

Cultural Heritage and Sciences

M. Isabel Prudêncio

The Cultural Heritage and Sciences (CHS) group is especially voted to the **study of the Portuguese cultural assets and corresponding environment contexts**, through the **application of nuclear methods**, including chemical characterisation and absolute dating.

Geochemistry, mineralogy and absolute dating are the main research domains, applied to archaeometry, environmental geology and paleoenvironmental reconstruction.

The analytical methods associated to the CHS group, include the instrumental neutron activation analysis (INAA) - comparative method, for chemical characterization, and luminescence dating (TL-OSL). Other methods, such as X-ray diffraction, SEM-EDS and Mössbauer are commonly used. These methods allow a detailed characterisation of archaeological and geological materials and the establishment of chronologies.

The application of ITN methodologies unique in Portugal, are fundamental for archaeology and geology, which are the main domains of the research projects of the CHS activity, through protocols, financed projects, collaboration with national and international laboratories and universities, and contracts/services with private or public institutions.

This group is specialized in trace-element analysis and geochemistry (i.e., geochemical fingerprinting) of archaeological specimens for the purpose of determining their provenance (source) by using the above mentioned analytical techniques as tools. To the best of our knowledge, we are the only archaeometrically oriented lab in Portugal with powerful analytical techniques in a single location. We also support geochemical research on the petrogenesis of various igneous, metamorphic, and sedimentary rocks, as well as environmental studies.

So, considering those main achievements, we can summarize the principal research domains of CHS group in the following:

- 1) Cultural Heritage
 - a. Archaeological / Museum artefacts (such as ceramics, metals, stones)
 - b. Monument stones
 - c. Sites surroundings characterization
- 2) Palaeoenvironmental Reconstruction
 - a. Landscape evolution
- 3) Earth Surface environments
 - a. Clay research
 - b. Natural weathering processes
 - c. Anthropogenic inputs to natural background environments

One of the CHS group most important activities involves the education and training of students from national and international universities. Because our students participate in the entire analysis beginning with sample preparation, irradiation, and measurement and continuing through the statistical analysis and data interpretation, they are well prepared to conduct research in academic and industrial environments.

The improvement of the scientific research based on nuclear techniques of analysis and its application to environmental studies by characterizing pollutants and determine their source and methods of reduction, as well as archaeological studies to fingerprint artefacts and determine the place of origin as a way to understand the activities of humans in the past, is a rolling target of the CHS group.

Research Team

Researchers

M. I. PRUDÊNCIO, Princ. , Group Leader
M. I. DIAS, Aux. (Invited)
A.M. SOARES Princ. (until Oct. 2005)

Students

M. J. TRINDADE, PhD student, FCT grant
A. JORGE, PhD student, U. Sheffield grant
C. CAPITÃO-MOR, MSc student
S. VILELA, MSc student
P. FRANCISCO, Undergraduate student
F. GEIRINHAS, Undergraduate student
A. C. VERÍSSIMO, Undergraduate student

Technical Personnel

L. FERNANDES
R. MARQUES
D. FRANCO
G. CARDOSO

Collaborators

M. A. GOUVEIA

Palaeoenvironmental Reconstruction

M. I. Prudêncio, M. I. Dias, M. A. Gouveia, J. C. Waerenborgh¹
A. C. Valera², L. Osterbeek³, F. Rocha⁴, L. Rebelo⁵*

The palaeoenvironmental reconstruction research is concerned with investigating and explaining environmental change on different spatial and temporal scales ranging from the geological through to present day situations and the modelling of change into the future. The group's research is particularly relevant in our understanding of the impact of climate change, supporting archaeological investigation, and assisting landscape evolution, particularly the Portuguese coast line, in order to determine the geological processes that control the evolution of the beach and the effects that this evolution has in the shoreline displacement.

Research undertaken by the group involves the analysis of former coastal environments and archaeological environments. Research techniques include palaeosol and sediment analysis, namely absolute dating and chemical and mineralogical characterization. Recent and current projects have included working with other research laboratories and universities.

The group is currently developing research in the following areas:

- Evolution of coastal environments
- Fluvial terrace geomorphology / chronology
- Sediment investigation of archaeological sites
- Application of palaeoenvironmental habitat management

Research also involves managing and conserving the natural environment and embraces an array of environmental issues, in order to understand impacts and how humans have been affected by natural and human-induced environmental changes and may be affected by future change.

The study of palaeogeographic / palaeoclimatic evolutions within a certain context is of great interest, especially if some stratigraphic indetermination occurs, namely considering the principal stratigraphic discontinuities, for which the use of several types of non-biostratigraphic markers, such as mineralogicals and geochemicals, became of great interest.

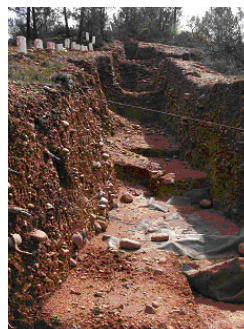
To achieve the main goals of the running projects the most used tools consists on the use of sedimentology / geochemistry to solve sedimentological problems, by

using nuclear methods, such as chemical analysis by instrumental neutron activation analysis (INAA), and the absolute dating by luminescence; these methods are complemented mainly with XRD, SEM, Mössbauer:

- to examine the relationships between clay minerals associations, iron oxides, chemical elements distribution, lithology and facies types;
- to assess both the capabilities and the limitations of clay sedimentology and chemostratigraphy in the study of sedimentary sequences;
- to contribute to the refinement of the paleogeomorphology of the Portuguese territory with well established chronologies, by luminescence methods;
- to identify useful mineralogical and geochemical fingerprints which able a reconstruction of the past in a certain geomorphological context.

These research fields aims to contribute to a better knowledge of the Portuguese Quaternary climate change scenario, based on multi-proxy investigations of paleosols, sediments and dunes. These investigations constitute the research component into long-term environmental change.

These themes combine to explore the very origins of our present environment.



¹ QFES ITN group

² GAFAL archaeologist (C.M. F. Algodres), Portugal

Era Arqueologia S.A. Portugal

³ Instituto Politécnico de Tomar

⁴ Departamento de Geociências da Universidade de Aveiro

⁵ IGM - INETI

* Collaborator

**Movable Cultural Assets – An example of results obtained in one “archaeometry of ceramics” project
Pre-historic pottery technology and provenance in the upper Mondego valley (central/northern Portugal)**

M. I. Dias, M. I. Prudêncio, M. A. Gouveia, R. Marques, D. Franco, A. Jorge¹, A. C. Valera², P. Day¹*

This archaeometric project aims to study technological procedures during the manufacture process of making ancient pots, and its provenance, in order to contribute to the establishment of continuities or innovations in ceramic production and on raw materials resources of populations through the third millennium BC in the upper Mondego basin at a local/regional scale. Three main methodological approaches were done to ceramics and potential raw materials (clays): neutron activation analysis (INAA), thin-section petrography and X-ray diffraction, evolving pottery assemblages from 10 settlements: 3 from the Early Neolithic, 3 from the Late Neolithic, and 4 from the Chalcolithic to Early Bronze Age. One of the foremost achievements concerns the technological variability of pottery assemblages recovered from those various domestic contexts, which well definition will be very helpful in the archaeological running project. On the basis of preliminary results, some observations regarding ceramic style and exchange can be introduced. In each site a clear main group of samples was discriminated in both chemical and petrographic terms. The clay pastes do not vary according to morphological types and/or decorative techniques, but with raw materials availability closest to the site. The results obtained so far reinforce the image of cultural homogeneity drawn from previous morphological studies, at both intra- and inter-site level, but petrographic and chemical ‘outliers’ agree in suggesting a possible non-local origin for a small number of pots.

¹ University of Sheffield – Department of Archaeology and Prehistory, England

² Era Arqueologia S.A. Portugal. GAFAL archaeologist (C.M. F. Algodres), Portugal .

* Collaborator

Non-Metallic Portuguese Resources. Inventory, chemical and mineralogical characterization of clays

M. I. Dias, M. I. Prudêncio, M. A. Gouveia, M. J. Trindade¹, F. Rocha², J. Coroado³*

This project makes part of a PhD thesis, whose main objectives are to make an inventory of availability of potential raw materials for ceramic production in the southern and occidental Portuguese borders, followed by an evaluation of chemical and mineralogical transformations of clay materials of different nature, during ceramics production processes, and its implications on provenance and technological procedures studies of archaeological ceramics. So far, important accomplishments were already obtained, such as a geochemical and mineralogical characterization of clay deposits from different origins/geological formations, mineralogical characterization of clay deposits from different origins, a very detailed (chemical, mineralogical and technological) characterization of the corresponding clay (< 2 µm) fraction. Different chemical and mineralogical composition was noted, like important variations in Ca, Mg and REE, which able to establish geochemical fingerprints for the main geological levels, specially the clayey ones, with more importance for ceramic production. Experimental studies are in course, evolving physical-chemical transformations with different temperature and atmosphere conditions reached upon heating processes.

¹ PhD student, FCT grant

² Universidade de Aveiro

³ Centro Tecnológico da Cerâmica e do Vidro. Instituto Politécnico de Tomar.

* Collaborator

Luminescence of inorganic systems. Dating and structural studies of mineral assemblies.

M. I. Prudêncio, M. I. Dias, G. Cardoso, L. Oosterbeek¹, L. Rebelo², A.C. Valera³

The application of luminescence technique for dating various kinds of samples of diverse archaeological and or geological contexts was a major objective, and important results were already obtained for the Quaternary chronological boundaries of Portuguese territory. Also age authentication of old ceramic wares was done, for which it gives the approximate date of the last firing. Nevertheless new applications of this methodology were implemented, especially concerned with a refinement of ascertain firing temperatures of ancient ceramics during technological procedure, minimizing pos-depositional contaminations which might induce bad temperatures rates with other methods, such as X-ray diffraction.

¹ Instituto Politécnico de Tomar.

² IGM - INETI

³ Era Arqueologia S.A. Portugal. GAFAL archaeologist (C.M. F. Algodres), Portugal