

Epidemiological Study of the Effects of Uranium Mining Residues

F.P. Carvalho, M. J. Madruga, J. Alves, M. Reis, J. M. Oliveira, P. Duarte, J. Gouveia, L. Silva, I. Lopes, A. Libânio, M. A. Tavares, G. Ferrador, L. Machado

Objectives

To investigate the radioactive contamination in selected counties (freguesias) with old uranium mines and tailings and compare with radioactivity levels in counties without mining activities. This project aims to contribute to the assessment of the radiological risk for the population and impact of past uranium mining activities on the public health and on the environment, following the Resolution of the Assembleia da Republica nº34/2001 of 29/03/2001.

Results

During the year 2003 the project implementation was planned, multiple contacts with local authorities undertaken and public sessions performed in every county in order to obtain the best collaboration from local populations to this study. The fieldwork performed encompassed the detailed investigation and analyses of environmental samples from seven counties, including heavily contaminated areas (Urgeiriça), areas with past uranium mining but without tailings, and areas without past or present mining activities (natural regional background).

Published, accepted or in press work

1. F.P. Carvalho, J.G. Alves, M.J. Madruga, J.M. Oliveira, J. Gouveia, L. Silva, Avaliação Radioecológica do Sítio de uma Antiga Exploração de Urânio não Licenciada, Mina do Barroco do Ouro. *X Jornadas Portuguesas de Protecção contra Radiações*, Instituto Superior Técnico, Lisbon, 20-21 Novembro 2003.
2. F.P. Carvalho, M.J. Madruga, M. Reis, J.G. Alves, J.M. Oliveira, J. Gouveia, L. Silva, Radioactive Contamination around Old Uranium Mining Areas in Portugal. *First International Meeting on Applied Physics*, Badajoz, Spain, 13-18 Outubro 2003
3. P. Duarte, T. Ferreira, M. Reis, F. P. Carvalho, Contribuição para uma Cartografia de Risco Radiológico na Antiga Região Mineira da Cunha

Baixa. *Ciências da Terra – Volume Especial V (VI Congresso Nacional de Geologia)*, Departamento de Ciências da Terra, Faculdade de Ciências e Tecnologia da Universidade Nova de Lisboa (Eds.), June 2003, pp. 96 (with full text in CD-ROM).

This research is combined with analysis of environmental contamination by heavy metals (IGM) and blood samples from the population for clinical parameters and chromosome damage caused by radiation (INSA and ITN/DPRSN).

This project has received the support of the IAEA for environmental risk assessment in uranium mining areas (POR/4/019). The impact on public health and intake of radionuclides is performed jointly with INSA and IGM in the framework of a research project funded by the Ministry of Health (MinUrar).

An international workshop to discuss results and exchange experience on the assessment of the impact of past uranium mining activities and environmental rehabilitation of those areas, was planned, and the organization undertaken with the support of the IAEA, for 11-13 February 2004.



Fig. 1- “in situ” gamma spectrometry

European Radon Research and Industry Collaboration Concerted Action (ERRICCA-2)

M.C. Faísca, P.M. Duarte, F.P. Carvalho, L. Machado, M. Reis

Objectives

The principal objective of the concerted action is the establishment of a new European scientific led industrial forum to reduce risks to health from radiation (principally radon) in the built environment. The forum which will operate on both European and National levels will help in:

- Disseminating existing research findings to industry and the public,
- Clarifying industry needs for further research,
- And for undertaking collaborative work in common topic areas.

Results

Increasing public awareness and confidence

Organization of the “Second Portuguese Journeys about Radon and Natural Radioactivity”. This Forum took place in Curia at 23rd and 24th January 2003 and they were present about 60 participants.

Building Materials and Radon barriers

We have performed exhalations rates from different Portuguese building materials as well as tests of radon barrier materials (namely bituminous materials).

Mapping and measurement (Figure 1)

Based on the totality of the questionnaires obtained during our indoor radon national survey (1989-1992) a digital database was accomplished. From the 4,200 individual questionnaires a total of 3,400 containing the most precise data (localities, level, ventilation type, etc.) were considered and re-interpreted.

The indoor radon data was crossed with geological information (using Geographic Information Systems) with the aim to produce a better and clear mapping of radon risk and radon affected areas. Geological polygons will replace old administrative polygons, once they are more representative and statistically significant (Table 1).

Reinforced indoor radon measurements are in course in some municipalities, mainly situated in radon-affected areas, in order to fill blank areas and improve the quality of indoor radon risk mapping.

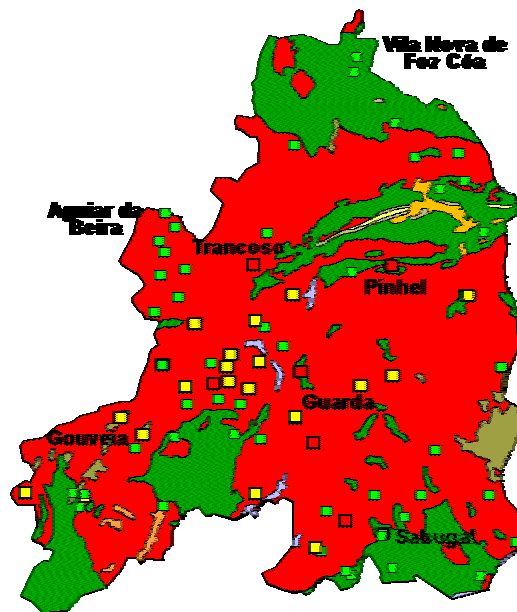


Figure 1 – Geological background and indoor radon measurements in Guarda region

(■ <200; 200<■<400; ■>400 Bq m⁻³).

Table 1 – Indoor Radon statistic parameters related with different geological backgrounds

	Granitoids	Metamor.	Vulcanic	Sediment.
Median	72	31	39	21
Maximum	1751	878	304	380
# Samples	1404	876	21	1011

Published, accepted or in press work

1. P. Duarte, C. Faísca, C. Pires, C. Calado, A Exalação do Radão do Solo em Prospeção Hidrológica. Resultados na Área da Fadagosa de Nisa (Alto Alentejo). *Ciências da Terra – Volume Especial V (VI Congresso Nacional de Geologia)*, Departamento de Ciências da Terra, Faculdade de Ciências e Tecnologia da Universidade Nova de Lisboa (Eds.), June 2003, pp. 64 (with full text in CD-ROM)
2. M. Reis, P. Duarte. Concentrações de Radão no Ar Interior de Alguns Locais da Escola Secundária da Sé-Guarda. *Internal Report DPRSN-C*, nº 21/2003.

Transport of ^{137}Cs and ^{90}Sr by the microalgae *Chlamydomonas reinhardtii* Dangeard

²J. Gil Corisco, J. A. Fernandez

Objectives

The radiological relevance of the artificial radioisotopes ^{137}Cs ($t_{1/2}\sim 30$ y) and ^{90}Sr ($t_{1/2}\sim 28$ y) comes from the capacity of these elements to incorporate into the *biota*, which is enhanced by their transfer along the trophic chains. The chemical similarity between cesium and potassium and between strontium and calcium, supports the hypothesis that, in living cells, the physiological mechanisms and molecular structures (channels and ion carriers) acting in the uptake of K^+ and Ca^{2+} , also participate in the transport of Cs^+ and Sr^{2+} . This thesis makes an approach to this subject, analysing and understanding the effect of some selected external variables on the biouptake of both radioisotopes, using as a physiological model the unicellular freshwater algae *Chlamydomonas reinhardtii*. Biouptake was tested through different concentrations of K^+ , Ca^{2+} , Na^+ and pH of the culture medium. The use of known Ca^{2+} and K^+ channel blockers and a plasmalemma ATPase inhibitor was made to verify any possible effects on the uptake of $^{137}\text{Cs}^+$ and $^{90}\text{Sr}^{2+}$.

Results

The results are part of the contents of the memory of thesis to be presented during the year 2004. Most prominent was the strong dependence of ^{137}Cs uptake on external K^+ , when algae were raised under a 1 – 50 micromolar range of KCl concentrations (fig.1). Loss rates also exhibit great dependence on external K^+ concentrations ≥ 0.1 millimolar (fig.2).

Figure 1

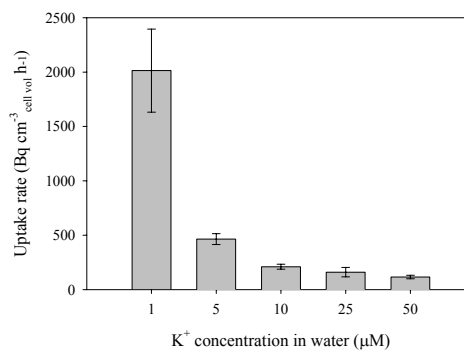
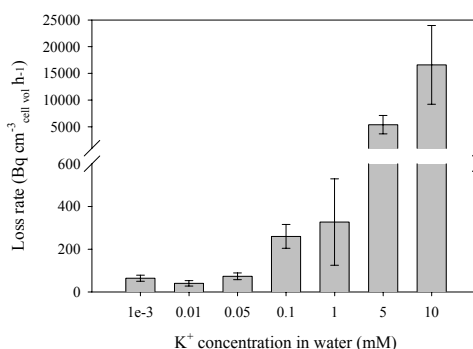


Figure 2



Published, accepted or in press work

Efecto del pH y de la concentración de K^+ en el medio sobre el volumen celular de *Chlamydomonas reinhardtii* D. ¹Linares-Rueda A, ¹Rubio L, ²Gil Corisco JA, ¹Zapico R, ¹García-Sánchez MJ, ³Martínez ML. y ¹Fernández JA.

VIII Congreso Hispano-Luso de Fisiología Vegetal. Mallorca, 16-19 Septiembre 2003, Universitat de las Illes Balears, Mallorca.

¹Facultad de Ciencias, Universidad de Málaga (FC/UMA) Dpto. De Biología Vegetal (Fisiología Vegetal) .
²Instituto Tecnológico e Nuclear Dpto. de Protecção Radiológica e Segurança Nuclear. ³(FC/UMA) Dpto. Estadística e Investigación Operativa, ³Universidad de Málaga, Campus de Teatinos S/N.29071.Málaga, España.

Environmental Survey Network

M. J. Madruga, F. P. Carvalho, M. M. Sequeira, G. Ferrador, M. A. Gameiro, M. Reis, J. Gouveia, L. Silva, L. Ramos, V. Silvino, L. Machado, J. M. Oliveira, A. Libânio, M. A. Tavares, M.A. Pereira, I. Faria

Objectives

The objective of this survey is the determination of artificial and natural radionuclide concentrations in the aquatic, terrestrial and atmospheric environmental compartments.

This programme has been performed in accordance with the European Network for Environmental Radioactivity, following the requirements of Art's 35 and 36 of the EURATOM Treaty.

Results

Samples of superficial waters, sediments and fish from Tejo (monthly, V. Velha de Ródão,), Zezêre (monthly, one sampling site), Guadiana, Mondego and Douro (annually, one sampling site) rivers are collected. Marine samples (sediments, seaweeds and mussels) are collected annually in five sampling sites along the Portuguese coast (Matosinhos, Figueira da Foz, Cabo de S. Vicente, Tejo and Sado estuary) (Fig.1-a). Samples of drinking water are taken monthly in Sacavém, V. Velha de Ródão and two other localities along the country. Rainwater samples are collected monthly in Sacavém and Castelo Branco. In what concerns the terrestrial compartment, samples of soils (annually, from four different regions in the country), mixed diet products (monthly, from 10 different regions), complete meals (quarterly) and milk (monthly, two samples) are collected (Fig.2-b). Aerosols samples are taken (weekly) in Sacavém.

Around 400 samples have been collected accordingly with international sampling procedures and about 1000 analyses for the determination of artificial and natural radionuclides, using gamma and alpha spectrometry, alpha/beta measurements and liquid scintillation technique, are performed. The determination of anionic and cationic concentrations in superficial waters, using the ionic chromatographic method is also carried out. The doses to the Portuguese population due to the ingestion and inhalation of artificial and natural radionuclides are calculated. From the point of view of biological and sanitary effects the values obtained are lower than the recommended to the population for radiological protection (96/29 EURATOM Directive). All the data are reported in Internal Reports [1] included into the database Easy Proteo 4.11 and sent to the EU Joint Research Centre, ISPRA, where they are introduced into the European Database.

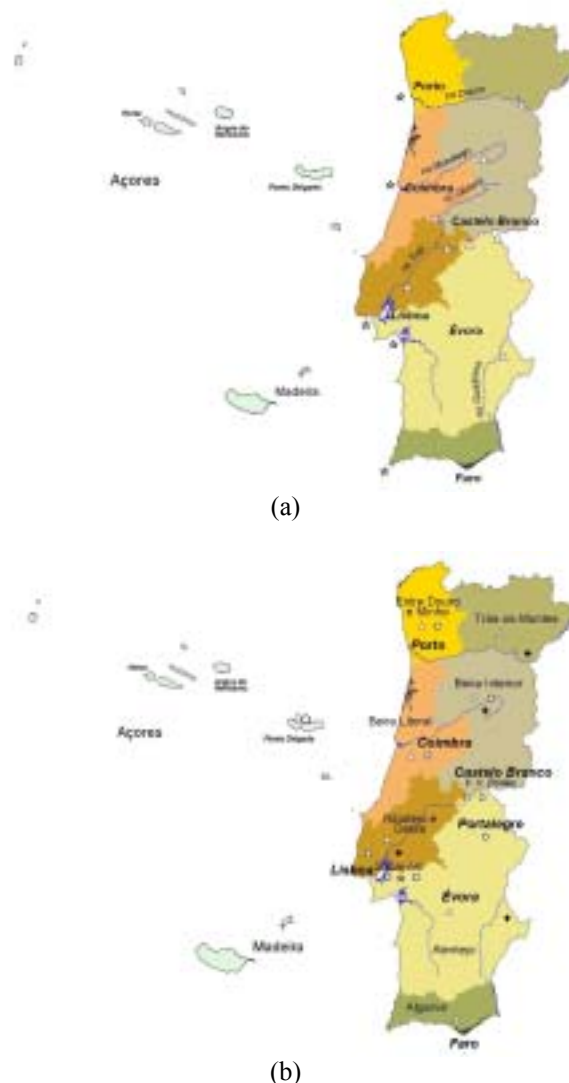


Fig 1- Sampling sites of the aquatic (a) and terrestrial (b) environmental monitoring.

Published, accepted or in press work

1. M.J. Madruga, F. Carvalho, M.M. Sequeira, G. Ferrador, M.A. Gameiro, M.Reis, J. Gouveia, L.Ramos, J.M. Oliveira, V. Silvino, L. Machado, I. Faria, A. Lucas, M.A. Pereira, M.A. Tavares, A. Libânio, C. Pires, S. Curado. *Vigilância Radiológica a Nível Nacional (Ano 2002). Relatório DPRSN, Série A, nº26/2003, ISBN 972-8660-27-8, Depósito Legal 194022/03.*

Radioactivity in Tejo and Zêzere Rivers to Assess the Impact of the Spanish Nuclear Programme

M. J. Madruga, F. P. Carvalho, M. M. Sequeira, V. Silvino, J. Gouveia, L. Silva, M. A. Pereira, L. Machado, L. Ramos

Objectives

To perform a survey of natural and artificial radioactivity in Tejo river, where exist nuclear installations (upstream in Spain) and in Zêzere river, which does not suffer the influence of the nuclear installations and is serving as a background to Tejo river.

Results

Sampling of water, sediments, hydrophytes and fish are carried out in Tejo river (monthly in Vila Velha de Ródão and Valada and quarterly in Barragem de Fratel and Bover). Monthly sampling of water is also performed at Castelo de Bode in Zêzere river (Fig 1).

The concentrations of ^{137}Cs , ^{90}Sr and ^3H in filtered samples of river water are determined using radiochemical analyses. The cationic and anionic concentrations are also determined by ionic chromatography. Artificial and natural radionuclides are determined in sediments (on the whole and in two sediment fractions) hydrophytes and fish by gamma spectrometry.

A collaborative programme between the ITN/DPRSN and the Departamento de Física da Faculdade de Veterinária (Universidade da Extremadura) has been carried out that focus on research of ^{137}Cs and ^{90}Sr transport mechanisms in sediments and water in Tejo river.

Intercomparison exercises for ^3H , ^{137}Cs and ^{90}Sr determinations in river water and exchange of results in between the two laboratories have been performed.



Fig 1- Sampling sites in Tejo and Zêzere rivers.

Published, accepted or in press work

1. A. Baeza, M.C.V. Carreiro, E. Garcia Delgado, C. Miró, M.M. Sequeira, C. Soletto. Series Temporales de ^{137}Cs en aguas del rio Tajo. Proceedings of the "XXIX Reunión Bienal de la Real Sociedad Espanola de Física", Madrid, July 2003, Vol I, 477-478.
2. M. M. Sequeira, V. Silvino, M.A. Pereira, J. Gouveia, L. Ramos, I. Faria, M. J. Madruga, F. Carvalho. Controlo Radiológico dos rios Tejo e Zêzere (ano 2002). *Relatório DPRSN, Série A, n°27/2003, ISBN 972-8660-28-6.*

Assessment of the Radioactivity in the Tagus Estuary due to Hospital Discharges

F. P. Carvalho, M. J. Madruga, J. M. Oliveira, J. Gouveia, L. Silva, M. A. Tavares, A. Libânio

Objectives

To assess the radioactive contamination of the estuarine environment due to discharges of liquid effluents containing radioisotopes from use in medicine. Preliminary results obtained in the previous year based on a few samples, have shown that artificial radionuclides are present in the estuary in measurable concentrations. A more detailed investigation was agreed with the city administration (Câmara Municipal de Lisboa) based on a monthly sampling programme.

Results

The estuary of the Tagus receives the drainage from domestic and all other kind of effluents discharged into the municipal sewers. This includes hospitals, commercial and some industrial facilities connected to the sewers. The municipality of Lisbon manages the sewers system and the wastewater treatment plants of the city. In Lisbon there are about 40 medical establishments using radioisotopes in nuclear medicine.

The survey of the discharges from sewers into the estuary was performed monthly in 8 points located near the outlet of the main sewers along the north bank. Samples of water, sediment, mussels and fish were collected monthly at these points. The analyses of the samples were performed as soon as possible, on fresh materials, in order to determine short-lived radionuclides.

Iodine-131 and Technecium-99m were frequently measured in samples, especially in water and in mussels. Occasionally, Cesium-137 was also detected in some sediment samples. These findings confirm and extend the preliminary results obtained in the previous year. Although the concentrations are generally low, the gamma radionuclides detected have origin in nuclear medicine units and their presence in the discharges could be avoided through appropriate measures. This research is still going into 2004 for completion of the agreement with the city administration.

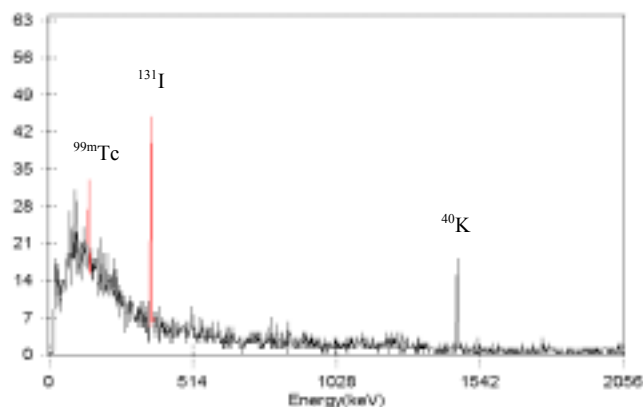


Fig 1 – Radioactivity in mussels from Tagus Estuary collected in December 2003.

Published, accepted or in press work

1. F. P. Carvalho, M.J. Madruga, J.M. Oliveira, J. Gouveia. Programa de Controlo da Radioactividade Artificial no Estuário do Rio Tejo, junto das Descargas dos Colectores do Município de Lisboa. Relatório DPRSN-C, nº 5/2003.

Services

1. Radioactivity in Drinking Waters

M.J. Madruga, G. Ferrador, M.M. Sequeira, I. Lopes, V. Silvino, M.A. Tavares, M.A. Pereira

Following the Portuguese Law (Decree-Law n°243/2001) it is compulsory the evaluation of the radioactivity levels in public waters (human consumption). In this sense the DPRSN is requested by Water Suppliers to perform measurements of global alpha and global beta, Tritium determinations and the calculation of Total Indicative Dose parameter in drinking waters. The determination of radon in same water samples is also carried out.

During 2003, a total of about 2100 analyses were performed.

In order to better answer to this request the accreditation procedures for global alpha and beta and Tritium radiochemical analyses has been carried out. During this year a new technique using liquid scintillation was developed for global alpha and global beta measurements as so as all the procedures necessary to the techniques accreditation.

2. Natural Radioactivity in Mineral Waters

M.J. Madruga, G. Ferrador, J. M. Oliveira, M.M. Sequeira, M.A. Tavares, M.A. Pereira

In order to obtain license to the commercialisation of mineral waters, an evaluation of its radioactive levels should be performed (Decree-Law n°84/90). The

radiological study will include analyses of ^{238}U , ^{234}Th , ^{226}Ra , ^{222}Rn , ^{210}Po , global beta and ^3H . Several enterprises often request by this radiological study. A total of 30 analyses were performed during this year.

3. Artificial Radioactivity Levels in Foodstuffs and other Samples

M.J. Madruga, L. Silva, J. Gouveia, M. A. Gameiro

By request of public and private enterprises and Direcção Geral da Fiscalização e Controlo da Qualidade Alimentar, different kind of samples, mainly food samples to be exported are monitored in order to determine concentrations of artificial radionuclides by gamma spectrometry. During this year 50 samples were analysed.

4. Indoor Radon

M. Reis, P. Duarte, M. A. Tavares

By request of public and private enterprises indoor radon measurements were performed in buildings. A total of 25 analyses were performed during this year.

Indoor radon measurements were carried out in Escola Secundária da Sé - Guarda, by request of the school Executive Council, in order to evaluate the radon levels on several laboratories and classrooms.

Since November 2003 a collaborative Protocol was established between DPRSN-ITN and DECO to answer the associate's indoor radon requests. A total of 200 measurements were already performed.

