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## **XXVth GMPCA symposium (Rouen, France, April 14 - 18, 2025)**

Since 1977, the GMPCA (Groupe des Méthodes Pluridisciplinaires Contribuant à l'Archéologie) symposium has brought together French and European researchers from various disciplines who contribute to archaeology through multidisciplinary. This 25th edition will take place in Rouen from April 14 to 20, 2025. It comprises 15 sessions organized into 4 themes: Water landscapes and socio-environmental dynamics (theme 1); Gestures of human-resource-object interactions (theme 2); Innovative tools for characterizing, imaging and dating (theme 3); The contribution of digital technology to reconstructing remains and landscapes (theme 4). The various sessions grouped under these 4 themes are designed to welcome research carried out within the framework of both preventive and scheduled archaeology. This symposium aims to take stock of advances in techniques applied to archaeology, to exchange views on current archaeometric research and to enable young researchers to present their work.

### **Theme 1. Water landscapes: from human-environment interactions to socio-environmental dynamics<sup>2</sup>**

- Session 1.1. Crises and resilience of societies in alluvial and lake contexts<sup>2</sup>
- Session 1.2. The trajectory of environmental socio-systems at the land-sea interface<sup>2</sup>
- Session 1.3. Archaeological sites in the Anthropocene: vulnerability, management and societal challenges<sup>3</sup>

### **Theme 2. Identify, analyse and reproduce the gestures of human-resources- objects interactions<sup>3</sup>**

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- Session 2.4. Reproducing to understand the gestures of the chaîne opératoire<sup>5</sup>

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- Session 3.2. 3D acquisition and multi-dimensional analysis<sup>6</sup>
- Session 3.3. New approaches to study archaeological material and objects<sup>6</sup>
- Session 3.4. Dating and processing of chronological data in outer environment<sup>7</sup>
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### **Theme 4. From vestige to digital landscape: Bringing together modelling, computational analysis, simulation and (geo)visualization within an interdisciplinary and reproducible scientific framework<sup>7</sup>**

- Session 4.1. Interoperability and data life cycle & open science in an interdisciplinary context<sup>8</sup>
- Session 4.2. Building and making: computational archaeology as a new paradigm<sup>9</sup>
- Session 4.3: Modelling and simulation of spatial phenomena<sup>9</sup>

## **Theme 1. Water landscapes: from human-environment interactions to socio-environmental dynamics**

**Coordination:** Cécile ALLINNE ; Stoil CHAPKANSKI ; Léa MAIRAVILLE ; Dominique TODISCO

**Keynote:** Emilie GAUTHIER

Continental and coastal hydrosystems have been attractive environments for human societies for thousands of years and all over the world. Those "water landscapes" were occupied and modified very early by societies, and played a crucial part in the processes of cultural and material diffusion. Because of their active hydro-geomorphological dynamics, these environments allow for very responsive answers facing climate forcings. Exposed to this dynamism, waterside societies needed to invent and develop specific solutions to reduce risks and vulnerability to flooding or erosion hazard. Therefore, in this theme, we will be attentive to consider and study the vulnerability of archaeological sites facing coastline retreat, thawing permafrost, riverbank degradation or fluvial erosion, as also documented by the archaeology. All of those items are important challenges for societies in France, but also worldwide.

### **Session 1.1. Crises and resilience of societies in alluvial and lake contexts**

**Coordination :** Dominique TODISCO, Léa MAIRAVILLE, Louise PURDUE, Pierre-Gil SALVADOR, Yann LEJEUNE

Continental hydrosystems (rivers, lakes) are attractive environments for human societies because of the many resources they offer (water, food, raw materials), the biodiversity they contain, and their potential for transport and circulation. These environments, which were anthropized at an early stage, served as routes for the spread of both culture and materials, combining trade and technology, while at the same time offering fertile land for agriculture, thereby encouraging the development of the first agrosystems. However, these environments are extremely dynamic, responding rapidly to hydro-climatic and geomorphological forcings, as revealed by river metamorphoses, meanders mobility within alluvial plains, variations in lake levels, chronic floods and the historical drying up of water tables. For riparian societies, these changes lead to hazards and even environmental crises requiring constant adaptation and specific development, such as channelization and dyking, to reduce vulnerability and the associated risks (e.g. flooding, bank erosion). The geoarchaeological contexts associated with continental hydrosystems are varied, ranging from great river corridors to wide floodplains, to the salt water bodies, with their changing shores, located in semi-arid regions (sebkhas/chotts/playas), to the northern and mountain lakes. In this first session, this wide range of hydro-environments will enable us to explore past interactions between human societies and water landscapes over the long term, on archaeological and geohistorical scales.

**Keywords:** fluvio-lacustrine environments; river dynamics; crises; risks; adaptation; geoarchaeology.

### **Session 1.2. The trajectory of environmental socio-systems at the land-sea interface**

**Coordination:** Cécile ALLINNE, Stoil CHAPKANSKI, Léa MAIRAVILLE, F. SALOMON, Jean-Philippe GOIRAN, Pierre STEPHAN

Coastal hydrosystems are dynamic environments at the land-sea interface, formed and controlled by a combination of terrestrial and marine hydrodynamic processes. They constitute

transitional geosystems between the flows of fresh water, sediments and nutrients. Since the earliest human settlements, coastal areas have offered a wide range of resources and have become the preferred places for societies to live and trade. However, the dynamics of coastal environments, over the short time span of human settlement, overlap with the trajectories of natural environments over the long term, resulting in disruption to the evolution of ecosystems. These situations predispose human settlements to threats and lead to variable responses by societies to hazards, while the environments are also affected by human activities. This second session will explore the evolution of coastal environments by analysing the diversity of unconsolidated and rocky coastlines (estuaries, deltas, lagoons, cliffs, etc.) and associated processes, over time and space, through the prism of socio-environmental co-evolution.

**Keywords:** coastal environments, transition areas, port interfaces, economic resources

### **Session 1.3. Archaeological sites in the Anthropocene: vulnerability, management and societal challenges**

**Coordination:** Dominique TODISCO, Cécile ALLINNE, Yoann CHANTREAU, M.Y. DAIRE, Florence VERDIN

Faced with erosion and recent changes in geomorphological environments, it is important to document the vulnerability of archaeological sites. In coastal, river, underwater and undersea environments, our archaeological heritage is threatened with destruction and degradation, as it is exposed to retreating shorelines, melting permafrost and scouring phenomena in rivers and on the seabed. Over the last fifteen years or so, a number of research programmes in France and Europe, but also more widely on the North American continent and in Greenland, have been set up to list and study this endangered heritage and to consider preservation solutions for sites where destruction is not imminent or has already begun. In France, this work has led to a growing awareness at institutional level, reflected in the creation of a new focus for national archaeological research programming that takes into account the threat to archaeological heritage posed by ever-accelerating coastal erosion. This 3rd session will feature presentations highlighting the issues of vulnerability and/or conservation of archaeological sites facing the climate change. Particular attention will be paid to sunken cultural remains, a consequence of eustatic rise.

**Keywords:** site preservation, vulnerability, heritage, conservation, climate change, coastal retreat, erosion, permafrost melting.

## **Theme 2. Identify, analyse and reproduce the gestures of human-resources- objects interactions**

**Coordination:** Guillaume BLANCHET, Valentin MICLON, Anne BOCQUET-LIENARD, Damase MOURALIS, Dominique TODISCO

**Keynote:** Florian TÉREYGEOL

The interactions between humans, resources and objects involve a multitude of tangible and intangible gestures and operations, of which archaeological remains are privileged witnesses. Recent methodological developments and the integration of these archives into multiscale studies are considerably increasing our knowledge of past societies. They enable us to understand socio-economic organisations, their links to ecosystems and their implications (social, economic, ecological and healthcare). Documenting and reproducing some of these interactions, and recognising their repercussions, are major objectives of current archaeological re-

search. This theme offers an opportunity to combine work in this dynamic from all chronological periods and in particular works aiming at describing and reconstructing the gestures used in the operational chain from the resources acquisition, their processing, transformation to use, to their dumping or recycling.

**Keywords:** Experimental archaeology; energy; resources; manufacturing/transformation; circulation/mobility; different levels of investigation/different scales of observation; differentiated socio-cultural spheres; health repercussions; cross-referencing with written sources.

## **Session 2.1. Acquiring and managing resources**

**Coordination :** Marie BALASSE, Sylvain BURRI, Alexa DUFRAISSE, Joseph GAUTHIER, François-Xavier LE BOURDONNEC

Whether to eat, produce objects and tools or to construct buildings, humans have had to deal with the resources available to them to fulfill their needs and desires. The study of resource acquisition and management, using different analytical approaches integrated within multidisciplinary approaches, is crucial to understanding both the cultural practices and the socio-economic organizations of ancient societies. The question of the nature of resources, their availability, their adaptation to needs and desires, their location in relation to the places where people lived or where they were transformed, the ways in which they were exploited, and their repercussions on the environment, landscapes and biodiversity will therefore be at the heart of this session.

**Keywords:** forests; quarries; fishing areas; mines; farming; deposit; raw material; mining; management

## **Session 2.2. Transforming resources**

**Coordination:** Sylvain BAUVAIS, Gaspard PAGES, Guillaume SARAH

The transformation of resources, whether mineral, plant or animal, involves a number of technical, economic, health, social and even cultural issues. While the transformation step generally takes place between the acquisition of resources and the use of an artefact or the consumption of a foodstuff, it can also take place in the context of recycling or reuse processes. The shaping of raw materials generally involve a wide range of operators - sometimes with very different statuses - whose know-how may diversify in time and area. This process generally involves several steps, calling on different types of resources (raw materials, fuels, tools) and on common or dissimilar practices, that leave distinctive traces of technical gestures. Proceedings remains - and sometimes evolution - of these transformation steps enable us to characterise some productions (context, efficiency, destination) and to identify the technical gestures used. In this context, the data revealed by archaeometry are essential for identifying, understanding and reconstructing processing operations and their purpose(s). The aim of this session is to assemble all the papers dealing with this step in the operational chain, with an emphasis on cross-disciplinary approaches.

**Keywords:** working; shaping; manufacture; human and material resources; workshops

## **Session 2.3. Use, consumption, exchange and circulation**

**Coordination:** Nadia CANTIN, Thomas DELBEY, Klervia JAOUEN, Valentin MICLON

Complementary to traditional approaches such as typologies, archaeometric methods help to reconstruct – among other aspects – living environments, consumption patterns and the movements of people and objects. In this way, everyday gestures, craft and industrial practices, and socio-economic organisations can be understood. This session brings together work that defines the trajectories of people, resources and objects, based on the biographies of artefacts, from their places of production, manufacture or acquisition, to the places where they are consumed and used. It also integrates studies on the circulation of humans, their knowledge and know-how and, more generally, their cultures.

**Keywords:** know-how and object; supply; mobility; eating; socio-economic organisations; transmission of gesture/technical transfers (heritage/cultural heritage)

### **Session 2.4. Reproducing to understand the gestures of the chaîne opératoire**

**Coordination:** Inès PACTAT, Florian TÉREYGEOL, Georges VERLY, Guillaume BLANCHET

This cross-disciplinary session is intended to present experiments carried out in various fields (from all chronological periods), allowing the reconstruction of all (or part) of a production chain (resource acquisition, transformation, consumption/use, rejection/recycling). The contribution of experimental archaeology has been essential for many years. This approach offers a way of reconstructing the practices and processes involved in acquiring resources, transforming them and then using them. When based on data gathered from archaeometric analyses and archaeological observations, experimental protocols can be used to test numerous hypotheses relating to the technical gestures involved in the various stages of an operating chain. The aim of this cross-disciplinary session is to bring together all contributions that present one or more experimental protocols based on archaeometric, archaeological or ethnoarchaeological data.

**Keywords:** Experimental archaeology; chaîne opératoire; ethnoarchaeology; referentials; energy; alteration; actualism; tracerology; neotaphonomy.

### **Theme 3. Objects, material, outer and underground environments: innovative tools for characterizing, imaging and dating**

**Coordination:** Anne BOCQUET-LIENARD, Carole NEHME, Stoil CHAPKANSKI, Guillaume BLANCHET

Archaeometry studies are constantly evolving, particularly due to the technological and analytical advances they benefit from. New methods, techniques and improved protocols contribute to increasing scientific knowledge about our tangible and intangible heritage. This theme focuses on methodological developments and innovative instruments implemented for the study of archaeological contexts and artifacts, on site or in the laboratory. It will bring together contributions on: (3.1) geophysical and remote sensing methods, (3.2.) photo- and lasergrammetry methods applied in archaeology, (3.3.) new instrumentation and non-invasive analytical techniques to analyse archaeological matter and objects, (3.4.) dating and processing of chronological data in outer environment and (3.5.) geochronological approaches and anthropogenic markers in underground environment.

### **Session 3.1. Geophysical and remote sensing techniques applied to geoar-**

## chaecology

**Coordination:** Cécile FINCO, Guillaume HULIN, Millena FROUIN, Laurent DESCHODT

Geoarchaeology, which combines Earth science and archaeology aims to understand geological and geomorphological processes affecting human settlements and taphonomic processes in archaeological sites. Geophysics and remote sensing techniques can provide crucial elements to answer these questions for geoarchaeologists by collecting non-invasive data about soil characteristics and the environment. The different scales of investigation of these techniques are a key point, offering a change of scale from a broad vision (e.g. satellite imagery, airborne by plane, or drone) to very targeted measurements (e.g. magnetic susceptibility measurements on cores) at the scale of the site and its immediate surrounding (e.g. electrical resistivity tomography, electromagnetic surveys...). Combining these methods with a geoarchaeological approach goes beyond the detection of remains to characterise the geological and environmental context., enabling to learn more about ancient societies and interactions with the surrounding.

**Keywords:** Geophysics; Remote sensing techniques; Non-invasive approach; Geoarchaeology

### Session 3.2. 3D acquisition and multi-dimensional analysis

**Coordination:** Paul FRANÇOIS, Sylvain RASSAT, Kim GENUITE, François DELISLE

3D data of all kinds (e.g. LiDAR, TLS, multibeam, photogrammetry, structured light using handheld scanners) are used for prospecting, archaeological interpretation and documentation of excavation sites and material. A set of practices common to the archaeological world has emerged for processing and analyzing these data. However, these practices, which came from different disciplinary fields, sometimes ignore complex environments and objects, compartmentalize acquisition techniques, or restrict the use of three-dimensional data.

Communications will be about steps in the 3D data life cycle: acquisition with tools or methods adapted to constrained environments and objects (aerial, underground, underwater, complex objects, shiny or transparent materials); processing to enhance data (e.g. manual or deep learning classification, alignment and fusion of three-dimensional data from several acquisition methods, georeferencing); exploitation aimed at maintaining the third dimension in the archaeological exploitation phase (e.g. HBIM) or visualization (augmented/virtual reality), possibly right through to restitution, as 3D model extractions are often limited to two dimensions (e.g. plans, elevations), data durability and openness (e.g. archiving, indexing, FAIR principles, etc.).

**Keywords:** photogrammetry; lasergrammetry; 3D scanner; LIDAR; Terrestrial Laser Scanner; Multibeam; 3d restitution; HBIM

### Session 3.3. New approaches to study archaeological material and objects

**Coordination :** Ludovic BELLOT-GURLET, François Xavier LE BOURDONNEC, Alain QUEFFELLEC, Xavier GALLET, Damase MOURALIS

A better understanding of the matter and/or the archaeological object requires knowing many factors such as: 1) characterization in order to identify its origin, 2) transformation, 3) trajectories, 4) uses 5) alteration. Recent analytical advances integrating different approaches are used to study in-situ archaeological artefacts, as well as the degree of conservation of such artefacts, or their analyses in the laboratory. The overall objective is to better understand such

(im)material heritage, its conservation and its added-value. This session aims to bring together contributions on new measurement protocols, sampling techniques and/or non-invasive instrumentation, which are portable or used in the laboratory (e.g. mass spectrometry, Raman spectroscopy, pXRF, portable OSL, LIBS, infrared); Such methods can be applied on artifacts in archaeological or natural sites.

**Keywords:** portable analytical methods, instrumentation, sampling, protocols

### **Session 3.4. Dating and processing of chronological data in outer environment**

**Coordination:** Philippe LANOS, Emmanuelle DELQUE-KOLIC, Jean-Claude LEFEVRE, Guillaume GUERIN.

This session focuses on: 1) studies using different dating methods (e.g. C14, OSL, paleomagnetism), 2) analytical progress (e.g. protocols, metrology) to better constrain the chronology of archaeological sequences and 3) the combination with other indicators such as stratigraphy. All the contributions will bring together recent studies in numerical and relative data, in order to address new or renewed applications of chronological data to the study of archaeological sites. Particular attention will be given to multi-technical and multi-support approaches on the same site. These approaches aim to solve chronostratigraphic problems, and to process integrative chronological models based on statistical datasets.

**Keywords:** absolute and relative dating; chronostratigraphy; methodological developments; chrono-statistical models

### **Session 3.5. Geochronological approaches and anthropogenic markers in underground environments**

**Coordination:** Sophie VERHEYDEN, Edwige PONS-BRANCHU, Carole NEHME

Human communities have been using underground environments since prehistory and throughout the history. Underground environments can be used for cultural or even religious, social or economic purposes. Underground environments (e.g. caves, rock shelters, quarries) comprise anthropic sites and/or contain markers (e.g. soot, DNA) or anthropic objects (see tools, bones). Such markers and objects can sometimes be trapped in deposits, such as detrital deposits covering the entire Quaternary or speleothems. This session focuses on archaeological sites in underground environments covering the Quaternary. It covers: 1) dating methods (e.g. C14, U-Th, OSL, cosmogenic) applied to underground deposits in order to constrain archaeological events/episodes or to define the frequency of human frequentations, 2) new analytical protocols applied to anthropogenic markers, and 3) new approaches to reconstruct the physical context of sites and the transformations related to the human uses.

**Keywords:** geochronology; anthropic markers; sedimentary archives; underground environment

## **Theme 4. From vestige to digital landscape: Bringing together modelling, computational analysis, simulation and (geo)visualization within an interdisciplinary and repro-**

## ducible scientific framework

**Coordination:** Nicolas BERNIGAUD, Frédérique BERTONCELLO, Maria-Elena CASTIELLO , Bertrand DAVID, Nicolas FREREBEAU, Anaïs GUILLEM, Thomas HUET, Julie GRAVIER, Raphaëlle KRUMMEICH, Gwénaëlle MOREAU, Marie-Jeanne OURIACHI, Sébastien PLUTNIAK, Sébastien REY-COYREHOURCQ, Muriel VAN RUYMBEKE

We face a reality on our field where all might come together: the risk of losing information or the destruction of artefacts, the impossibility to observe directly inferred phenomena and the challenges due to multiple ways to look at the research object that is intrinsic to interdisciplinary dialogue. Within the realm of a reproducible research, this theme examines archaeology through its digital practices in the construction and visualisation of the archaeological narrative in all its many forms. Within these three sessions, we seek to make visible scientific issues at stake associated with archaeological data, software and statistical or generative modelling. We believe that it is important to understand why and how these practices are adopted and may become part of the multidisciplinary field of archaeology. The first session focuses on the multiple ways data harmonisation and interoperability are dealt with in archaeology, but also addresses more basic scientific issues on data and archaeological archives happening (4.1), the second seeks issues at stake in computational archaeology, questioning the role of these new practices and methodologies within a critical perspective (4.2), and the last session offers a critical point of view of archaeological facts providing a reflexive framework to better manage the simulated mechanisms at stake in complex systems (4.3). At last, the theme will enable dialogues between and gathering of different communities (CAA, NASSA, CIDOC etc.).

**Keywords:** Spatial Archaeology; Interdisciplinarity; Interoperability; Digital Humanities; Computational Reproducibility; Models and Simulations; Geovizualisations

### Session 4.1. Interoperability and data life cycle & open science in an interdisciplinary context

**Coordination:** Bertrand DAVID, Anaïs GUILLEM, Thomas HUET, Raphaëlle KRUMMEICH , Gwénaëlle MOREAU, Muriel VAN RUYMBEKE

Data collection and production depend largely on archaeological practices and contexts. Intimately they are dependent on a certain number of criteria: the type of project, the evolution of types of measurement, increasing specialisation and multidisciplinary, etc. This tends to produce ever more heterogeneous data, increasingly massive and on a variety of media/formats.

Archaeology is a science that almost systematically destroys its object of study by the excavation process. The pace of preventive archaeology is accelerating, meaning the acceleration for the destruction of its material layers. The increase in preventive excavations results in a fast growth of archaeological data. If this data is not preserved over the long term, it runs the risk to be lost. This makes it all the more urgent to rally the communities of researchers around the concepts of data sharing and digital preservation.

Databases, whether individuals or collectives, should ideally be conceived and developed as one of the building blocks of global knowledge. To achieve this, it is necessary to work on both interoperability and data harmonisation. By interoperability, we mean setting up interactions between datasets/sources. By harmonisation, we mean the comparability of the objects studied.

Expected communications will present actual cases of linking databases or datasets, with the goal of sharing, interoperability and/or harmonisation. They may also detail one or more stag-



es in the data management: implementation of a data management plan (DMP), development of a conceptual model, use of standardised vocabularies, alignment of typological repositories, and so on. But we could also welcome more fundamental contributions about the future of archaeological archives: might it become itself an object of study in the future?

**Keywords:** digital humanities; interoperability; harmonization; data sharing; ontology; knowledge graph; FAIR principles; DMP; data/digital preservation; metadata; open science; open data; data archive

## **Session 4.2. Building and making: computational archaeology as a new paradigm?**

**Coordination:** Nicolas FREREBEAU, Raphaëlle KRUMMEICH, Sébastien PLUTNIAK, Sébastien REY-COYREHOURCQ

A revitalization of formal and statistical methods to archaeology has marked the last decade, driven by a continuous increase in the volume of data. Within this context, ways to collect and process data are more or less intuitive for archaeologists. Through these years, digital humanities was also enlivened by intense debates about its definition and practice, leading a shift in humanities and social sciences practices from "reading and criticism" of sources to "building and making" by writing and executing computer programs. Since the 1980s, computer scientists have defined literate programming as a method of writing computer code primarily for human readability, with computational execution being a secondary concern. Both communities adopted a similar goal: rendering intelligible the relationship with computers and data processing or representation.

The scope of this session is to study the role of digital methods in the development of archaeology. Are these methods merely methodological tools, or do they pave the way for new paradigms, transforming archaeology through the evolution of its tools and data? Should the emergence of these new practices be seen as empowering archaeologists in relation to digital technologies? Within challenges due to reproducibility crisis, and the scarcity of funding and recruitment, how can we "build and make" a digital archaeology that is open, accessible, and reproducible?

Proposed communications may present a new tool focusing on debate regarding transformations in archaeological practices or reflexive issues on the role of these new practices, illustrated by cases study.

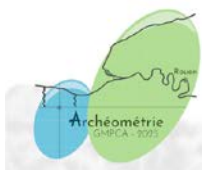
**Keywords:** data mining; processing and visualization, literate programming; software development; computational reproducibility

## **Session 4.3: Modelling and simulation of spatial phenomena**

**Coordination:** Nicolas BERNIGAUD, Frédérique BERTONCELLO, Maria-Elena CASTIELLO, Julie GRAVIER, Marie-Jeanne OURIACHI, Sébastien REY-COYREHOURCQ

Archaeology is a science that does not allow direct observations of the processes studied. Generative models, including agent-based simulations, are very effective in thinking about the dynamics that could have produced the configurations and trajectories identified from the data collected.

Indeed, based on the formalization of the processes/mechanisms supposed to be at work in past societies, they make it possible to simulate interactions within complex systems, such as socio-environmental systems.



While the expressiveness of computer languages and dedicated platforms leads us to consider these models as real "virtual laboratories" for experimentation, the development of the use of these methodologies in archaeology remains contrasted, between enthusiastic expansion and "critical" retraction (Lake, 2014). However, a small community of archaeological modellers has emerged in Europe over the past fifteen years.

The session aims to take stock of developments in this field of research in France and abroad. How did this nascent community take up the issues specific to the modelling of past societies? How does it meet the challenges posed by the organization and current practices of archaeological research?

The expected papers will focus on an example of modelling/simulation of past societies explaining how the following challenges are addressed:

- construction: model objectives, input data, level of complexity of the model and in the model, coupling of formalisms, model family, neutral landscape
- exploration: patterns, equifinality, stochasticity, sensitivity, spatial dimension, exploration and visualization
- validation: internal coherence of the model, multiplicity of hypotheses, comparing model outputs/observed data
- reproducibility, interoperability, reusability
- on the contributions/difficulties of interdisciplinarity
- on the lack of training/interests/means/visibility
- etc.

Papers will also be able to develop a reflective approach to modelling and simulation in archaeology.

Keywords : generative simulation models; epistemology; networks and communities of practice; issues and perspectives; past societies; agent-based modelling