Experimental Archaeology Conference 2025

EAC 14

Date: Monday May 12th 2025 - Friday May 16th 2025

Location: The event will be located at the Federal University of Paraná, at the Juvevê Campus, Where the Center for Archaeological Studies and Research (CEPA) and the Museum of Archaeology and Ethnology (MAE) are located.

Address of the location: Rua Bom Jesus, 650. Campus Juvevê. Universidade Federal do Paraná.

Final Program

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Conference Timetable

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(public craft)</td><td rowspan="8">Excursion</td><td rowspan="8">Excursion</td></tr>
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All times shown are in local Brasília Time (BRT) - [UTC-3]

Session 6 - Ceramics

Wednesday 14th May

15:15 - 15:30	**Temper of animal and human-related origin in prehistoric ceramics in the light of experimental, traceological and physicochemical studies** *Maria Kurant (online speaker)*
15:30 - 15:45	**As pastas cerâmicas e a queima à lenha: processos ameríndios** *Lilian Panachuk, Isabela Veigas*
15:45 - 16:00	**Reconstructing the Incrustation Technique: Experimental Insights into Post-Firing Decoration of Prehistoric Pottery** *Andreja Kudelić, Natali Neral and Ina Miloglav*
16:00 - 16:15	**Insights into Raw Material Selection in Prehistoric Pottery: Experimental Study of Physical and Mechanical Properties of Ceramics** *Natali Neral, Andreja Kudelić, Ana Maričić*
16:15- 16:30	Questions and discussion

Temper of animal and human-related origin in prehistoric ceramics in the light of experimental, traceological and physicochemical studies

Maria Kurant

Nicolaus Copernicus University

In prehistory, clay intended for the production of ceramic vessels was subjected to various processes aimed at improving its technical parameters, e.g. softening, or preventing shrinkage and cracking during drying and firing. One of them was adding various types of temper. In Neolithic and sub-Neolithic cultures, these were very often tempers made of organic materials of animal origin, and sometimes, perhaps, related to the human body. The significance of such practices often went beyond the purely utilitarian sphere, related to the material and spiritual culture of prehistoric communities, which makes it an important issue for the study of prehistory.

Unfortunately, so far, only some types of the most common temper of this kind, such as shell and bone, have been covered by broader studies. Identifying others in historical material is still complicated. This presentation aims to introduce an attempt to answer the question about the possibility of recognizing and distinguishing "atypical" organic additives that could have been used as temper in Neolithic and Sub-Neolithic pottery (e.g. meat, blood, hair, nails, wool, fur, eggshells).

The conclusions were based on experimental archaeological research, microscopic studies and physicochemical analyses (SEM-EDX, GC-MS). The research aimed to develop a method that would allow for the reliable identification and classification of such temper found in prehistoric pottery. The results of the experimental studies were verified by analyzing fragments of Sub-Neolithic pottery from a complex of sites in Šventoji in Lithuania.

As pastas cerâmicas e a queima à lenha: processos ameríndios

Lilian Panachuk[1], Isabela Veigas[2]

[1] *Faculdade de Filosofia e Ciências Humanas, Universidade Federal de Minas Gerais.*
[2] *Departamento de Faculdade de Filosofia e Ciências Humanas, Universidade Federal de Minas Gerais*

Nas terras baixas da América do Sul, no contexto ameríndio, a pasta de argila utilizada na olaria tradicional é construída de diferentes maneiras. Por exemplo, as mulheres Asurini do Koatinemo, falantes do tronco Tupi associado à família Tupi-guarani, não acrescentam nada à pasta (SILVA, 2000). As ceramistas Urubu-Kaapor, da mesma família Tupi-guarani, acrescentam a cinza de caraipé (RIBEIRO, 1996). Falantes da língua Tupi-Mondé, as ceramistas Paiter Suruí retiram elementos da pasta e sovam bastante a massa (VIDAL, 2011, 2013, 2017).

As ceramistas Karajá, falantes de Macro-jê, deixam o barro secar e pulverizam, peneiram eliminando impurezas, para depois hidratar o pó de argila (WHAN, 2010). Acrescentam cinza de “cega machado” qual o nome da árvore? à massa, com proporções de água bem definidas, como salientou Whan (2010), a madeira dura é muito apropriada para a queima lenta e controlada.
As ceramistas Kadiweu, de língua Guaycuru, adicionavam à massa de argila, até o final do século XIX, pó de coco torrado (Guido Boggiani, 1945), e chamote (Herbert Smith, apud MULLER, 2017). Darcy Ribeiro (1980) e Lévi-Strauss (2001) viram a mudança para o uso do chamote ou cinzas, sendo comum atualmente também a areia.

Nessa pesquisa nosso Grupo de estudos do Simbólico e Técnico da Olaria deseja apresentar alguns resultados da combinação das massas em queima à lenha, para debater sobre características dos materiais e resultados. Essa pesquisa resulta do apoio financeiro obtido pelo EDITAL UFMG PRPq – 09/2023, projeto é intitulado “Entre saberes de artistas e cientistas da olaria tradicional: preparo da argila e comportamento físico dos materiais cerâmicos”.

Palavras-chaves: Pastas cerâmicas, características de materiais, saberes ameríndios, resultados de queima.

Reconstructing the Incrustation Technique: Experimental Insights into Post-Firing Decoration of Prehistoric Pottery

Andreja Kudelić[1], Natali Neral[1] and Ina Miloglav[2]

[1] Institute of Archaeology
[2] University of Zagreb

The incrustation technique used to decorate ceramic vessels was widespread in prehistoric pottery across Europe, particularly during the Copper and Bronze Ages in the Pannonian Basin and the Balkans. While several studies have analyzed the composition of the white inlay, the exact application procedure—especially regarding the binder and the method of applying the inlay—has remained unexplored.

This research introduces, for the first time, a proposed recipe, technique, and manufacturing sequence for the white inlay used to decorate prehistoric pottery. The findings are supported by integrated analytical methods and an archaeological experiment. Compositional analysis of inlays preserved on Copper and Bronze Age ceramics from Croatia reveals recipes consistent with those documented in the Pannonian Basin, identifying three key components: hydroxyapatite (from bone material), aragonite (from mollusk shells), and calcite, which were tested in the experiments
According to the proposed hypothesis, burning (endothermic reaction) of these raw materials at temperatures above 700 °C and slaking (exothermic reaction) should result in plastic, but durable and solid material i.e. lime-based plaster. Experimental results confirmed this hypothesis, demonstrating that the plaster from mollusc shells and the bone material represents the basic technological procedure by which the incrustation was made and applied to the ceramic vessels as a post-firing decoration technique.

Keywords: Incrustation technique, Copper and Bronze pottery, Croatia, White inlay, Hydroxyapatite, Aragonite, Lime-based plaster

Insights into Raw Material Selection in Prehistoric Pottery: Experimental Study of Physical and Mechanical Properties of Ceramics

Natali Neral[1], Andreja Kudelić[1], Ana Maričić[2]

[1] Institute of Archaeology
[2] University of Zagreb

The selection of raw materials is an essential step in pottery production, determining the quality and functionality of the final ceramic products. This selection process is shaped by the interplay of raw material availability, the optimization of production techniques, functional requirements, and cultural considerations (Rice 1987, Arnold 2000, Livingstone Smith 2000, Gosselain et al. 2005). The analysis of these raw materials, including clays and tempering materials, provides essential insights into the factors guiding these choices.

This study therefore investigates the physical and mechanical properties of ceramics and their raw materials to evaluate how variations in clay composition and tempering materials influence technological process in terms of paste preparation, shaping and firing, and the mechanical properties of ceramics. Additionally, it examines whether these raw material selections were driven by resource availability, functional needs, or other factors and whether these considerations applied equally to clays and tempering materials.

The study focuses on two clay types—sandy clay and inclusion-poor clay—and four tempering materials: calcite, grog, sand, and vegetal material, all commonly utilized in prehistoric pottery production in Croatia. The methodology includes testing the plasticity (analysis of the Atterberg limits) and shrinkage of the clays, as well as point load index testing of 56 experimental ceramic briquettes made using different recipes.

The findings reveal that inclusion-poor clay, with a high clay mineral content and fewer crystalloclasts, demands a more intricate preparation and shaping and extended firing process but yields stronger ceramics. In contrast, sandy clay, abundant in crystalloclasts like quartz and feldspar, is easier to process and fire but produces ceramics of lower strength. Additionally, the study shows that the effect of tempering materials is strongly influenced by clay type, with a more significant impact on inclusion-poor clay.

Consequently, the results of the experiments highlight how variations in clay composition shape ceramic production processes and mechanical properties, underscoring the need for potters to adapt their techniques to the specific characteristics of the clay. Communities that selected sandy clay prioritized its ease of preparation and firing, whereas the deliberate use of inclusion-poor clay, despite its more demanding processing, reflects a strategic preference for functional advantages such as enhanced strength and durability.

Keywords:Raw material selection, Clay composition, Tempering materials, Physical and mechanical properties, Ceramic production techniques, Prehistoric pottery, Functional requirements

References:

Rice, P.M. 1987. Pottery Analysis: A Sourcebook. The University of Chicago Press, Chicago and London, 559 p.
Arnold, D. 2000. Does the Standardization of Ceramic Pastes Really Mean Specialization? J. Archaeol. Method Theory, 7(4), 333–375. doi:10.1023/A:1026570906712
Livingstone Smith, A. 2000. Processing clay for pottery in northern Cameroon: social and technical requirements. Archaeometry 42, 21–42.
Gosselain, O. P., Livingstone Smith, A., Bosquet, D., Martineau, A. 2005. The Source Clay selection and processing practices in Sub-saharan Africa. Pottery manufacturing processes: Reconstruction and interpretation 1349, 33–47

Reconstructing the Incrustation Technique: Experimental Insights into Post-Firing Decoration of Prehistoric Pottery

Andreja Kudelić[1 2], Natali Neral[2] and Ina Miloglav[1 3]

[1]Center for experimental archaeology, Zagreb, Croatia

[2]Institute of Archaeology, Croatia, nneral@iarh.hr, akudelic@iarh.hr

[3]Department of Archaeology, Faculty of Humanities and Social Sciences, University of Zagreb, Croatia, imiloglav@ffzg.hr

PREPOT HRZZ CULPLU

Prehistoric pottery style: Incrustation (a white paste inlay)

Introduction

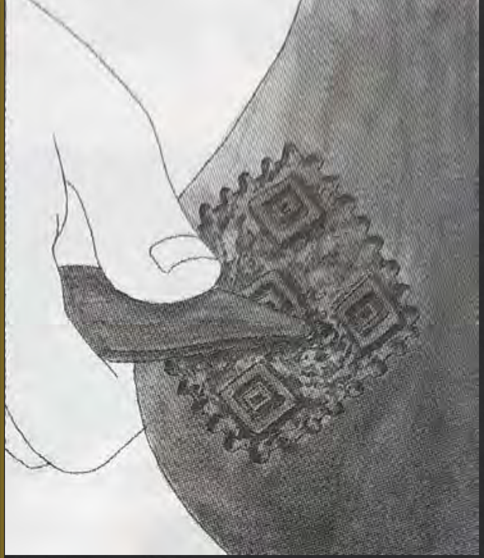
Geographical distribution of Copper and Bronze Age pottery styles

Croatia

Cooper Age
4350 – 2450 BC

Bronze Age
2450 – 800 BC

Introduction



Present research state

Stylistic analysis

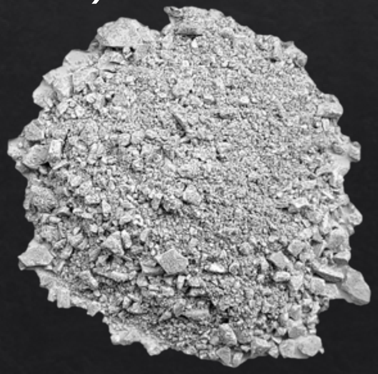
Mineral nad chemical composition (calcite, talc and bone powder, shells)

Operational Sequence

Three main components:

- Hydroxyapatite (bone material)
- Aragonite (Mollusc shells)
- Calcite

Burning raw material



Grinding (powder)

+ ? = ?

Homogenization of paste and mixing with binding agent

Application before of after firing the vessel

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OBJECTIVES

- Analyse the composition of Late Copper and Bronze Age inlays to identify the raw materials used.
- Reconstruct the manufacturing and application process by testing hypotheses about binding materials—challenging the idea of organic or clay-based binders and instead proposing lime- and bone-based plaster techniques.
- The goal is to propose a recipe, production technique, and application method, all supported by analytical methods and archaeological experiment.

Analytical methods

- FT-IR – Fourier-transform infrared spectroscopy
- Optical microscopy – thin section
- X-ray diffraction (XRD)

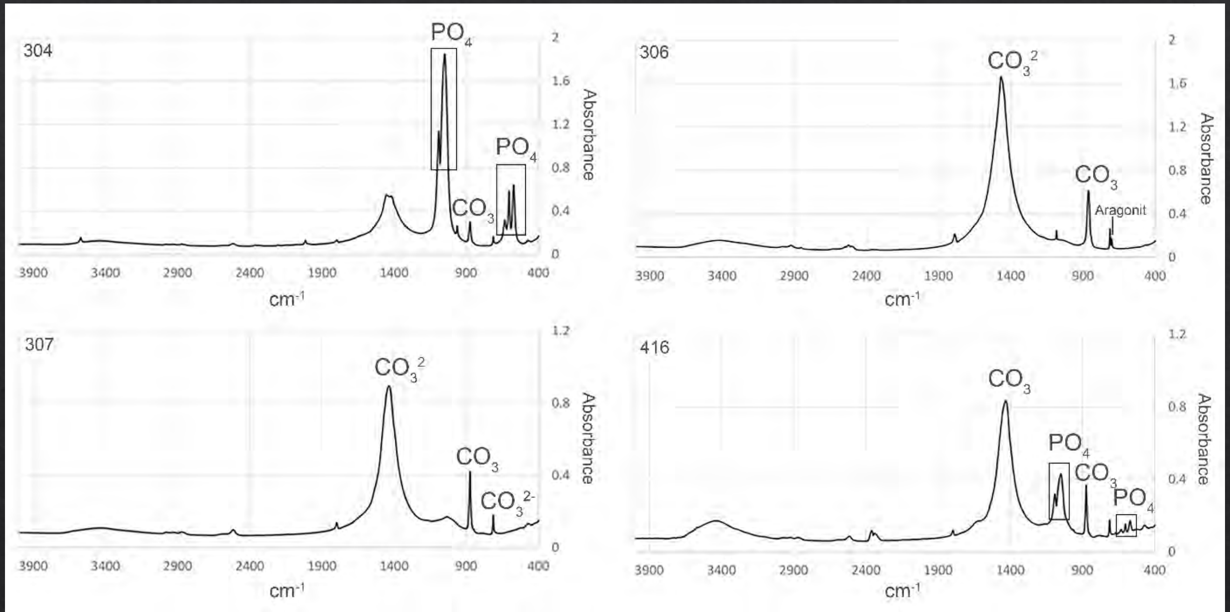
Archaeological experiment

- controlled conditions
- real conditions

Results of Analytical methods

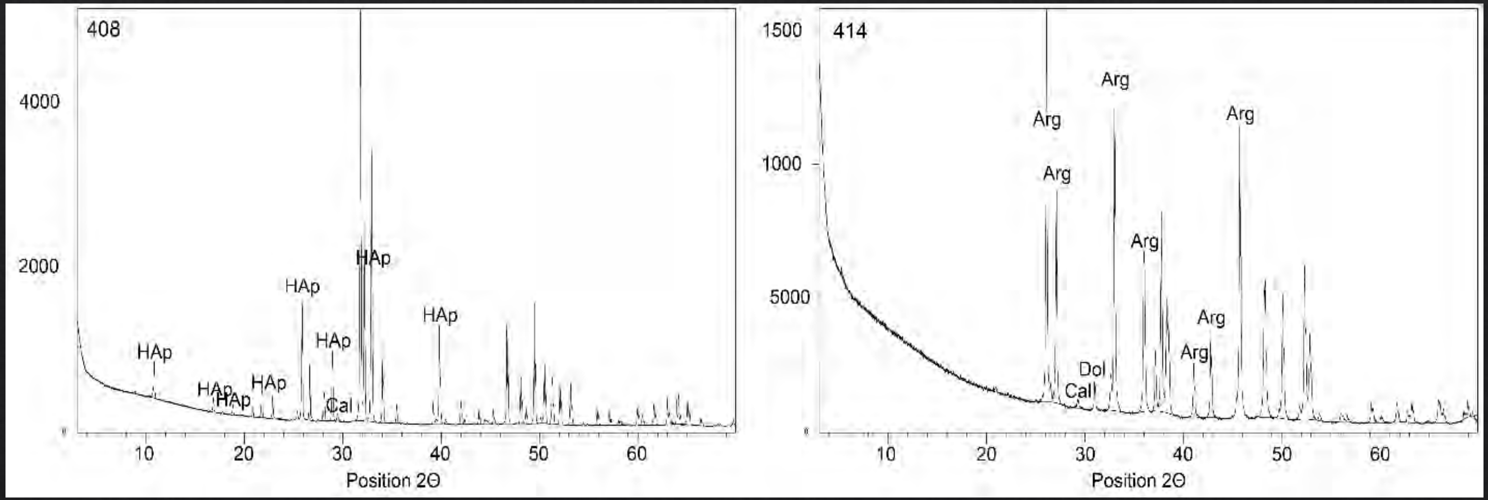
Compositional analysis of white paste from the vessel surface

Results



FT-IR spectra of archaeological incrustation inlays indicating the presence of **hydroxyapatite** (304), **aragonite** (306), **calcite** (307) and both the calcite and hydroxyapatite (416).

X-ray diffraction patterns of archaeological incrustation (samples 408 and 414). HAp – **hydroxyapatite**, Cal – **calcite**, Arg – **aragonite**, Dol – dolomite



Hypothesis

RESEARCH QUESTIONS

- How was the white paste prepared and applied to pottery?
- What firing conditions and durations were needed to process the raw material and achieve the desired properties?
- How was the paste homogenized, and what type of binding agent ensured its durability and adhesion?

Hypothesis

HYPOTHESIS

Lime-based and bone-based plaster

Binding agent

Bone material

Bioapatite → Firing 700-900°C → Calcination transformation to hydroxyapatite → Grinding – bone powder → H2O → Bone-based plaster

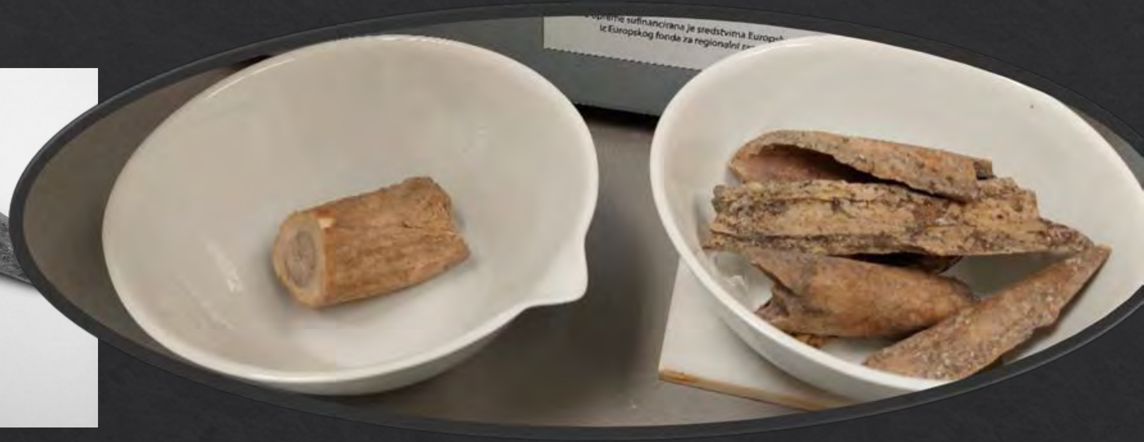
Mollusc shells

Aragonite → Firing 450°C → Calcite → Firing above 700 °C → Quicklime → H2O (slaking) → Lime-based plaster

Experiment

Experiment in controlled conditions: mammal bones and antler

STEP 1 - firing



Sample number	Firing method	Type of raw material	Warm-up time (min.)	Soaking time (min.)	Soaking temperature (°C)
251	Laboratory kiln	Animal long bone	45	75	900
250	Laboratory kiln	Deer antler	45	75	900
/	Laboratory kiln	Human skull	45	75	900
412	Laboratory kiln	Human long bone	45	75	900

Results

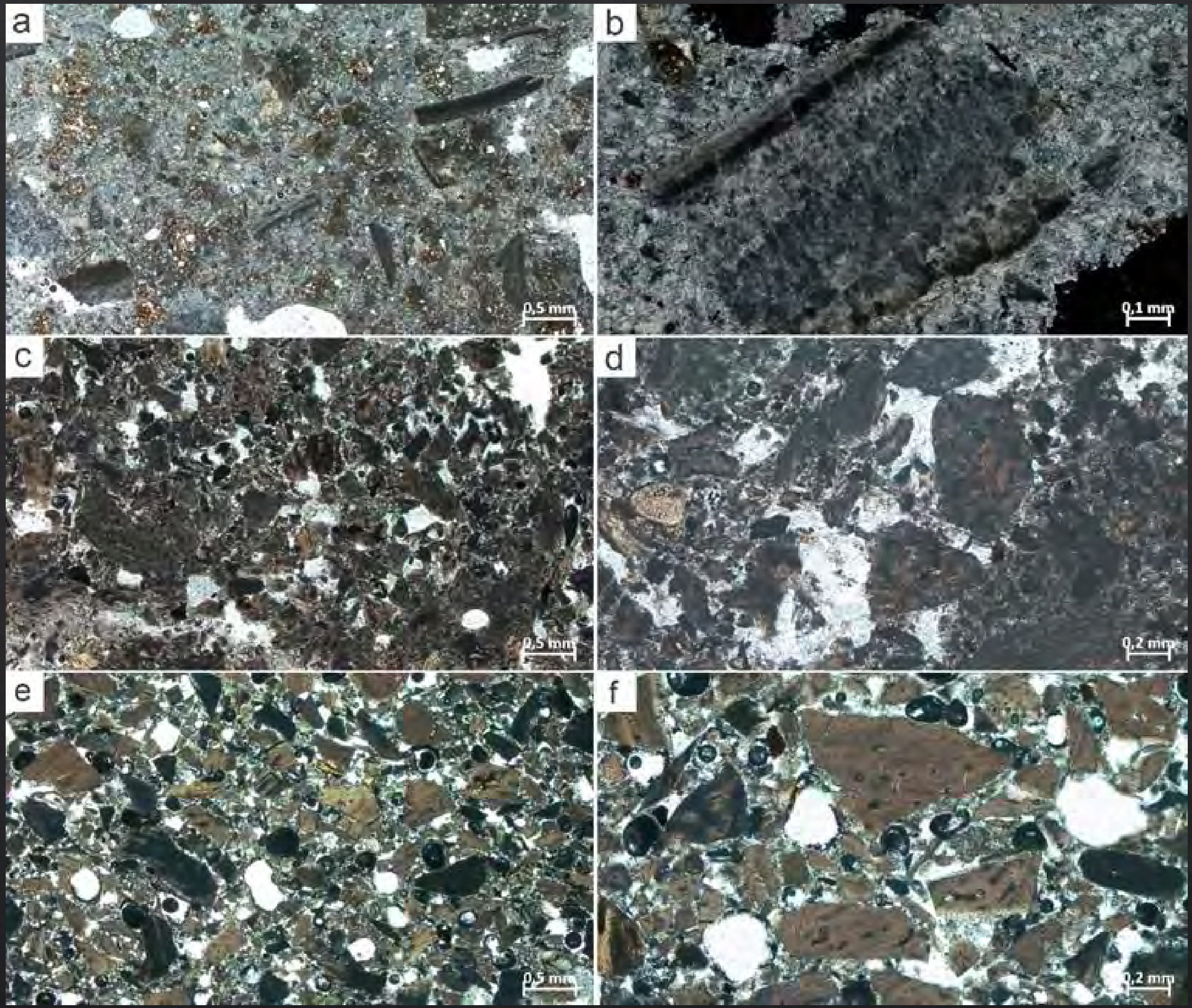
Sample number	Experiment / Firing method	Type of raw material	Warm-up time (min.)	Soaking time (min.)	Soaking temperature (°C)	Colour	Grinding	Sieving needed	Paste
251	Controlled conditions (Laboratory kiln)	Animal long bone	45	75	900	Yellowish white	Heavy	Yes	Fine
250	Controlled conditions (Laboratory kiln)	Deer antler	45	75	900	White	Very Easy	No	Very fine
/	Controlled conditions (Laboratory kiln)	Human skull	45	75	900	Yellowish white	Heavy	Yes	Fine
412	Controlled conditions (Laboratory kiln)	Human long bone	45	75	900	White	Easy	No	Very fine
413	Controlled conditions (Laboratory kiln)	Mollusc shell	20	5	400	Greyish white	Easy	No	Fine

Discussion

Comparison between archaeological and experimental incrustation

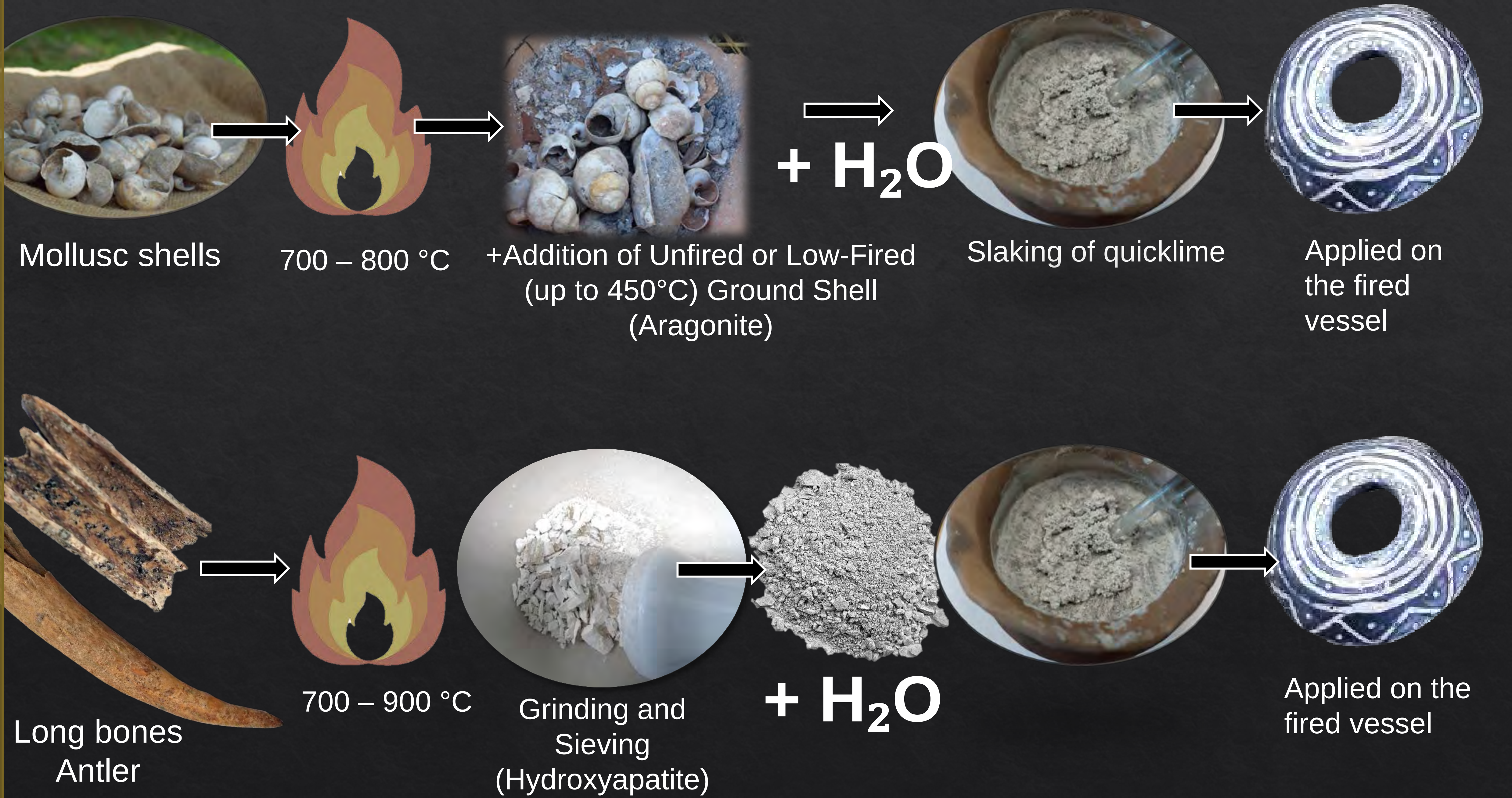
Archaeological shell-based inlay

Archaeological bone-based inlay



Microphotographs of experimental incrustation. A and B – paste made of shells (sample 249), B – foliated and prismatic layer of mollusc shell in XPL, C and D – paste made of antler (sample 250), D – bone fragments with osteons, E and F – paste made of animal bones (sample 251), F – bone fragments with fibrous microstructure and osteons

Conclusion


Mollusc shells
700 – 800 °C
+Addition of Unfired or Low-Fired (up to 450°C) Ground Shell (Aragonite)
+ H_2O
Slaking of quicklime
Applied on the fired vessel
Long bones
Antler
700 – 900 °C
Grinding and Sieving (Hydroxyapatite)
+ H_2O
Applied on the fired vessel

ACKNOWLEDGMENTS

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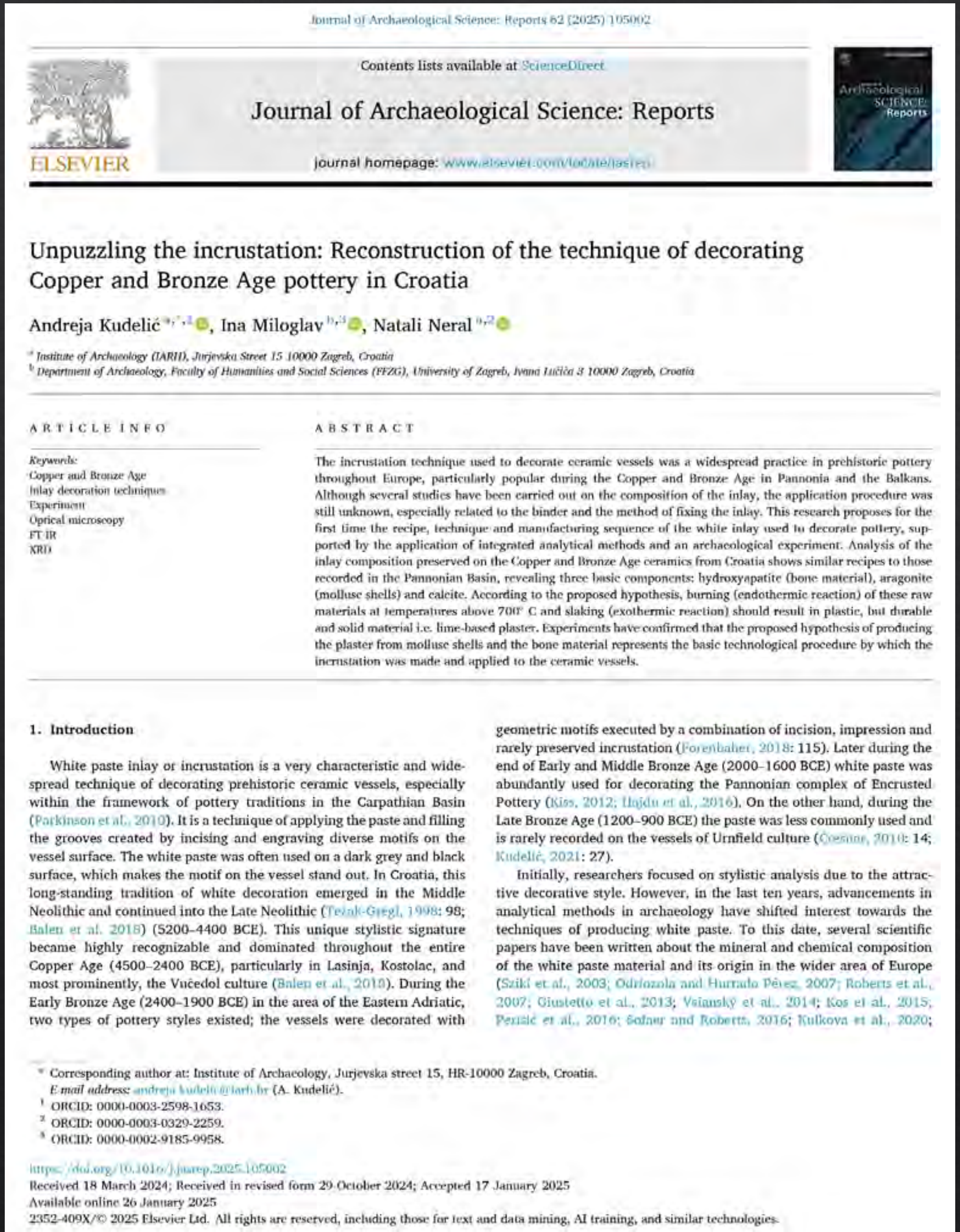

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Unpuzzling the incrustation: Reconstruction of the technique of decorating Copper and Bronze Age pottery in Croatia

Andreja Kudelić [a,*,1], Ina Miloglav [b,3], Natali Neral [b,2]

[a] Institute of Archaeology (IARH), Jurjevska Street 15 10000 Zagreb, Croatia
[b] Department of Archaeology, Faculty of Humanities and Social Sciences (FFZG), University of Zagreb, Ivana Lučića 3 10000 Zagreb, Croatia

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ABSTRACT

The incrustation technique used to decorate ceramic vessels was a widespread practice in prehistoric pottery throughout Europe, particularly popular during the Copper and Bronze Age in Pannonia and the Balkans. Although several studies have been carried out on the composition of the inlay, the application procedure was still unknown, especially related to the binder and the method of fixing the inlay. This research proposes for the first time the recipe, technique and manufacturing sequence of the white inlay used to decorate pottery, supported by the application of integrated analytical methods and an archaeological experiment. Analysis of the inlay composition preserved on the Copper and Bronze Age ceramics from Croatia shows similar recipes to those recorded in the Pannonian Basin, revealing three basic components: hydroxyapatite (bone material), aragonite (mollusc shells) and calcite. According to the proposed hypothesis, burning (endothermic reaction) of these raw materials at temperatures above 700° C and slaking (exothermic reaction) should result in plastic, but durable and solid material i.e. lime-based plaster. Experiments have confirmed that the proposed hypothesis of producing the plaster from mollusc shells and the bone material represents the basic technological procedure by which the incrustation was made and applied to the ceramic vessels.

1. Introduction

White paste inlay or incrustation is a very characteristic and widespread technique of decorating prehistoric ceramic vessels, especially within the framework of pottery traditions in the Carpathian Basin (Parkinson et al., 2010). It is a technique of applying the paste and filling the grooves created by incising and engraving diverse motifs on the vessel surface. The white paste was often used on a dark grey and black surface, which makes the motif on the vessel stand out. In Croatia, this long-standing tradition of white decoration emerged in the Middle Neolithic and continued into the Late Neolithic (Težak-Gregl, 1998: 98; Balen et al. 2018) (5200–4400 BCE). This unique stylistic signature became highly recognizable and dominated throughout the entire Copper Age (4500–2400 BCE), particularly in Lasinja, Kostolac, and most prominently, the Vučedol culture (Balen et al., 2018). During the Early Bronze Age (2400–1900 BCE) in the area of the Eastern Adriatic, two types of pottery styles existed; the vessels were decorated with geometric motifs executed by a combination of incision, impression and rarely preserved incrustation (Forenbaher, 2018: 115). Later during the end of Early and Middle Bronze Age (2000–1600 BCE) white paste was abundantly used for decorating the Pannonian complex of Encrusted Pottery (Kiss, 2012; Hajdu et al., 2016). On the other hand, during the Late Bronze Age (1200–900 BCE) the paste was less commonly used and is rarely recorded on the vessels of Urnfield culture (Ćosnar, 2010: 14; Kudelić, 2021: 27).

Initially, researchers focused on stylistic analysis due to the attractive decorative style. However, in the last ten years, advancements in analytical methods in archaeology have shifted interest towards the techniques of producing white paste. To this date, several scientific papers have been written about the mineral and chemical composition of the white paste material and its origin in the wider area of Europe (Sziki et al., 2003; Odriozola and Hurtado Pérez, 2007; Roberts et al., 2007; Giustetto et al., 2013; Vsianský et al., 2014; Kos et al., 2015; Perišić et al., 2016; Šofner and Roberts, 2016; Kulkova et al., 2020;

* Corresponding author at: Institute of Archaeology, Jurjevska street 15, HR-10000 Zagreb, Croatia.
E-mail address: andreja.kudelic@iarh.hr (A. Kudelić).
[1] ORCID: 0000-0003-2598-1653.
[2] ORCID: 0000-0003-0329-2259.
[3] ORCID: 0000-0002-9185-9958.

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