluents from the IPO’s Medicine Nuclear Retention Tanks, was carried out by the Group before discharge into the public sewage.

6. Nuclear vessels radiological monitoring

Environmental radioactivity survey programmes consisting on continuous monitoring of radioactive aerosols and airborne radioiodine, sampling of water, sediments and biological species for gamma spectrometry analysis were carried out when nuclear vessels reach the Portuguese harbours. This year, **5** nuclear vessels stayed at Portinho da Costa harbour and estuary of Rio Tejo. The reports were sent to Ministry of Defence.

7. Radioactivity in scrap metal

In 2010, and as result of radiological surveys requested by the smelting industry, **8** events related to the detection of radioactive materials in scrap metal at melting factories have been reported. The material collected has been stored at Pavilhão de Armazenamento Interino de Resíduos Radioactivos, (PAIRR) as radioactive waste. Reports were sent to the smelting company.

8. Radiological protection and safety verifications and monitoring

During 2010, GRRR has carry out **555** gamma spectrometry analysis and **10** verifications and monitoring concerning radiological protection and safety purposes at medical and industrial facilities and also to research projects.