

Health and Environmental Studies Using Ion Beams

Teresa Pinheiro

The development of methodologies for the application of X-ray based techniques, of nuclear microscopy using ion beams and of synchrotron radiation to the study of biomedical, toxicological and environmental problems constitute the guiding line of the research activities within the group. The physiology of trace elements and their implications in many pathological conditions due to exposure to environmental pollutants and the establishment of bio-indicators of exposure relevant for toxicological studies have been the more meaningful topics of research. The exploitation of the Nuclear Microprobe capabilities, at the Van de Graaff accelerator, has been granted as a priority in what concerns the running Biomedical applications. The improvement of methodologies for the elemental distribution and sample structure characterisation, which involves different techniques as PIXE, RBS, STIM, etc., will continue to be carried out, having also in mind the usage of synchrotron radiation.

As present lines of activity are ruled by external funding from international and national organisations, it is imperative that a more comprehensive approach of the biomedical and toxicological aspects under study would be programmed. This approach should involve cellular response assessment. Therefore, the joint teams from ITN and from the University of Lisbon, have done efforts to implement adequate methodologies to estimate expression of specific

biochemical pathways involved in xenobiotics turn over. The study of these aspects has been initiated through a post-graduation programme of work.

However, as far as several environmental health and toxicological studies related with noxious effects of chemical elements are concerned, the analytical capabilities of ITN are already insufficient for the relevant scientific problems to study, as repeatedly pointed out by the external evaluation boards. It would be advantageous to be able to invest on challenging analytical facilities for elemental analysis and to attempt to create appropriate infrastructures to support methodologies requiring controlled environment conditions. Also to accomplish the mid- and long-term conjectured perspectives, there is an urgent demand for research personnel in the group. The perspectives pointed out and the foreseen work, are strongly dependent on adequate human resources in order to assure the collaborations established and the multidisciplinary character of the work developed.

This strategy, based on 1) novel scientific approaches to complement know-how achieved on the biology of chemical elements and on 2) human resources amendment, could grant to ITN an increased and fair recognition by the external scientific community and a more competitive position towards the financing entities.

Research Team

Researchers

- Teresa Pinheiro (**Group Leader**)
- Luís C. Alves, Research Student (25%)

Associate Researchers

- Ana Maria Crespo (FC-UL)
- Cristina Santos (FC-UL)
- António Bugalho de Almeida (FM-UL)

Graduate and Pós-Graduate Students

- Sónia Seixas (**PhD** UA/FC-UL)
- Carlos Monteiro (**PhD** ISCS/FC-UL)
- Nuno Raimundo (**Lic** FC-UL)

Technicians

- Rute Pinheiro (80%)

Publications

Journals:	1 and 3 in press
Conf. Communications:	5
Theses:	1

Funding

Research Projects^(a): 900 ×10³ PTE

(a)		×10 ³ PTE
-	From air to human lungs (IAEA POR9479) (1998-2001)	
-	(ITN/16 000 USD)	
	ITN/Co-ordinator: Teresa Pinheiro , Partners A. Bugalho de Almeida, Dept. Pneumology, FM-UL, M.C. Freitas, Reactor, ITN.....	900
-	Research on Ecotoxicity Indicators in Aquatic Communities at the Guadiana River (PEAMP/NMA/666/95) (1997-2000) (5000 × 10 ³ PTE)	
	Co-ordinator: Maria da Luz Mathias (FC- UL), Partners: ITN (Teresa Pinheiro)	—

Application of Ion Beam Techniques to Biomedical and Eco-toxicological Studies*

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M.L. Mathias⁵, A. Bugalho de Almeida⁶, M.L. Carvalho⁷, P. Chevallier⁸

Objectives

The major activities were centred on the physiological significance of chemical elements in biological and biomedical samples. The elemental distribution and mapping in different soft and hard tissues (human, rat, mollusc, etc..) can be related and/or indicative, of biomedical or toxicological problems or both. In addition, Quality Assurance procedures have started to be applied to the methodologies developed and analytical techniques used.

Results

The major achievements within the programmed work for the current year can be summarised as follows:

A. *Biomedicine*

- A.1. Toxic Elements in the Respiratory System - Nuclear Microprobe applications to study the physiological aspects of inhaled aerosols. Some of the results so far obtained were accepted for publication in Nucl. Instrum. and Methods.
- A.2. Chronic Pulmonary Conditions - Evaluation of elemental and clinical (pulmonary function and lung inflammation tests) data gathered from an exposed population (IAEA POR9479);
- A.3. Teeth elemental distributions in population groups exposed to different environments and in pathological conditions (diabetes, chronic diseases) (EC-TMR, LURE). Some of the results are published. Others submitted to periodic journals, wait for the editor's decision.

B. *Toxicology and Eco-toxicology*

- B.1. Closing project "Research on toxicity indicators in aquatic communities at the Guadiana River", JNICT/DGA/PEAM/P/NMA/666/95 - Data evaluation and publication preparation. Three papers were submitted to Biological Trace Element Research and Science of the Total Environment (editors decision not known yet).
- B.2. Study of the potential toxicity of selenite in rat tissues (Biochemistry Graduation Thesis and PhD. Thesis).
- B.3. Biological monitoring of metal pollutants in a marine ecosystem (PhD thesis). Preliminary

results for two Portuguese coastal fishing grounds were accepted for publication in Marine Pollution Bulletin.

C. *Normalisation of X-ray Spectrometries for Chemical Analysis*

- C.1. Internal and external Quality Control (QC) - application of Quality Assurance methodologies (ISO 5725) to measurement results. Results of QC evaluation for Particle Induced X-ray Emission, Energy Dispersive X-ray Fluorescence and Total Reflection X-ray Fluorescence techniques, were recently submitted to Spectrochimica Acta B.

Further work

All contracts will end on the first trimester of 2001. It is expected however that these studies could proceed supported by new proposals to submit to the FCT (Fundação para a Ciência e Tecnologia), EC or IAEA or other financing institutions. Bilateral co-operation with the University of Sevilla and Faculty of Pharmacy of Barcelona focusing elemental distributions in animal tissues and arsenic transfer from soils to trophic chain is foreseen. The studies also involve training activities (post-graduation level). An application to the European Synchrotron Radiation Facility, ESRF (Grenoble) is also being prepared for the Cr and Ni distribution in human respiratory mucosas study using the micro-SRXRF technique at line ID22.

Published (or in press) work

- [1] Carvalho, M.L., Casaca, C., Pinheiro, T., Marques, J. P., Chevallier, P., Cunha, A.S., Analysis of human teeth and bones from the Chalcolithic period by X-ray spectrometry, *Nucl. Instr. and Meth B* **168** (2000) 559-565.
- [2] Santos, M.C., Pinheiro, T., Raimundo, N., Monteiro, C., Pinto, R.E., Evidence for an effect of selenium supplementation on the concentration of rubidium in several rats tissues, *Congresso Nacional de Bioquímica*, 28-30 September 2000, Póvoa do Varzim, Portugal.

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