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Bridging Bone Diagenesis and Residue Taphonomy in Paleolithic Archaeology

First Round Table

September 2nd, 2025

Working Group:

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Introduction

Bone diagenesis is a complex yet extensively studied process in archaeology. The assessment of bone preservation is not only central to the analysis of bone remains (faunal and human remains, bone tools) but is also crucial for evaluating the integrity of samples used in other analyses (e.g., ancient DNA, radiocarbon dating), as well as for studying site formation and fossilization processes. One discipline significantly influenced by bone diagenetic processes and the preservation state of stratigraphy is Residue Analysis, which intersects microarchaeology and functional studies, focusing on the morpho-chemical analysis of microscopic particles found on lithic artifacts to assess the use of ancient tools. We aim to bring together people from various research fields who have experience in assessing bone preservation using diverse approaches, among which IR spectroscopy.

Objectives

With this Workshop, we want to bridge the existing gap between bone preservation studies and residue analysis by establishing a working group to discuss how bone diagenesis influences residue chemistry, with the goal of facilitating a dialogue that moves from these two distinct areas toward a common line of research.
We will use this opportunity to start a discussion on methods for assessing residue taphonomy in various sedimentary environments, strategies for authenticating ancient datasets, and novel approaches to residue isolation and identification in soils, including the use of biomarkers.

Location

"Sala Romaní" IPHES-CERCA. Zona educacional 4, Campus Sescelades URV (Edifici W3). 43007 - Tarragona – SPAIN.

Online participation:

Microsoft Teams
Meeting ID: 366 645 865 489 7
Password: H4uN2Nt9

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Program

9:00 – 9.10	Greetings and Presentation of the Workshop
9.10 – 09.30	**A. Ollé.** *A multi-analytical approach to the analysis of residues on experimental and archaeological stone tools*.
09.30 – 09.50	**C. Dominici**. *Monitoring changes in human activities at the end of the Upper Palaeolithic. A comprehensive approach for the critical assessment of ancient organic residues.*
09.50 – 10.10	**A. Vallejo.** *Searching the invisible to describe the past*.
10.10 – 10.30	Coffee break
10.30 – 10.50	**H. Del Valle**. *From Molecules to Archaeological Context: bone diagenesis applied to Stratigraphy and Cultural Heritage.*
10.50 – 11.10	**F. Boschin, C. Dominici**. *The effects of diagenetic processes on residue analysis. An update from layer 24a1 (Aurignacian) of Grotta Paglicci, southern Italy*.
11.10 – 11.30	**F. Berna**. *Reconstructing paths of bone mineral diagenesis: Solubility, authigenic minerals, fluorine, and fire.*
11.30-12.15	Roundtable: Identification of gaps in knowledge, limitations of residue analysis in ancient contexts, possible synergies.
12.15	Closing Remarks

A multi-analytical approach to the analysis of residues on experimental and archaeological stone tools

Andreu Ollé[1,2], Lena Asryan[1,2], Juan Luis Fernández-Marchena[3,1], Juan Ignacio Martín-Viveros[1,2], Paula Mateo-Lomba[4,1], Hélène Monod[5,2], Antonella Pedergnana[6,7], Laxmi Tumung[1,2], Clarissa Dominici[8,9], Cuauhtemoc Araujo-Andrade[10], Mónica Marro[10], Pablo Loza[10]

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Together with microwear traces, residues are considered a key source of information for investigating the function of prehistoric stone tools. However, studying substances adhering to ancient lithic surfaces poses a series of challenges. Apart from the intrinsic problems of archaeological preservation, such as the molecular decay of organic matter and the wide variety of aggressive site formation processes, residues are difficult to identify, and it is not always easy to distinguish ancient material from modern contaminants. Even when these setbacks can be overcome, a further challenge arises in the form of distinguishing natural and incidental residues from use-related ones.

In this presentation, we summarise the research carried out on residues adhering to stone tool surfaces at the Lithic Technology Laboratory at IPHES-CERCA in recent years. This research was based on a multi-scalar and multi-analytical approach to enable archaeologists specialising in functional analysis to characterise residues non-invasively. Both experimental and archaeological data are presented and discussed.

Monitoring changes in human activities at the end of the Upper Palaeolithic: A comprehensive approach for the critical assessment of ancient organic residues.

Clarissa Dominici[1,2], Chiaramaria Stani[3], Giovanni Birarda[4], Lisa Vaccari[4], Francesco Berna[1,2], Francesco Boschin[2], Andreu Ollé[5,6], Matteo Rossini[2], Adriana Moroni[2,7,8]

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This study integrates three analytical approaches (AAs) to analyse a single dataset of high-resolution infrared (IR) spectra obtained from archaeological residues found on 23 backed pieces from the Epigravettian (Late Upper Palaeolithic) levels of Grotta della Cala (Marina di Camerota, Italy). These are: AA1 – qualitative analysis, AA2 – chemometrics, and AA3 – predictive modelling.

We compare the results from each AA, advocating for: a) a comprehensive, community-wide effort to describe comprehensively the spectral features observed in each analysis (AA1); b) the development of statistically-driven methods to enhance objectivity in data interpretation (AA2); and c) the establishment and collaborative expansion of shared reference libraries, for the interpretation of archaeological residues (AA3). The presented predictive model is scalable and flexible and we anticipate its expansion with additional spectroscopic data and integration with highly specific biomolecular information, such as that provided by spectrometric techniques.

Searching the invisible to describe the past

Claudia Adsuar Fuster[1], Francesco Caruso[1], Nerea Herranz[1], Martina Romani[2], Olivia Gómez-Laserna[2], Josep Maria Vergès[3,4], Vincenza Forgia[5], Maite Maguregui[1], Asier Vallejo[1]

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The description of the past has been based on macroscopical analysis during years, however, the search of the invisible marks based on microscopical analysis gives a new point of view which improves the description of the past.

Organic biomarkers accumulated in several ancient artifacts can help us to determine their use. In this context, the lanoline accumulated in the flint blades used for sheep shearing could be a good biomarker to determine the beginning of the sheep shearing. Nevertheless, the degradation of this wax and its characterization is necessary to know if really, lanoline can be a good ancient biomarker. In this study, flint blades with lanoline have been aged and analysed using different analytical techniques, hyperspectral imaging, FT-IR and GC-MS, for its characterization and determine the persistent compounds or the degradation ones useful as ancient biomarkers and determine the beginning of the sheep shearing.

From Molecules to Archaeological Context: bone diagenesis applied to Stratigraphy and Cultural Heritage

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Bone diagenesis comprises a complex set of processes that modify bone components in response to burial conditions. Understanding these conditions helps reconstruct deposit formation and their associated stratigraphic sequences. Traditionally, and particularly in Holocene sites, bone diagenesis has been used to study organic matter degradation to enhance the accuracy of isotopic analyses, radiocarbon dating, and ancient DNA recovery. Currently, and in connection with the development of paleoproteomics, significant progress is being made in understanding diagenetic processes in Pleistocene contexts.

In this presentation, we summarise the ongoing applications of bone diagenesis research at IPHES-CERCA. Some projects are oriented toward fossil conservation and restoration challenges, while others focus on understanding diagenetic processes in karst systems and stratigraphic characterization of archaeological assemblages. This research has enabled the development of a fossil recontextualization model for the Galería site (Atapuerca, Spain), through the integration of analytical techniques such as FTIR, XRD, and TEM, in combination with machine learning algorithms.

The effects of diagenetic processes on residue analysis: an update from layer 24a1 (Aurignacian) of Grotta Paglicci, southern Italy

Clarissa Dominici[1,2], Matteo Rossini[2], Chiaramaria Stani[3], Giovanni Birarda[4], Lisa Vaccari[4], Francesco Berna[1,2], Francesco Boschin[2]

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In the analysis of Palaeolithic residues recovered from lithic artefacts, the acquisition of chemical data can be challenged by several factors, such as degradation processes, burial conditions, chemical exchange with soil minerals, microbial activity, natural depositions, and many more.

In this contribution, we explore part of the vast field of 'residue taphonomy' proposing the results of the in-depth analysis of residues from 13 lithic artefacts coming from layer 24a1 (Aurignacian – 32,112-34,447 years cal BP) of Grotta Paglicci, southern Italy, by Synchrotron Radiation (SR) FTIR microscopy. Starting from the state of presentation of the faunal assemblage from this layer, we investigate possible transfer processes of carbonate hydroxyapatite from bones to lithic tools, as this mineral has been widely detected in all residue samples analysed, with no observable differences based on sampling location or techno-typological analyses. This finding is furtherly discussed through the analysis of 13 archaeological bone samples, two modern bone references, and one sediment sample from layer 24a1.

Reconstructing paths of bone mineral diagenesis: Solubility, authigenic minerals, fluorine, and fire

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The mineral composing bone, bone carbonate hydroxyapatite (CHA), sometime referred to as bone bioapatite, precipitates within the collagen matrix as platelet-like nano-dimensional crystals. This mineral habit along with numerous elemental substitutions makes the bone CHA inherently thermodynamically unstable and thus highly reactive upon postmortem deposition.

Here I will start with reviewing the solubility of bone CHA crystals, the formation of authigenic phosphate minerals, and the potential diagenetic path that bone CHA crystals may follow. I will continue with illustrating how integrating petrographic and FTIR micro-spectroscopy analyses of bone samples and intact sedimentary deposits can help reconstruct bone diagenesis. I will conclude with examining the potential relevance of applying FTIR microscopy and our knowledge on bone mineral diagenesis and authigenic minerals formation for the study of residues preservation on bone and stone tools.

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