MINISTERE DE L’EDUCATION NATIONALE, DE L’ENSEIGNEMENT SUPERIEUR ET DE LA RECHERCHE

INSTITUT FRANÇAIS D’ARCHÉOLOGIE ORIENTALE

ARCHAEOMETRY: ANOTHER POINT OF VIEW

9h30: Welcome

10h: Introduction

10h15-10h45: Dr. Stéphanie Leroy: “IRANGKOR: an Integrated, Multidisciplinary Approach to Evaluate the Role of Iron (Production, Trade, Consumption) in the Expansion of the Khmer Empire, Cambodia (9th to 15th c. CE)”

10h45-11h15: Prof. Dr. Ernst Pernicka: “Precise and Accurate Analysis of Gold 7 Alloys: Varna, the Earliest Gold of Mankind: A Case Study”

11h15-11h40: Coffee Break

11h40-12h10: Dr. Delphine Neff: “Preservation of Metallic Artefacts: Understanding the Long Term Degradation Processes thanks to Multi-scale Characterisation”

12h10-12h40: Dr. Roland Schwab: “Manufacture of Roman Bronze Statues from the Limes Germanicus”

12h40-13h: Discussion “Studying archaeological objects” Chaired by Dr. Anita Quiles, Dr. Johanna Sigl, Ms. Jane Smythe

13h-14h: Lunch

14h00-14h30: Prof. Dr. Ludovic Bellot Gurlet: “Contribution of Vibrational Spectroscopies (Raman, Infrared) in Archaeometry: from Materials to Ancient Techniques”

14h30-15h00: Dr. Edwige Pons-Branchu: “Cross Dating Carbonate Formations Overlying Palaeolithic art: Methodological Aspects and Application for Art Dating in Spain, China, Congo and France”

15h00-15h30: Prof. Dr. Jan Heinemeier: “14C Dating in Interdisciplinary International Projects”

15h30-16h: Discussion “Applying Modern Archaeological Methods in-situ” chaired by Dr. Anita Quiles, Dr. Johanna Sigl, Ms. Jane Smythe

16h: Conclusion and Coffee Break
ABSTRACTS
CONTRIBUTION OF VIBRATIONAL SPECTROSCOPIES (RAMAN, INFRARED) IN ARCHAEOLOGY:
FROM MATERIALS TO ANCIENT TECHNIQUES

PR. DR. LUDOVIC BELLOT-GURLET

Sorbonne Universités, MONARIS "de la Molécule aux Nano-objets : Réactivité, Interactions et Spectroscopies”
UMR 8233 UPMC/CNRS, Université Pierre et Marie Curie, 4 Place Jussieu, 75252 Paris, France.

Recent developments of instruments in Raman and infrared spectroscopies provide researchers with the ability to tackle various methods of archaeometric non-invasive analyses performed in laboratory or on site. Results from the use of such instruments will be presented and examples will illustrate the archaeometric information that can be obtained using Raman and/or infrared spectroscopies. Examples will be taken from the study of natural organic substances and constitute a precious set of evidence illustrating human exploitation strategies, exchange networks, and techniques for their presence in numerous ancient objects. With the re-evaluation of vibrational spectroscopies and the potential of spectral treatment procedures, alternatives or complementary techniques to the usual destructive analytical strategies based on separation methods, can be proposed. Studies related to inorganic materials will also be presented that have implications on the scientific investigation of pigments, stone tools, ceramics, and glass. This presentation will underline the contribution on material identification and the documentation of the history of technologies.

Notes:
This paper will introduce a number of collaborative $^{14}$C dating projects that the Danish Aarhus AMS $^{14}$C Dating Centre has successfully undertaken. Such international interdisciplinary collaborations have been essential to the development of new techniques and results in a variety of fields such as: dietary reconstruction of subsistence patterns, chronology of buildings by dating samples of mortar, and high precision dating of the Thera eruption on Santorini, which had hitherto eluded attempts of conclusive radiocarbon dating.

Notes:
IRANGKOR: AN INTEGRATED, MULTIDISCIPLINARY APPROACH TO EVALUATE THE ROLE OF IRON (PRODUCTION, TRADE, CONSUMPTION) IN THE EXPANSION OF THE KHMER EMPIRE, CAMBODIA (9TH TO 15TH C. CE)

DR. STÉPHANIE LEROY

Stéphanie Leroy1, Mitch Hendrickson2, Alexandre Disser1, Emmanuelle Delqué-Kolic3, Enrique Vega1, Philippe Dillmann4, Théo Blanchet1, Pira Venunan4, Brice Vincent5, Dominique Soutif5, Christophe Pottier5, Martin Polkinghorne6, Roland Fletcher7

The Khmer Empire, based at the UNESCO World Heritage site of Angkor in Cambodia, rapidly extended their political influence across mainland Southeast Asia between the 11th and 13th c. AD. Traditionally, Angkor’s power base is attributed to an elaborate bureaucratic system, regional centres, and road system; however, the actual mechanisms that facilitated the sudden expansion remain obscure. Lack of key resources around the capital suggests this network provided materials necessary to enable agricultural output, supply of armies, construct temples and hydraulic facilities, and trade with foreign nations. Given the massive scale of Angkor’s accomplishments a corresponding increase in industrial-scale activities should be witnessed in raw material collection, refining, distribution and use across the landscape. Iron, with its dynamic technological characteristics and universal utility, is viewed as an ideal – and currently undocumented – medium to investigate these empire-building processes for the medieval Khmer.

IRANGKOR is the first intensive study of khmer iron production with the explicit goal of shedding new light on the iron circulation and broader exchange system within the khmer Empire. For the last 10 years, LAPA investigated the significant physical and chemical properties and features of iron objects, in particular those linked to microscopic Slag Inclusions (SI) embedded within artefacts, to provide crucial information on the iron-making processes, technology and more recently provenance and absolute dating to provide a renewed vision of trade flows, supply and employment of iron in specific historical, chronological and socio-economic contexts. These innovative methodologies based on an integrated interdisciplinary approach are here developed to the medieval Khmer context.

This communication aims to present and discuss the context, the multidisciplinary collaboration, the methodological stages as well as the results obtained in the frame of this international project.

Notes:

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2 - University of Illinois – Chicago, United-States
3 - Laboratoire des Sciences du Climat et de l’Environnement (LSCE - LMC14) (CNRS, CEA, UVSQ, Université de Paris-Saclay), France
4 - Silpakorn University, Bangkok, Thailand
5 - Ecole Française d’Extrême-Orient, France, Cambodia, Thailand
6 - Flinders University, Adélaïde, Australia
7 - Université de Sydney, Australia
Preservation of Metallic Artefacts: Understanding the Long-Term Degradation Processes Thanks to Multi-scale Characterisation

Dr. Delphine Neff

Laboratoire Archéomatériaux et Prévision de l’Altération: IRAMAT LMC CNRS & NIMBE LAPA CEA/CNRS, CEA Saclay, France.

Metallic artefacts undergo corrosion over long periods, which results in a loss of readability or shape of the artefacts, immensely damaging for the preservation of metallic cultural heritage. Stabilisation and protection treatments are conducted to preserve them from destruction based on immersion or coating protocols that can lack efficiency. This is why the development of scientific studies to understand the physico-chemical processes involved is necessary. This presentation will explain how the NIMBE/LAPA has developed a specific approach to achieve this aim. It will be shown how this form of scientific research is conducted in close collaboration with curators. Case studies of artefacts coming from the archaeological site of Glinet (16th c AD. Normandy France) and the marine site of Les Saintes Maries de la mer (1st BC, Bouches du Rhône France) will be given as examples.

Notes:
During the last decade an analytical routine was established that allows researchers to determine the composition of gold artefacts for major and trace elements by LA-ICP-MS. This micro-invasive method has proven highly suitable for obtaining detailed characterization of prehistoric gold in order to investigate its ‘chaîne opératoire’. At the CEZA laboratory (Mannheim Germany), two different analytical set-ups were developed that are based upon different calibration strategies: 1) liquid calibration with the ICP-MS operating under wet plasma conditions, and 2) external calibration by solid standard reference materials with the ICP-MS operating under dry plasma conditions. Both strategies described and compared within this paper yielded accurate and precise results for determining the whole range of matrix components within the gold, yet enable flexible adjustment according to different sample properties. An archaeological case study of gold finds from the chalcolithic cemetery of Varna (Bulgaria) demonstrates the practical suitability of these analytical methods for archaeometallurgical studies. These analyses yielded valuable information for defining and comparing groups of gold artefacts that allude to their distribution within the burial site. However, the comparison of artefact gold with geological gold samples proved problematic, and clear relations between artefacts and specific gold occurrences are difficult to demonstrate.

Notes:
Cross Dating Carbonates Formations Overlying Palaeolithic Art: Methodological Aspects and Application for Art Dating in Spain, China, Congo and France

Dr. Edwige Pons-Branchu


Dating cave art when 14C dating on charcoal is not possible (e.g. in case of red painting or engraving) is challenging and several studies this last decade have proposed indirect dating methods. Dating of the support and thin calcitic layers covering the representations can provide a minimum age (terminus ante quem) for the underlying paintings and/or engravings, or a maximum age (terminus post quem) when the support is dated. Our interdisciplinary research focuses on analytical improvements and intercomparison laboratory analysis, methodological aspects for testing the validity of the chronology, and archaeological interpretations. Analytical improvements of the dating method include several aspects, among which for the 230Th/234U method, blank levels control, work with very low 230Th levels and inter-laboratory comparisons. Methodological aspect include cross dating using both 230Th/234U and 14C dating tools in order to validate the determined age, taking into account all necessary corrections of both methods (detrital thorium and dead carbon). As far as possible, especially when the two dating methods give very different ages, mineralogical and petrographical studies were undertaken. Optical and cathodoluminescence microscopy were undertaken on thin layers in order to define the mineralogy of dated material to determine if several growth episodes are recorded in the speleothems, and to evidence dissolution/recrystallisation events that may have perturbed the dating system. Archaeological interpretations and discussions are drawn in close collaboration between archaeologists and geochronologists. We will present interdisciplinary and international cases of rock art dating present in decorated caves and open air sites. The selected sites include historic and prehistoric art representations from France, Spain, China, and Congo-Kinshasa.

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Manufacture of Roman Bronze Statues From the Limes Germanicus

DR. ROLAND SCHWAB

Deputy Director of the Curt-Engelhorn-Center for Archaeometry (CEZ), and contact person for Studies on corrosion, technology and origin of prehistoric and historic metal materials, Mannheim (Germany)

Romans created large metal statues as a form of imperial propaganda. Life-sized and larger-than-life statues of emperors, gods and heroes filled the cities, military camps, and sanctuaries throughout the Roman Empire. These sculptures do not necessarily survive completely intact. Most were destroyed and melted down for the reuse of the valuable metal, with more than 5000 fragments have been recorded to date from the provinces along the Limes Germanicus. A research project founded by the German Volkswagenstiftung has investigated the different scientific methods of casting techniques that include alloy compositions and surface working such as gilding, chiselling, repair, and joining. More than 500 fragments have been analysed for alloy composition and more than 100 samples have been analysed for lead isotopy. Cross sections of fragments have been examined by optical and scanning electron microscopy.

Roman statues are made of leaded or even of highly leaded bronze. The lead isotope ratios from most of the statues obtained from the Limes match German deposits in the Rhine Massif. This lead was minted during the Roman period and exported as PLUMBVM GERMANICVM to the whole empire. It becomes quite obvious that these statues must have been cast locally, which is supported by technological observations. Several technical features of the Limes statues differ from the technology of Italian statues. Ratio fragments not isotopically matching German deposits, would indicate lead from France or the Balkan provinces; however, this is still a hypothetical at the moment. According to the high lead content observed on these statues, leaf gilding is understood to be the dominant gilding technology, albeit with a few examples of fragments with fire-gilding or both.

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