General Information

Reference : UMR5608
Work location : Toulouse city, France
Publication date : -
Scientific supervisors : Sandrine Baron and Franck Poitrasson
Type of employment contract : doctoral position
Contract duration : 36 months – Full time
Source of funding : French National Centre for Scientific Research (CNRS)
Start date of the position : November 01, 2020
Gross salary : -

Description of the thesis subject

Background of the research work

Isotopes are a very promising approach for metal tracing in history and archaeology to reconstruct ancient trade routes. However, the precious nature of gold objects limits the use of this approach because of the requirement of samples preservation. The tracing of coins by means of multi-elemental analysis using the *in situ* laser ablation method does not allow the identification of a geographical origin as with isotopic methods. In the absence of techniques adapted to the measurement of isotope ratios with sufficient precision and accuracy for a robust use of the data, the literature presents few reliable isotope data on archaeological objects made of gold, which is otherwise a monoisotopic element. The objective of this project is to use the latest analytical developments in geochemistry to establish accurate sub-millimetre-scale isotopic measurements of lead, iron and copper contained in medieval African gold coins. The objective is to trace the geographical origin of these coins and to identify the circulation routes of gold in the Trans-Saharan trade during medieval periods.

Abstract of the research work

The research that will be conducted under this doctoral contract is fully interdisciplinary. The doctoral student will have to establish a bibliographical synthesis - as exhaustive as possible - from different fields. These include both research conducted (i) in archaeometry and history on the provenance of gold, (ii) on the use of femtosecond laser in isotope geochemistry, (iii) on the geology/geochemistry of gold ores in general and (iv) on current research conducted in numismatics. This collection of a very diverse - but complementary literature - will allow a cross-referenced and critical analysis of the new developments and results acquired during the thesis work from an archaeological and historical perspective.

In the beginning, the PhD student will have to develop the protocol for *in situ* isotopic analyses of lead, iron and copper on gold standards using a femtosecond laser coupled to an MC-ICP-MS (high-resolution mass spectrometer). These analyses will be carried out in Toulouse, but trips to other places may be necessary to conduct inter-laboratory calibration during the development of this new analytical method. The same isotopic measurements will be carried out by wet method on the same materials to ensure that the *in situ* methods developed are accurate.

In a second step, this protocol of *in situ* isotopic analysis will be deployed on gold coins of African origin (Fatimid coins from the monetary treasury recently discovered off Caesarea on the Israeli coast). Beforehand, travel will be necessary to Orleans (IRAMAT laboratory, CNRS UMR 5060) in order to carry out *in situ* multi-elemental analyses on some of these gold coins.

Then, in a third step, high-resolution multi-elemental and isotopic analyses on targeted gold ores will be carried out using the wet method. For this purpose, the PhD student may also be required to participate in field campaigns for the geological sampling of ores (Israel, Ethiopia, West Africa and Spain). He or she will also participate in international conferences and must be able to write scientific articles of international standing.

This research presents a certain degree of risk-taking due to the innovative aspect, but also, in rupture, of the methods and approaches proposed here with regard to the state of the art on the subject.

Profil of the applicant student

The PhD student must hold a Research Master's degree in geochemistry with a solid knowledge of geology and isotopy but also research experience in geochemical analysis - in general - on materials. Knowledge or experience, or at least a strong interest in archaeology and history would be appreciated. He or she will need

to be fluent in English. Because of the highly interdisciplinary nature of the research to be carried out here, the doctoral student will have to be open-minded and able to adapt to different working contexts (travel to different laboratories and field missions) and to practices and/or methods of reasoning related to the different disciplines. In addition to a good academic level, natural curiosity and strong motivation are essential.

Working context

As the thesis project is at the interface between archaeology/history of metals and isotopic geochemistry, the PhD student will be straddling two CNRS laboratories in Toulouse which already have succefuly worked together on related topics. These are the TRACES (UMR 5608) and GET (UMR 5563) laboratories.

The TRACES laboratory hosts the "METAL" team *i.e.* "**M**etals: **E**conomics and **T**echniques through **A**rchaeology and the **L**aboratory". The latter is dedicated to the history and archaeology of metals in diachrony, for which the use of an interdisciplinary approach is a tradition. This team has recognised knowledge in mining and metallurgical archaeology through archaeological and archaeometric research carried out notably on the largest mining and metallurgical districts of classical antiquity across the Mediterranean basin (Spain, Portugal, Romania, Greece...) but also for the medieval (France, Morocco, West Africa) and Celtic (England, France) periods. The team also has a tradition of working on the economy and provenance of metals, especially iron, lead, silver and gold. The PhD student will therefore be in an environment conducive for the acquisition of a culture in the archaeology and history of metals.

The GET laboratory has been developing the geochemistry of "non-traditional" stable isotopes (Fe, Zn, Si, Hg, Mg...) for more than 15 years. In addition to understanding the mechanisms of distribution of these isotopes in nature, they are used to studies in earth and environmental sciences, planetology, archaeology, etc. To conduct this research, the laboratory has a clean room for mineralising and purifying elements before their isotope analysis by mass spectrometry using a multi-collection plasma source hosted at GET for the Midi-Pyrénées Observatory. This service also has an ultra-fast (femtosecond) laser ablation system for the accurate and precise *in situ* analysis of stable metal isotopes. GET has also hosted a transverse "Archaeometry" axis for many years, providing a link with the archaeology laboratories of the Toulouse University and GET. The student will therefore be integrated into a group that is already involved in interdisciplinary research combining geology and archaeology.
The Toulouse environment is also conducive to other types of analysis of observations and characterisation of solid samples (SEM, MET, electron microprobe, etc.).

The doctoral student will be supervised by Sandrine Baron and Franck Poitrasson respectively present in the TRACES and GET laboratories.

Contacts for more details:

Sandrine Baron
sbaron@univ-tlse2.fr

Franck Poitrasson
Franck.Poitrasson@get.omp.eu