PhD offer in ^{14}C and archeomagnetism dating of archaeological ceramics

Contexte

We are offering a PhD position at the Laboratoire des Sciences du Climat et de l'Environnement (Gif-sur-Yvette, France) between the GeoTrAc and CliMag teams in the 'Archives and tracers' theme. The PhD position is part of the ERC-StG AGROCHRONO project, which studies the development of agro-pastoralism in the Indo-Iranian borderlnads. The objectives of the ERC project are to obtain and specify the chronological, cultural, economic and environmental framework in which the first agro-pastoral populations in the region evolved from the 7th millennium BC onwards. The subject of this thesis forms part of the chronological aspect of the project, with the development of combination of archaeomagnetism and molecular radiocarbon dating of archaeological ceramic vessels.

The south-east of Iran and Pakistan is crucially lacking chronological data for the Neolithic and Chalcolithic periods. A large number of sites have been discovered but their chronological links, based mainly on archaeological material, lack absolute data to anchor the chronology. An absolute dating programme is needed to clarify the chronologies of the region. However, the classic remains for ^{14}C dating are often rare or poorly preserved in this region. This is the case, for example of bone collagen, which is poorly preserved in arid environments. Archaeological ceramics provide a source of both relative and absolute dating, which must be exploited.

Major advances have recently been made in ^{14}C dating of archaeological ceramics, using a molecular approach to dating the organic remains left over from the use of the ceramics. Two fatty acids of animal origin are isolated by preparative gas chromatography before being dated by ^{14}C. This method has been tested and validated for sample masses in excess of 200µg of carbon. However, pilot studies in Iran have shown little preservation of lipids in the ceramics, which means that the next stage of development will involve reducing the size of the samples routinely targeted.

Ceramics also provide absolute chronological information thanks to their magnetic properties, which record the intensity of the Earth's magnetic field during firing. The secular variation of the field at periods of interest is sufficiently well known in Mesopotamia to enable archaeomagnetic dating applications. However, this variation is poorly constrained in the areas of interest of the AGROCHRONO project due to the lack of reference data.

The aims of the thesis are therefore to work on the combination of ^{14}C and archaeomagnetism dating on archaeological ceramics in order to :

- Test the complementarity of ^{14}C and archaeomagnetic dating on archaeological ceramics from north-west Iran, where the variation of the geomagnetic field and the chronology are known.
- To determine the secular variation of the geomagnetic field at the Indo-Iranian border by measuring the same material using both methods.
- To provide chronological information on the Neolithic and Chalcolithic sites studied in the ERC project via ceramic material.

The experimental work will involve learning archaeomagnetic dating techniques, classical ^{14}C dating on microsamples and on specific molecules. The candidate will:

- Develop the combination of dating methods by optimising the sample sizes to minimise the impact of these invasive techniques on the archaeological material.
- Establish the local secular variation curve of the geomagnetic field intensity.
- Carry out chronological modelling using existing data, and data generated during this thesis and the AGROCHRONO project, using dedicated tools (OxCal, ChronoModel).

During the course of the thesis, the candidate, working in contact with his/her supervisors and the technical and post-doctoral staff employed on the project, will also have the opportunity to :

- Learn the study of organic residues in ceramics, which is necessary to identify datable ceramics prior to molecular ^{14}C measurements of archaeological ceramics;
- Learn ^{14}C measurements on other archaeological materials (charcoal, bones) and sediment cores.
- Have training in palaeomagnetism protocols (characterisation of magnetic mineralogy, palaeointensity methods).
- Take part in field campaigns.
- Disseminate their work at international conferences and through publications in peer-reviewed journals.

Host environment

The successful candidate will be supervised by Gwenaël Hervé (CEA research engineer, CliMag team), an expert in archaeomagnetism on archaeological objects, and Emmanuelle Casanova (CEA research engineer, GeoTrAc team), an expert in radiocarbon dating and organic geochemistry and leader of the AGROCHRONO ERC project.

The CliMag team has a Palaeomagnetism laboratory fully equipped for the project, with cryogenic magnetometers, palaeointensity furnaces and highly sensitive equipment for characterising magnetic mineralogy.

LSCE's GeoTrAc team has a ^{14}C dating laboratory. It is equipped with a chemical preparation laboratory and an organic geochemistry laboratory with gas chromatography for isolating individual molecules, a wide range of manual and automatic lines for burning samples in CO_2 and converting them into graphite, adapted to the nature and size of the samples processed, and a compact accelerator, the EchoMICADAS, for measuring ^{14}C.

Candidate‘s profile

Education and skills

- Master 2 or engineering degree or equivalent, in archaeometry, archaeological sciences, geochemistry, physics or related subjects
- An interest in geochronology and the development of methods
- Knowledge of the risks associated with chemical laboratory work, working with instruments and complying with safety regulations
- Rigour and attention to detail when working with unique, small (non-replaceable) samples

Personal skills

- ability to work in a team
- communication skills

Rigour and organisation

Start date : october 2025

Send CV, cover letter and Master's grades report to emmanuelle.casanova@lsce.ipsl.fr and gwenael.herve@lsce.ipsl.fr