

## LAARD1 ABSTRACTS



## *Influence of the Ceramic Matrix on Lipid Retention and Extraction from Archaeological Potteries*

Yaël Antonaros <sup>(1)</sup> - Jehan Waeytens <sup>(2)</sup> - Kristin Bartik <sup>(3)</sup> - Alicia Van Ham-Meert <sup>(4)</sup>

*Université libre de Bruxelles, EMNS & 4Mat, Brussels, Belgium* <sup>(1)</sup> - *Université libre de Bruxelles, Département enseignement interdisciplinaire en Sciences pharmaceutiques, Brussels, Belgium* <sup>(2)</sup> - *Université libre de Bruxelles, EMNS, Brussels, Belgium* <sup>(3)</sup> - *Université libre de Bruxelles, 4Mat & CreA-Patrimoine, Brussels, Belgium* <sup>(4)</sup>

**Keywords:** Calcium carbonate, Ceramic matrix, Lipids

Triacylglycerols, plant sterols, and terpenoids are valuable biomarkers in Organic Residue Analysis. They are generally well preserved within porous unglazed ceramics due to their hydrophobic and chemically stable nature, which help prevent leaching and microbial breakdown. The entrapment and retention of these residues are influenced by the ceramic matrix's porosity and composition and recent studies have highlighted the potential role of calcium carbonate, commonly used as a temper in archaeological ceramics, in lipid retention and extraction.<sup>1,2</sup> The amount of calcium carbonate present could lead to differential recovery of lipids and thus bias the extracted lipidic profile.

Our project combines traditional mineralogical characterization methods (XRD, XRF, SEM-EDX, Hg  $\mu$ porosimetry) with AFM-IR<sup>3</sup>, which allows for precise mapping of residues within ceramic matrices, to investigate the influence of the ceramic matrix on lipid extraction. Additionally, we are constructing a reliable model of the cooking processes in different ceramic matrices, in view of obtaining detailed temperature profiles. This will enable to work with a broader dataset and a better understanding of the thermal history of archaeological ceramics, further refining our ability to interpret artefact use and cultural practices.

### References

<sup>1</sup>Hammann, S., Scurr, D.J., Alexander, M.R. & Cramp, L.J.E. Mechanisms of lipid preservation in archaeological clay ceramics revealed by mass spectrometry imaging. PNAS 117, 14688–14693, (2020).

<sup>2</sup>Cayme, J-M., Vahur, S., Teearu, A., Oras, E., Leito, I. The impact of mineral composition on the yield and preservation of selected fatty acids in replicate archeological ceramics. Journal of Chemical Metrology 18, 95-113 (2024).

<sup>3</sup>Mathurin, J. et al. AFM-IR nanospectroscopy of nanoglobule-like particles in Ryugu samples returned by the Hayabusa2 mission. Astronomy & Astrophysics 684, 1-14 (2024).

## *Lipids, Lapita, and Lore*

**Mathieu Leclerc** <sup>(1)</sup> - Karine Taché <sup>(2)</sup> - Anne-Julie Bilodeau <sup>(3)</sup>

*Australian National University, School of Archaeology & Anthropology, Canberra, Australia* <sup>(1)</sup> - *Canada Chair in Biomolecular Archaeology, Université Laval, Québec, Canada* <sup>(2)</sup> - *Historical Sciences, Université Laval, Quebec City, Canada.* <sup>(3)</sup>

**Keywords:** Pottery, Residue, Vanuatu

Pottery was introduced in Remote Oceania around 3,000 years ago by communities known as Lapita peoples who settled on large island groups from New Guinea to Tonga and Samoa. Despite being the most frequent artefact left by the past societies who inhabited the 4,000 km chain of Oceanic islands, little is known about how the pottery vessels were used, particularly the foods and products that were cooked and stored in them.

We are presenting here the results from the analysis of lipids preserved in archaeological pottery from the Lapita cemetery site of Teouma (2870–2920 BP), in Vanuatu, Southwest Pacific. We compare pots of different forms and decorative styles to assess potential variations in use.

Lapita pottery is often viewed as carrying ideological meaning, particularly through its distinctive dentate-stamped decorations. By analysing the residues in highly decorated pots associated with burials and comparing them to those in undecorated pots, we provide direct evidence for this hypothesis. To refine our interpretation, we compare these results with experimental cooking vessels.

This pilot study lays the groundwork for a new 3-year project integrating lipid analysis with traditional knowledge from Vanuatu communities, among the few in the Pacific where traditional pottery manufacture has continued into the 21<sup>st</sup> century.

## *Evolving Lipid Evidence: Decoding Contributions of Aquatic Fat in Early Pottery of the Southeastern United States*

Anne-Julie Bilodeau <sup>(1)</sup> - Karine Taché <sup>(1)</sup>

*Laval University, Department of Historical Sciences, Quebec City, Canada <sup>(1)</sup>*

**Keywords:** Earliest North American pottery, Lipid residue analysis, Late Archaic shell rings

New biomolecular data from lipid residue analysis conducted on one of the oldest potteries in North America now allows for a better understanding of Late Archaic (5000-3000 cal. BP) foodways in the southeastern United States. These pots have been uncovered on coastal sites referred to as shell rings, which represent the first year-round villages and large-scale feasting sites. Molecular and isotopic analyses were conducted on 60 pottery sherds and 20 baked clay objects (BCO) from St. Catherines and McQueen, two well-known shell rings located on St. Catherines Island (Georgia, USA), and dating respectively from 4300 to 4100, and 4100 to 3900 cal. BP. BCO are low-fired clay nodules that are thought to have been used in an indirect cooking method, although this hypothesis had never been tested by lipid residue analysis before. Results indicate a ubiquitous contribution of aquatic origin alongside plant and terrestrial animal-derived lipids in residues from pottery and BCO samples, validating previously untested hypothesis. Fatty acid ratios and trace amounts of aquatic biomarkers, however, led to erroneous initial interpretations and highlight the necessity of designing a multi-steps analytical protocol when conducting lipid analysis of ancient ceramics. Single-compound isotopic values are coherent with a mixing of marine aquatic resources and plant oils and/or animal fats. In addition, decorated sherds more often yielded lipid profiles indicating terrestrial animal fat contributions than undecorated sherds. Venison has frequently been described as an important feasting resource, suggesting that these pots were used during special gatherings.

## *Characterization of the Fish Products Lipidic Signatures in Ethnographic Pots for a Better Interpretation of Archaeological Remains*

Louise Martignac <sup>(1)</sup> - Léa Drieu <sup>(2)</sup> - Julien Vieugué <sup>(3)</sup> - Anne Mayor <sup>(4)</sup> - Moustapha Sall <sup>(5)</sup> - Martine Regert <sup>(2)</sup>

CNRS, UMR 7264 / UMR 8068, Nice, France <sup>(1)</sup> - CNRS, CEPAM UMR7264, Nice, France <sup>(2)</sup> - CNRS, TEMPS UMR8068, Paris, France <sup>(3)</sup> - Laboratoire d'Archéologie africaine et Anthropologie (ARCAN), Faculté des Sciences de Université de Genève, Genève, Switzerland <sup>(4)</sup> - UCAD, Faculté des lettres et sciences humaines, Dakar, Senegal <sup>(5)</sup>

**Keywords:** Lipids, Fish products, Ethno-archaeology

There are still open questions regarding the lack of biomolecular evidence of aquatic products in European Neolithic ceramics, despite the availability of these resources (Craig *et al.*, 2013). It is still unclear whether this reflects ancient foodways (no consumption or not in pottery), or whether their chemical composition is highly conducive to natural degradation, leading to difficulties of detection.

Ceramic vessels from the Diola Kassa in Lower Casamance (Senegal) were studied: 6 ethnographic vessels used for fish-based recipes, and 8 ethno-experimental vessels in which fish was experimentally processed several times. To assess the interpretative potential and limitations of this ethno-archaeological method, we also studied an archaeological dumping site, “La Poubelle des Mamans”, located in Lower Casamance (Debels *et al.*, 2024) and vessels buried during 1 and 2 years.

These vessels have been chemically investigated using suitable protocols to detect aquatic products (Cramp & Evershed, 2014). Lipids were recovered with acidified methanol extractions, GC-MS and isotopic analyses were performed.

We have observed that, despite repetitive use, none of the recipients showed all the biomarkers of aquatic resources listed in the literature. There is a wide variability in the molecular composition of the vessels with no discernible trend according to the duration of use or extraction yield.

These results will help the interpretation of archaeological lipid extracts. They provide clues to assess the extent to which fish-based diets can be inferred from the lipids absorbed in pottery and objectify the lost information. By providing interpretative keys to study aquatic products consumption, we attempt to understand the relationship between past societies and their environment.

*Contents of Early Vessels in the Eastern Gulf: Organic Residue Analysis of Sixth-Fifth Millennium BC Imported Mesopotamian Vessels in South-Eastern Arabia*

Akshyeta Suryanarayan <sup>(1)</sup> - Sophie Méry <sup>(2)</sup> - Nuria Moraleda Cibrian <sup>(3)</sup> - Joan Villanueva Ribes <sup>(3)</sup> - Martine Regert <sup>(4)</sup>

*University of Oxford, Faculty of Asian and Middle Eastern Studies, Oxford, United Kingdom* <sup>(1)</sup> - *CNRS, UMR 7041, Archéologies et sciences de l'Antiquité (ArScAn), Nanterre, France* <sup>(2)</sup> - *Institut de Ciència i Tecnologia Ambientals, Universitat Autònoma de Barcelona, Barcelona, Spain* <sup>(3)</sup> - *CNRS, CEPAM, Université Côte d'Azur, Nice, France* <sup>(4)</sup>

**Keywords:** Southeastern Arabia, 'Ubaid pottery, Lipid residues

The earliest known pottery vessels in south-eastern Arabia are Mesopotamian in origin, known as 'Ubaid or black-on-buff pottery, and date from the late sixth to the mid-fifth millennium BC. At this time, aceramic Middle Neolithic Arabian populations were mostly mobile; engaging in hunting, gathering, fishing and herding. They were also navigating around the Persian Gulf coast, exchanging products such as softstone, obsidian, haematite, livestock and pottery, with 'Ubaid pottery either being exchanged directly or down-the-line with Mesopotamian communities. It is also hypothesised that 'Ubaid pottery and/or the products within them carried connotations of prestige in Middle Neolithic Arabian communities, and were used in specific contexts to display wealth and/or status while serving food. As the possession and exchange of pottery was possibly a "profoundly symbolic and political act", 'Ubaid pottery may have been linked to new means of wealth accumulation and display, redistributed in acts of ceremonial gift-giving or exchange at communal or feasting events. This poster will present the results of organic residue analysis of 'Ubaid vessels from two coastal sites in south-eastern Arabia, Akab and Umm al-Quwain 2, to discuss the contents detected within 'Ubaid pottery and raise questions about 'what pottery was good for' for aceramic Middle Neolithic coastal Arabian communities. As indigenous pottery production in southeastern Arabia only began a millennia later in the third millennium BC, the results provide unique insight into the symbolic role of ceramics for a mobile population.

*Lifting the Lid on the Hebridean Neolithic: Using Organic Residue Analysis to Reconstruct Foodways in the Hebridean Social Landscape*

Daniel Brown<sup>(1)</sup> - Lucy Cramp<sup>(1)</sup> - Duncan Garrow<sup>(2)</sup>

*University of Bristol, Department of Anthropology and Archaeology, Bristol, United Kingdom<sup>(1)</sup> - University of Reading, Department of Archaeology, Reading, United Kingdom<sup>(2)</sup>*

**Keywords:** Neolithic, Ceramics, Organic Residue Analysis

This contribution will present key results of my doctoral project which focuses on the analysis of dietary practices and the subsequent interpretation of foodways and the related societal frameworks of the early farming communities of the Early-Middle Neolithic of the Outer Hebrides, Scotland c. 3700-3200 BCE. The project utilises cutting-edge organic residue analysis of Neolithic Hebridean pottery lipids from islets, domestic sites and tombs – both GCMS analysis to scan for specific trace biomarkers, and stable isotope analysis to determine the origins of animal fats and subsequently to determine what foodstuffs were cooked and eaten in these vessels.

Hebridean crannogs are artificial islets set within lochs. Underwater surveys have recovered large quantities of Neolithic ceramics from the loch-beds surrounding some of these islets. It has been proposed that these islet sites were important centres for the formation of community identity via ‘commensal activities’ such as feasting (Copper and Armit 2018). Therefore, by re-constructing the dietary patterns of these sites, the role of food in these commensal dynamics can be explored.

My work extends previous analyses of pottery residues from four Hebridean islets, bringing in additional crannog sites for comparison and increasing the representation of key forms of pottery to test hypothesised differences in use. I have compared these results with those from both domestic and tomb contexts and have determined a difference in dietary patterns between these different types of sites. This also means that there was likely a difference in both the activities and the social meaning of these sites.

Reference

Copper, M. and Armit, I. 2018. A Conservative Party? Pots and People in the Hebridean Neolithic. *Proceedings of the Prehistoric Society* (84): 257-275

## *Coastal or Continental Culture? The French Atlantic Coast during the End of the Neolithic Period*

Camielsa Prévost <sup>(1)</sup>

*Laboratoire IMBE (UMR7263 – CNRS – IRD237 – AMU/AU), Avignon Université, Avignon, France <sup>(1)</sup>*

**Keywords:** Ceramic use, Atlantic coast, Late Neolithic

Reconstructing ancient sea levels is tricky on the French Atlantic Coast because of the flat landforms: in some places it is difficult to determine whether we are standing on an ancient coastline or a few kilometres inland. In this region, acidity, limited sedimentation, and erosion hinder the preservation of archaeological and zooarchaeological data. Bio-organic materials are exceptional outside marshes, which limits any evidence of fishing or basketry (i.e.). However, several sites provide clear evidence of fishing or shellfish gathering, demonstrating their proximity to the seashore. Ceramics at these sites are difficult to study due to complex cultural mosaic, simple forms, rare decoration and high fragmentation.

A PhD study on the lipid content of a large series of ceramics (n=500) from 23 archaeological sites explore the lifestyles of the populations of the end of the Neolithic and the beginning of the Bronze Age (4300-1500 BCE), their relationship with the coastal territory and the exploitation of maritime resources. Main findings revealed strong ties to livestock (dairy and ruminant meat) and land use with beeswax, pine resin, and vegetable wax – which seems to reflect specific local practices. The rarity of aquatic biomarkers found in ceramics suggest that fish were treated differently, even though they were prepared on the site.

This study offer insight into the Late Neolithic maritime cultural facies of the Atlantic coast, in terms of environmental exploitation and site proximity to the barrier beach. The behaviours highlighted contrast to those known via ORA studies i.e. in Northern Europe or Japan.



## *Dietary Practices of a Rural Society in Western Germany Under Rome: Lipid Analysis of Pottery Covering Major Historical Transitions (1<sup>st</sup> to 4<sup>th</sup> Century CE)*

George Janzen <sup>(1)</sup> - Leandra Schunk <sup>(1)</sup> - Arno Braun <sup>(2)</sup> - Sabine Hornung <sup>(2)</sup> - Sabine Fiedler <sup>(1)</sup>

*Geographical Institute, Johannes Gutenberg University, Mainz, Germany* <sup>(1)</sup> - *Institute of Pre- and Early History, Saarland University, Saarbrücken, Germany* <sup>(2)</sup>

**Keywords:** Organic residue analysis, Roman Germany, Diachronic study

Organic residue analysis of archaeological pottery allows us to study the economies (subsistence, trade), social structure, and ritual practices of past populations, as well as observe the development of these aspects through time. In our study, we analyzed 142 pottery sherds from two settlements (a *vicus* and a *villa rustica*) near Hermeskeil (co. Trier-Saarburg) in Western Germany, populated by the Treveri people. These sites cover the timeframe from the onset of Roman rule in the area (Late La Tène/Early Imperial) to the economic decline caused by political unrest and frequent Germanic raids (mid-3<sup>rd</sup> to mid-4<sup>th</sup> century CE). The sherds were subjected to multiple (2–3 ×) sampling, sequential extractions (solvent followed by acidified methanol extraction), and gas chromatographic analysis. Up to 93 % of the vessels contained significant amounts of lipids ( $> 5 \mu\text{g g}_{\text{pottery}}^{-1}$ ). Multiple sampling was shown to have helped to achieve that number. The vast majority of extracts bore signatures associated with animal fats, while plant biomarkers were exceedingly rare. Principal component analysis indicated a relatively monotonous diet. In addition, thermal decomposition products were detected in high abundance at one of the sites. Some of these compounds have not been previously reported. The aim of this project is to track dietary practices in a geographically limited context during a historically significant era that saw a change in power, a period of prosperity and integration into an empire-wide trade network, the Crisis of the Third Century, and finally economic collapse and displacement.

## *From Organic to Ceramic Remains: The Biomolecular Signature of an Ancient Ferment*

Tziona Ben-Gedalya<sup>(1, 2)</sup> Cynthianne Spiteri<sup>(3, 4)</sup> Herodium Expedition<sup>(5)</sup>

*Eastern R&D Center, Ariel, Israel (1) - Department of Molecular Biology& Adelson School of Medicine, Ariel University, Israel (2) - Eberhard Karls University Tübingen, Germany (3) - ArchaeoBiomics, Department of Life Sciences and Systems Biology, University of Turin, Italy (4) - Herodium Expedition, Hebrew University of Jerusalem, Israel (5).*

### Abstract:

Located on the margins of the Judean desert along the Dead Sea rift, within an earthquake prone region, the site of Herodium combines well-defined archaeological evidence of an early Roman period winery, the Judean desert climate, and contexts sealed by ancient episodes of collapse attributed to earthquakes. Together, these features position the Herodium winery as an exceptional case study, providing the opportunity to systematically study well preserved organic remains of ancient winemaking.

We conducted a micro-excavation of the fermentation vessels and collected samples and controls for a wide interdisciplinary study to contextualize our findings. We here focus on the organic residue results.

Preservation of ancient wine signatures was explored in different substrates and archaeological artefacts including ceramic fermentation vessels, their coatings, ancient grape pomace remains and sediment controls.

Using Gas Chromatography-Mass Spectrometry, we observed well-preserved residues demonstrating evidence of wine and pine tar/resin, the latter probably used as a sealant as thick remnants were found adhering to the inner surfaces of the ceramic containers. The residues we identify complement the evidence obtained from a suite of scientific analyses.

This study provides insights regarding the interpretation of wine in archaeological findings, enhances understanding of wine making traditions in the Mediterranean basin and informs on a culinary aspect of the vibrant Roman influenced globalization processes in Judea at the end of the first century BCE.

## 5 A Day: The Role of Plant Substances in the Ancient Diet of Corsica during Protohistory

Maïlys Turini <sup>(1)</sup> - Léa Drieu <sup>(1)</sup> - Alex Malergue <sup>(1)</sup> - Maxime Rageot <sup>(2)</sup> - Hélène Paolini-Saez <sup>(3)</sup> - Kewin Peche-Quilichini <sup>(4)</sup> - Thomas Perrin <sup>(5)</sup> - Martine Regert <sup>(1)</sup>



CEPAM (UMR 7264 CNRS), Université Côte d'Azur, Nice, France <sup>(1)</sup> - Institut für Archäologie und Kulturanthropologie, Universität Bonn, Bonn, Germany <sup>(2)</sup> - Laboratoire Régional de l'Archéologie, TRACES (UMR5608 CNRS), Ajaccio, France <sup>(3)</sup> - Collectivita di Corsica, Musée de l'Alta Rocca, Livia, France <sup>(4)</sup> - TRACES (UMR5608 CNRS), Université Toulouse II Jean-Jaurès, Toulouse, France <sup>(5)</sup>

**Keywords:** Lipids, Plants products, Corsican protohistory

The Mediterranean area is known for its poor preservation of organic matter, particularly plant products, which are under-represented due to the predominance of lipids in organic residue analyses and the low lipid content of plants. However, recent analyses of organic residues have revealed excellent preservation of organic molecules in Corsican pottery (Drieu *et al.*, 2018; Rageot *et al.*, 2016), offering new research perspectives on foodways in the Mediterranean.

In this work, we focused on the identification of plant substances using an innovative method (Garnier and Valamoti, 2016) that allows, from a single sample, the detection of lipids (including triacylglycerols) and short-chain acids present in plants via GC-MS and LC ESI-MS/MS methods. Fifty samples from three protohistoric sites were analysed.

The results show that organic compounds were well preserved, depending on the archaeological sites, with a wide range of molecules identified, from triacylglycerols to short-chain acids. These data highlight the diversity of plant substances used in culinary practices during the Bronze and Iron Ages (grapes, vegetable oils and waxes). LC ESI-MS/MS analyses allowed us to determine the origin of the oils (olive). Other plant substances identified include birch bark tar and conifer resins and tars, which appear to have been used repair ceramics.

This new approach expands the range of molecules studied, including a more detailed study of triacylglycerols, provide new insight into the consumption of plant products and the early domestication of plants such as olives and vines on the island.

*Evidence for Intensified Dairying at the Corded-Ware Cultural Horizon in Central and Northern Europe Using Lipid Residue Analysis and Zooarchaeology*

Lizzie Wright <sup>(1)</sup> - Alex Lucquin <sup>(1)</sup> - Andrew Kenney <sup>(1)</sup> - Jonica Ella Doliente <sup>(2)</sup> - Daan Raemaekers <sup>(3)</sup> - Jos Kleijne <sup>(3)</sup> - Annelou van Gijn <sup>(4)</sup> - Lucy Kubiak-Martens <sup>(5)</sup> - Adrian Huber <sup>(6)</sup> - Christian Harb <sup>(7)</sup> - Oliver E. Craig <sup>(1)</sup>

*BioArCh, Department of Archaeology, University of York, York, United Kingdom* <sup>(1)</sup> - *Department of Chemistry, University of York, York, United Kingdom* <sup>(2)</sup> - *Institute of Archaeology, University of Groningen, Groningen, Netherlands* <sup>(3)</sup> - *Faculty of Archaeology, Leiden University, Leiden, Netherlands* <sup>(4)</sup> - *BIAX Consult Biological Archaeology & Environmental Reconstruction, Zaandam, Netherlands* <sup>(5)</sup> - *Kantonsarchäologie Zürich, Zurich, Switzerland* <sup>(6)</sup> - *Kantonsarchäologie Lucerne, Lucerne, Switzerland* <sup>(7)</sup>

**Keywords:** Corded Ware, Dairying, Lipid residue analysis

The appearance of the Corded Ware Culture across many areas of Central and Northern Europe during the 3<sup>rd</sup> millennium BC was a major period of cultural transition, which has been linked to a series of human migrations from the Pontic-Caspian steppe region. Some previous zooarchaeological work has indicated that this also may have been a time of economic and agricultural change, with intensification of cattle husbandry. It is not known, however, how widespread this shift was, its exact nature or whether or not it is linked to the arrival of new human groups into the region. This paper will present extensive lipid residue analysis on pot and foodcrust samples to examine the use of pottery across the transition to Corded Ware in two regions: The Netherlands and Switzerland. This work shows an increase in dairy residues in Corded Ware pottery in both regions. The results will be presented alongside zooarchaeological work investigating evidence for changes in animal husbandry at this time.