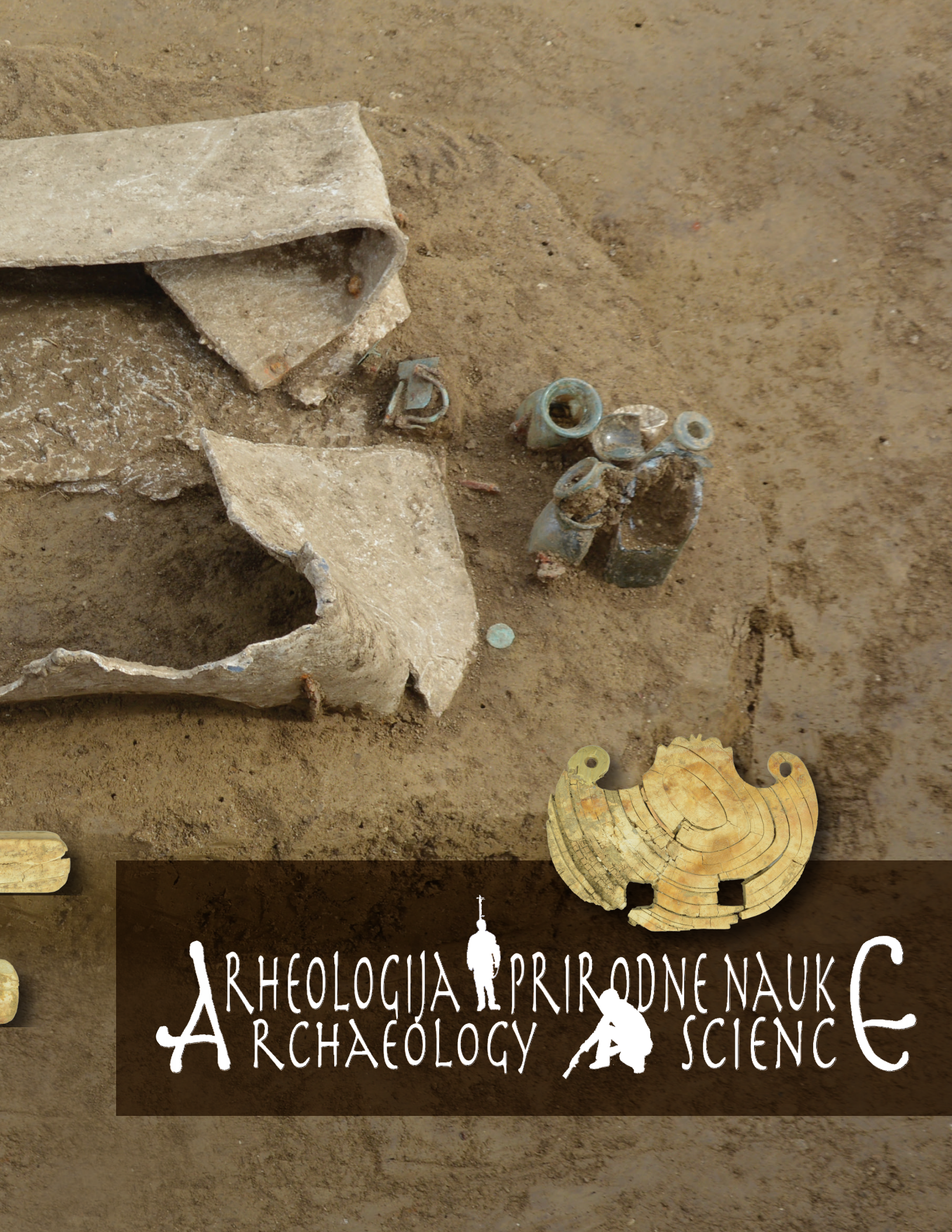

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Journal cover:
Lead coffin with grave inventory from the southern necropolis of Pećine at Viminacium (Photos by the Institute of Archaeology, Belgrade and Goran Stojić)

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EXPLORING WILD FRUIT CONSUMPTION AT THE LATE NEOLITHIC SITE OF DIVLJE POLJE-RATINA, SERBIA

ABSTRACT

Wild edible fruits have largely been overlooked in archaeological research in the continental Balkans, mainly due to their infrequent appearance in charred botanical assemblages and the predominant focus on crops and early agriculture. The well-preserved and abundant wild fruit remains found in the Late Neolithic layers of the site of Divlje Polje in Ratina (Serbia), have sparked interest in this subject. The archaeobotanical samples discussed in this study were collected during the rescue excavations at the site in 2021 and 2022. The paper presents preliminary data, focusing on the contents of the Late Neolithic pits.

The diversity of wild-gathered plants from various habitats at Divlje Polje indicates intensive procurement activities by the Neolithic inhabitants, while also providing valuable insights into the paleoenvironment. Special attention was given to the most abundant taxon—hazel—and to one of the least numerous—water chestnut, whose presence in the West Morava Valley region was quite unexpected. Water chestnut has primarily been found in the Vojvodina province, both in prehistoric times and in the present day. The paper also revisits the issues related to preservation bias caused by charring and the difficulties of inferring the dietary significance of wild plants based on their relative proportions in archaeological deposits.

KEYWORDS: WILD-GATHERED PLANTS, LATE NEOLITHIC, VINČA CULTURE, DIVLJE POLJE-RATINA, CENTRAL BALKANS, RESCUE EXCAVATIONS.

INTRODUCTION

Even as agriculture advanced, the collection of wild plants remained an important part of the diet in farming societies. Although they may not contribute to food intake as much as crops, they do enrich the diet with much needed nutrients, minerals and vitamins, and are valued for their exquisite taste. Diachronic changes in the use and importance of wild-gathered fruits in the Central Balkans remain challenging to fully understand, especially given the limited data available for the Mesolithic and Early Neolithic periods (Marinova *et al*. 2012/2013). Consequently, observed patterns, such as the increase in the diversity of wild-gathered plants during the Late Neolithic compared to the Early Neolithic, may be influenced by the small sample sizes (de Vareilles *et al.* 2022). However, persistent collection of some fruits and the growing body of data for the Late Neolithic (Vinča culture, 5400/5300-4500 cal BC) has provided a more nuanced perspective

on the significance of certain species. It has been suggested that some fruit-bearing trees, such as Cornelian cherry, wild apple and pear, may have been managed, possibly by promoting their growth through the creation of more open landscapes around them (e.g., Borojević 2006; Filipović, Marić and Tasić 2023; Valamoti and Mimi 2024). Discoveries of stored or extensively used wild fruits and nuts, such as water chestnut at Opovo (Borojević 2006) and wild pears at Vinča-Belo Brdo (Borojević *et al.* 2020; Filipović, Marić and Tasić 2023), suggest the existence of local traditions and preferences during the Late Neolithic. However, this topic remains poorly understood due to the limited data on collected taxa, which restricts the opportunity for a more detailed discussion.

The remains of wild fruits have been recorded at eleven Late Neolithic sites (including Divlje Polje) within the territory of present-day Serbia (de Vareilles *et al.* 2022: Table A1, Table S1). The sites differ in sampling methods and sample sizes; the number of samples taken ranges from 2 to 440, and in some cases, the exact volume of soil or the sampling methods were not specified in the published reports (for details, see Filipović and Obradović 2013; de Vareilles *et al.* 2022). The diversity of fruits and nuts is influenced by the sample size; however, sites with at least 40 samples tend to produce a similar spectrum of species (de Vareilles *et al.* 2022: Table 1, S1). The main mode of preservation across all sites is charring, with mineralised remains rarely found, and limited to only a few taxa (mainly *Sambucus* sp. and *Vitis* sp.) (e.g., Filipović and Obradović 2013; Borojević 2006; Van Zeist 2001/2002). Charring introduces a bias because of differences in charring conditions and the varying ways in which plants react to the process (e.g., Boardman and Jones 1990; Märkle and Rösch 2008; Wilson 1984). Additionally, each species varies in its likelihood of exposure to fire. Small, fleshy fruits (e.g., wild strawberry, grape and bramble) are typically eaten raw without coming into direct contact with fire, unless thermally processed (e.g., drying through heating). In contrast, hazelnut shells and stones of Cornelian cherries fruit are more likely to end up in a fire as by-products of consumption or as kindling. Additionally, these remains preserve well when charred, and their distinctive features allow even fragments to be easily identified (e.g., López-Dóriga 2015; Bishop 2019; Filipović *et al*. 2020). Therefore, inferring the dietary importance of wild fruits/nuts from their relative proportions in archaeological deposits is challenging, particularly with charred assemblages (*cf.* Colledge and Conolly 2014).

This paper presents the preliminary results of the archaeobotanical analysis of Late Neolithic layers at the Divlje Polje site in Ratina. The samples were collected during rescue excavations in 2021–2022, prompted by the construction of a highway adjacent to the West Morava river. The study focuses on wild fruits and nuts, following the discovery of a rich and diverse assemblage. It serves as a case study illustrating the challenges of reconstructing the relative significance of wild plant foods based on charred remains. Additionally, it offers a broad comparison of fruit and nut use at Divlje Polje with other contemporaneous sites in the region.

THE SITE

Divlje Polje is situated in the village of Ratina, approximately 5 km south of Kraljevo. It lies on a raised river terrace near the confluence of the Ibar and West Morava rivers (**Figure 1**). Initial excavations of the site began in the early 1980s (Валовић 1983). The first excavations in 1980 were conducted by T. Vučković, a curator at the National Museum Kraljevo. In the following years, the excavation continued as a collaborative project between the National Museum Kraljevo and the Center for Archaeological Research, Faculty of Philosophy in Belgrade (Валовић 1983, Valović 1985, 1986). In 2007, construction work on a nearby road led to the devastation of the north-eastern part of the site. Consequently, a geoelectrical survey and small-scale excavations were conducted in the western part of the site that same year (Романов 2010)[1]. Renewed interest in the site was triggered by the construction of a new highway route. In 2021, a geomagnetic

[1] Rescue excavations were organised by the National Museum Kraljevo, led by Tatjana Mihailović.

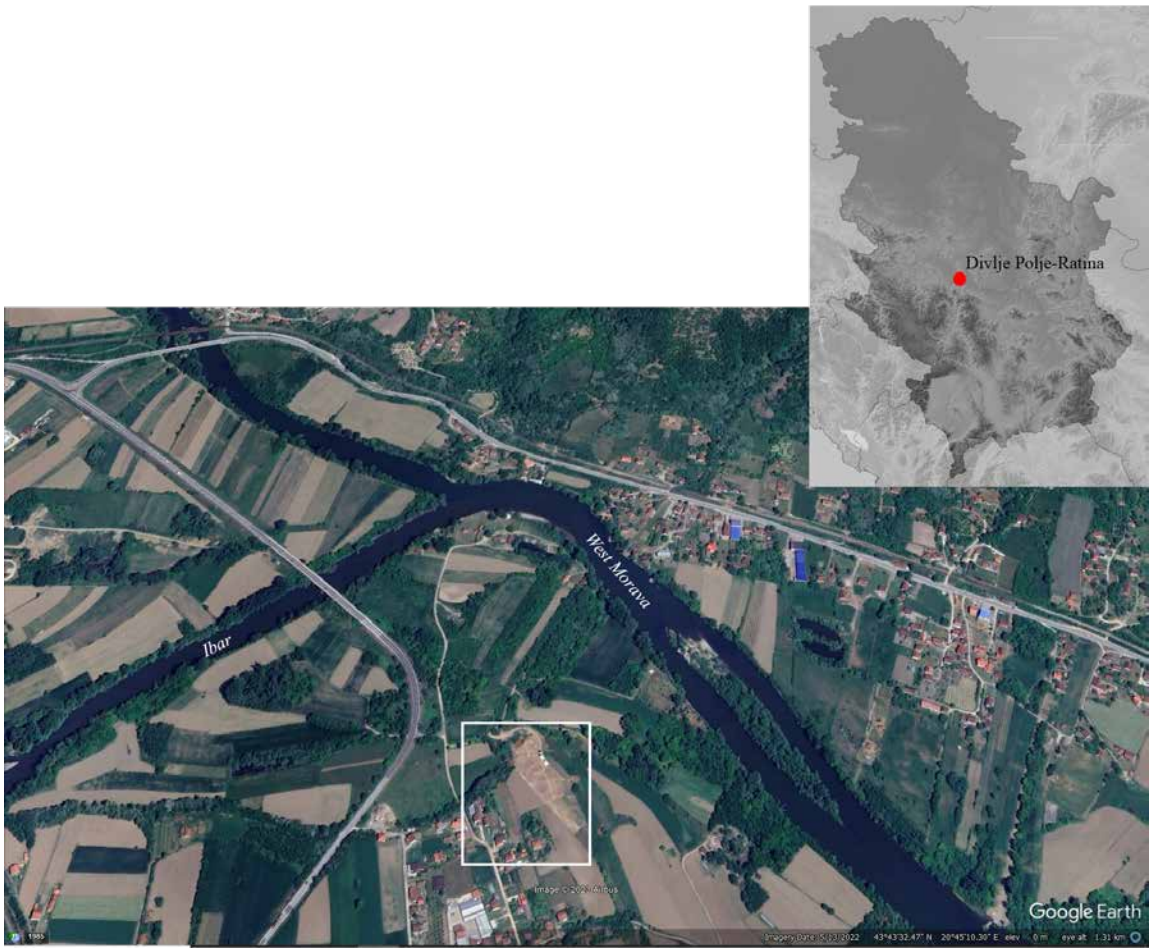

Figure 1. Location of the site of Divlje Polje, with the encircled area marking the zone of rescue excavations conducted in 2021-2022 (Google Earth image, Imagery Date 13.5.2022.) and Relief map of Serbia (© Geologicharka / Wikimedia Commons / CC BY-SA 3.0, https://commons.wikimedia.org/wiki/File:Relief_map_of_Serbia.png) (tags and adaptation done by Đurđa Obradović).

survey and test excavations were conducted before the large-scale rescue excavations, which took place during the autumn of 2021 and the spring of 2022[2].

The site was inhabited during the Late Neolithic and Iron Age. Based on the characteristics of the Neolithic pottery assemblage, Valović (Валовић 1983) dated the occupation of the site from the Vinča-Tordoš II to the end of Vinča-Pločnik II phase (5200-4650/4600 BC). The Iron Age occupation of the site is related to the Late La Tène period (c. 1st century BC) (Романов 2010). No radiocarbon dates have been available for this site, as the soil acidity destroyed the animal bones (Valović 1985: 45), and the collection of botanical remains was not a part of any previous investigations. In light of this, the carbonised plant material collected from recent rescue excavations, along with the well-preserved bones found in a few pits, could offer a more precise chronology for the site.

S. Valović estimated the size of the Late Neolithic settlement to be approximately 2 hectares (Валовић 1983). Both early and recent archaeological excavations were conducted only in the eastern part of the settlement, confirming that it extended approximately 125 metres in a

[2] The geomagnetic survey was conducted by the Center for New Technology Viminacium, while the Institute of Archaeology, under the direction of Slaviša Perić, was responsible for the rescue excavations. The results of the geomagnetic survey and rescue excavations are yet to be published, as preparations for a detailed report on the findings are still underway.

north-south direction. The eastern boundary is marked by the raised edge of the river terrace, but since the western part of the site lies beneath the modern settlement, it is not possible to precisely detect the settlement's width in the east-west direction.[3]

The early reports mention at least two phases of Neolithic occupation with distinctly different architecture: an earlier phase with pit-houses and a later phase with rectangular above-ground dwellings. It was interpreted as an enclosed settlement, surrounded by a ditch on the southern side, though it was not specified whether this belongs to the earlier or later phase of the settlement (Валовић 1983: 33). During the excavations in 2021–2022, none of the excavated Late Neolithic pits seem to have had a dwelling function and the noted ditch registered in the southern part of the site was from the Iron Age. New findings do not necessarily contradict previous interpretations, but resolving the complex issue of the settlement's history will require a detailed analysis of the unpublished documentation from both excavation campaigns.

The plant material analysed in this paper originates from nine Late Neolithic pits excavated in 2021-2022. Pits 1–3 are located in the northern part of the settlement, Pits 4 and 5 in the central section, and Pits 6–9 in the southern periphery. Based on preliminary analysis of the pottery and stratigraphy, the pits from the northern and central part of the site can be assigned to the early phase of the Late Neolithic settlement (Vinča-Tordoš II). In the southern part, Pits 8 and 9 can also be assigned to the early phase, while Pit 7 appears to be later, as it contained material from the Vinča--Pločnik phase. The dating of Pit 6 remains unclear due to the presence of atypical pottery types and forms.

Evidence of *in situ* burning is present in pits 5 and 6. In Pit 5, this pertains to a charred layer at the bottom of the pit, with evidence of reddish burned soil beneath (**Figure 2**).[4] The charred layer contained a significant amount of carpological remains (**Table 1**) mixed with wood charcoal. Therefore, it was interpreted as evidence of a fire fuelled by wood. For now, it is unclear whether this represents a single burning event or prolonged use of the pit as a fireplace. The lack of investment in constructing the fireplace, along with the relatively thin and pale burned bottom layer and the good preservation of the plant remains, may suggest that it was used for a short period and soon after it was covered with sediment. Pit 6 is elongated and narrow, with burned walls and a scorched bottom, and is filled primarily with burned reddish soil and fragments of burned daub. Within the upper layer of Pit 6, one intact vessel and five fragmented ones were found, all displaying evidence of secondary burning. The function of this pit remains a subject of debate, with one suggestion being that it was used for firing pottery. The other pits, including the later use of Pit 5, can be broadly classified as refuse pits. The lack of evidence of *in situ* burning suggests that the charring of plant remains is primarily related to burning events outside the pits, with the charred remains subsequently deposited into the pits.

MATERIALS AND METHODS

Over the two excavation seasons (2021-2022), 88 archaeobotanical samples were collected, i.e., 940 litres of soil. Due to the extensive excavation area and the presence of a shallow, disturbed cultural layer, sampling was conducted selectively, focusing primarily on pits, a ditch, specific areas within houses, or areas near ovens. Multiple samples were collected from each feature,

[3] In the test trenches from 1984, located 500 metres southwest of the "centre" of the settlement, a thin cultural layer without architectural remains was registered (Valović, Unpublished report 1984). The "centre" refers to the area excavated during the 1982-1983 seasons. Valović suggested that the absence of architecture in this area may be due to the small excavated area or because it was a free open space reserved for economic activities, which he refers to as a "salaš." Thus, these results were not conclusive regarding the extent of the settlement. The trenches from the 2007 season were placed in the western part of the settlement, but finds are mostly attributed to the Iron Age, while earlier Late Neolithic material is present in the humus layer.

[4] The pit was discovered during supervised construction work, after the official excavations had been completed. By the time the pit was identified in the profile of the long trench dug by construction workers, its eastern section was damaged, so the remaining part of the pit was excavated manually. Archaeobotanical samples were taken solely from the bottom of the pit, where visible plant remains were present.

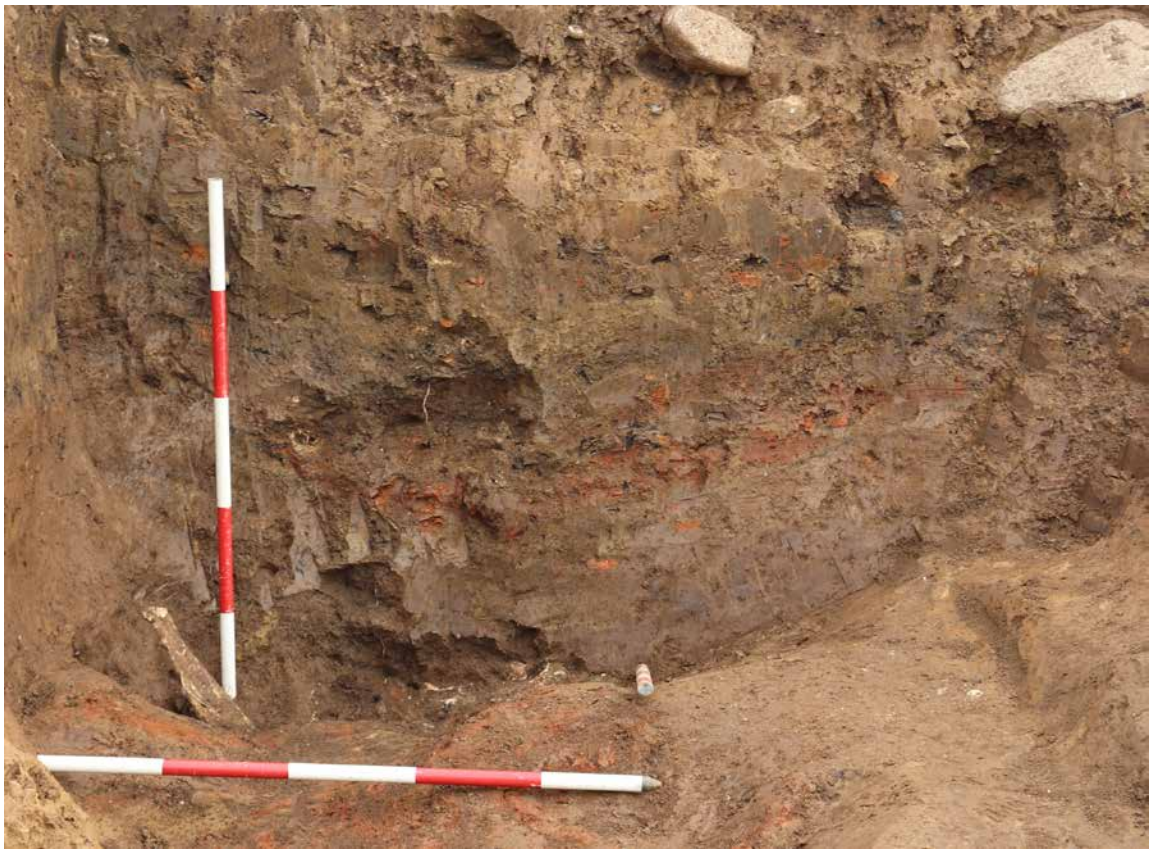

Figure 2. Eastern profile of Pit 5 (Documentation of the Institute of Archaeology, Belgrade).

typically around 10 litres of soil per sample. Plant remains were extracted using machine flotation. Light fractions were collected using pieces of fine cloth with less than 0.3 mm apertures, while heavy residues were retained by a 1 mm mesh.

Of the 79 Late Neolithic samples, 53 have been processed so far. The focus was placed on the material retrieved from the pits, as the presence of charred macro-remains was observed during flotation and in a cursory examination of the light residue. The light residue samples from eight pits were fully sorted, while only two out of ten light residue samples from Pit 1 (Trench II, Units 13, 16, and 23) were processed. The contents of Pit 1 are still included in the discussion but are regarded with caution, as the analysis of all samples from the pit may result in changes in the documented plant diversity. The heavy residue samples were sorted only from Pit 5, as they contained a large quantity of macro-remains, mainly hazelnut shells. Multiple samples deriving from the same pit were amalgamated, despite some variations in botanical density and composition.

Seven pits (Pits 1-5, 8-9) are associated with the early phase of the settlement (Vinča-Tordoš II), while Pit 7 corresponds to the later phase (Vinča-Pločnik), and Pit 6 is broadly classified as Late Neolithic. Consequently, the results primarily reflect plant use and practices related to the early phase of the settlement. Due to the small quantity of remains in pits 6 and 7, the results are not discussed within separate phases.

Most of the plant remains from Divlje Polje are charred. The frequent presence of mineralised seeds of dwarf elder (*Sambucus ebulus*), and, to a lesser extent, elderberry (*S. nigra*), is considered a possible modern intrusion. Therefore, mineralised seeds of *Sambucus* species are excluded from the final counts, and the data presented in **Table 1** pertains only to the charred remains. On the other hand, mineralised remains of the field gromwell (*Buglossoides arvensis*) were included; in some cases, the fruitlets were greyish, indicating they may have been exposed to high temperatures.

The samples were sorted under a low-power (10x-40x) stereomicroscope. The botanical

Context		PIT 1	PIT 2	PIT 3	PIT 4	PIT 5	PIT 6	PIT 7	PIT 8	PIT 9
Sector		1	1	1	3	3	4	4	4	4
Trench		II	V	XIV	TT1, TT3	XVIII	XI	XI	XI	XI
Quadrant		D1/D2/C2	D5	G1, H1, H2	E16	D15	A23, B23	C22	C21	C21
Unit		23, 13	19, 28, 42, 43	71, 73, 83, 95	8, 10, 16	22	15	13, 17	19	27, 29
Number of samples		2 (10)	14	6	12	6	5	4	1	3
Volume (l)		19 (90)	212	86	143	31	45.5	47	18	34
Total plant remains		14	178	200	56	2,408	10	41	2	7
Botanical density		0.8	0.6	2.2	0.4	72.4	0.2	0.9	0.2	0.2
CROPS	Common name									
Triticum monococcum	Einkorn	1	1	2	2	22				
Triticum monococcum, glume base				2		26				
Triticum dicoccum	Emmer		11	18	6	27	1		1	
Triticum dicoccum, glume base			2		2	22	2	2		
Triticum sp.	Wheat	3	27	42	16	70	3			
Triticum sp., glume base				3	3	112	1			
Hordeum vulgare	Barley		17	15	5	26		4		4
Cerealia indeterminata	Indeterminate cereals	4	8	24	11	56		1		
Lens culinaris	Lentil		1							
Pisum sativum	Pea		1			3				
Leguminosae sativae	Indeterminate pulses					6				
Linum usitatissimum	Linseed/flax	1	20	24	1	410		8		
TOTAL		**9**	**88**	**130**	**46**	**780**	**7**	**15**	**1**	**4**
FRUIT/NUT TAXA										
Cornus mas	Cornelian cherry		10	2	1	252	1	1		
Corylus avellana, shell fragments	Hazel	1	7	18		902				
cf. *Fragaria vesca*	Wild strawberry			4		3		2		
Malus/Pyrus sp.	Apple/pear					7		1		
Physalis alkekengi	Bladder cherry		42	8	3	144		6		
Rubus sp.	Raspberry/blackberry		5	1		45				
Sambucus ebulus	Dwarf elder		1	2		7				1
Sambucus nigra	Black elder			2		9				
Sambucus sp.				2	1	5				
Trapa natans	Water chestnut					2				
Vitis vinifera	Grape					54				
TOTAL		**1**	**65**	**39**	**5**	**1,430**	**1**	**10**		**1**

Table 1. Summary of seed/fruit remains (unless otherwise stated) from the Late Neolithic pits at Divlje Polje – Ratina.

Context		PIT 1	PIT 2	PIT 3	PIT 4	PIT 5	PIT 6	PIT 7	PIT 8	PIT 9
WILD/WEED TAXA										
Buglossoides arvensis	Field gromwell			2		9				
Carex divulsa	Grey sedge					1				
Chenopodium album	Fat hen			4		4				1
Compositae	Daisy family				1		1			
cf. Cruciferae	Mustard family					3				
Echinochloa crus-galli	Barnyard grass					1				
Fallopia convolvulus	Black-bindweed			1		10				
Galega officinalis	Goat's rue					1				
Galium sp.	Bedstraw	1		2		2				
Poaceae, large seeded	Grass family	1	2		1	4		1		
Poaceae, small seeded	Grass family		1	12		15		6	1	1
Lamiaceae	Mint family					7				
Leguminosae	Legume family					1				
Leguminosae, small seeded	Legume family			1		7				
Linum sp.	Flax					45				
Polygonaceae	Buckwheat family		1	3		12				
Polygonum aviculare	Common knotgrass				2					
Scleranthus annuus	Annual knawel					2				
Setaria sp.	Foxtail grass				1	7				
Silene sp.	Catchfly					54				
Solanaceae	Nightshade family	2	20	6		10	1	9		
Verbena officinalis	Common vervain		1			3				
TOTAL		**4**	**25**	**31**	**5**	**198**	**2**	**16**	**1**	**2**

Table 1. (continued)

material was identified using a personal reference collection and relevant botanical literature (e.g., Cappers, Bekker and Jans 2006; Schoch, Pawlik and Schweingruber 1988). A number of the rarely occurring fruits and seeds remain unidentified for the time being and await further analysis. This also applies to arbitrary categories in the wild/weed taxa group, such as the *Setaria* type, small and large-seeded Poaceae, etc. These categories contain well-preserved seeds that can be more precisely identified.

Wherever feasible, the quantification of identifiable charred seeds, fruits, and chaff was based on counts of the 'minimum number of plant parts' represented. The quantification of crop remains was carried out as follows. Along with whole cereal grains, apical and embryo ends were identified and the more frequent end was counted. Longitudinally split grains were included in the counts, with two halves considered as one whole grain. Cereal chaff was quantified by counting individual glume bases: hulled wheat spikelet forks were recorded as two glume bases, while terminal spikelet forks were counted as one. Pulse seeds were quantified by counting embryos, two cotyledons of the same species were scored as one. Similarly, the minimum number of items was estimated for other seeds and fruits, with the exception of hazelnuts and water chestnut.

Due to their high degree of fragmentation[5], hazelnut shell fragments were not converted into a minimum number of items (MNI); instead, all shell fragments were counted, regardless of their size. Only two charred fragments with horn-like projections were identified as remains of water chestnut (*Trapa natans*) endocarp (**Figure 3**). These may represent one or two different nuts, despite being found within the same sample, and were counted as two.

The botanical richness of the samples was evaluated by considering the total number of items per sample and the number of items per litre of floated soil (density[6]) (**Table 1**). The potential degree of utilisation of crop and fruit/nut taxa was assessed by looking at the abundance and ubiquity (the number of occurrences across the assemblage) (**Figures 4; Figure 5; Figure 6**). It should be stressed that the latter parameter – the frequency of remains across the assemblage – was observed on the context level, based on amalgamated samples.

RESULTS

Archaeobotanical analysis identified a variety of crops in the pit fills, along with wild-gathered fruits and potential weed taxa (**Figure 4; Table 1**). All the pits contain mixed contents, mainly consisting of crop grains and crop processing residues (e.g., chaff and arable weeds). However, pit 5 stands out with an exceptionally high number of fruit and nut remains.

The abundance and density of plant remains vary between pits. Pits 1, 6, 8, and 9 contain less than 30 remains each. This is partly due to

[5] Several methods were employed to calculate the MNI of fragmented hazelnuts in the archaeobotanical research. Azorín and Antolín (2014) evaluated different methods and suggested a specific formula based on their experimental research. This formula takes into account the size of the fragments, which would necessitate a detailed re-analysis of the hazelnut assemblage from Ratina.

[6] The density for Pit 1 is calculated based on the number of remains present in two samples, with a total volume of 19 litres, while the total sampled soil volume from this pit is 90 litres.

Figure 3. Water chestnut (*Trapa natans* L.): charred fragments of the fruit endocarp (photo taken by Đurđa Obradović).

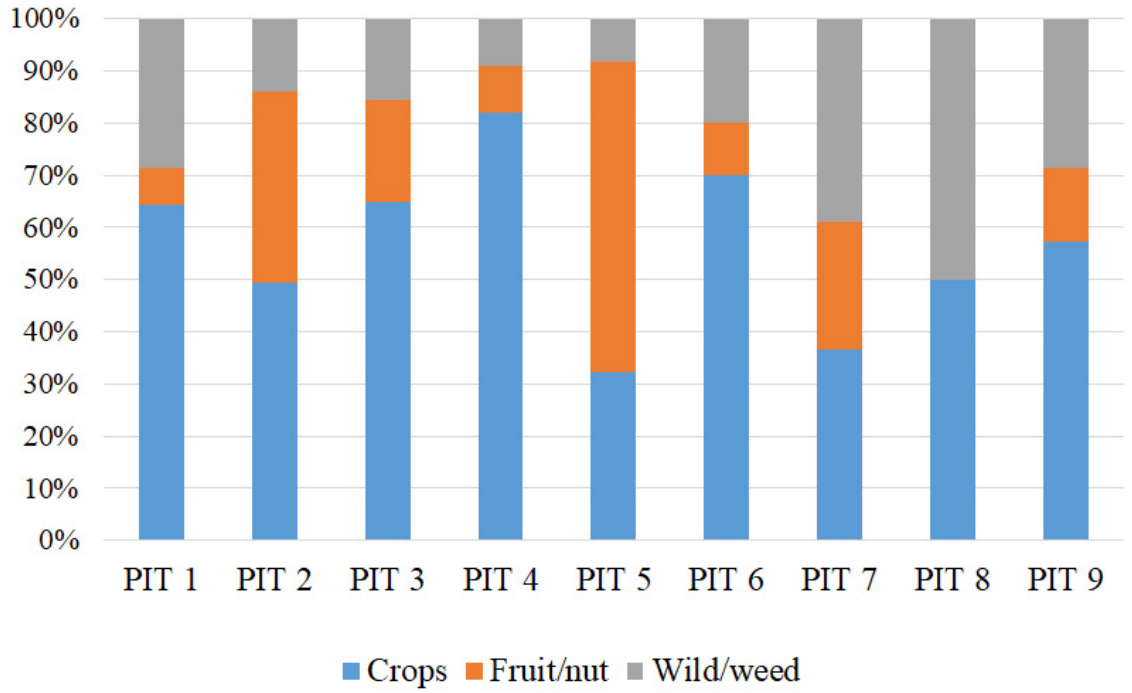

Figure 4. Proportions of crops, fruit/nut and wild/weed remains in the Late Neolithic pits.

a smaller number of samples being taken from these pits (as indicated by volume in **Table 1**). In the case of Pit 1, the low number of plant remains results also from only two out of ten samples being processed. A moderate number of plant remains (40-200) was found in the more extensively sampled pits 2, 3, 4 and 7, however, the density of the remains is similar to the former. In all the mentioned pits, except for Pit 6, there was no evidence of *in situ* burning, indicating that the plant material originated elsewhere. The low density of plant remains in these pits can point to a slow/gradual deposition of moderate amounts of charred material (*cf.* Jones 1991: 66). Pit 6, where there was evidence of *in situ* burning, contained only ten carpological remains and a small amount of charcoal. The small amount of carpological remains may not be surprising if this feature was associated with firing pottery rather than food preparation; however, the small quantity of charred wood typically used as fuel is noteworthy. The lack of charred remains may have resulted from unfavourable charring conditions or other factors, highlighting the need for a clearer understanding of the feature's use and the processes that contributed to the formation of its fill.

As previously mentioned, Pit 5 stands out for its remarkable diversity and density of plant remains; just over 2,400 remains were recovered from only 30 litres of soil. These remains were charred *in situ*, as a result of crop and wild plant residues from processing or consumption being discarded or accidentally thrown into the fire lit within the pit.

Overview of the botanical assemblage

Table 1 lists the identified taxa and the absolute counts of the remains. The taxa are grouped into three categories: crops, fruit/nut, and wild/weed taxa.

Crops

The cultivated species identified in the Late Neolithic layers at Divlje Polje include einkorn (*Triticum monoccocum* L.), emmer (*Triticum diccocum* Schrank), barley (*Hordeum vulgare* L.), pea (*Pisum sativum* L.), lentil (*Lens culinaris* L.), and flax/linseed (*Linum usitatissimum* L.) (**Table 1**). Crop remains are not numerous but are ubiquitous in the samples (**Figure 4**).

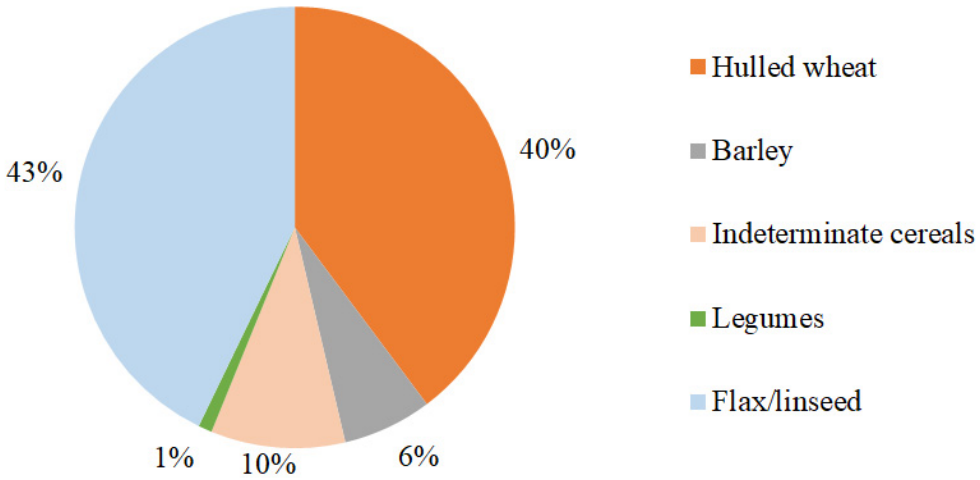

Figure 5. Relative proportions (based on absolute counts) of the main crop types.

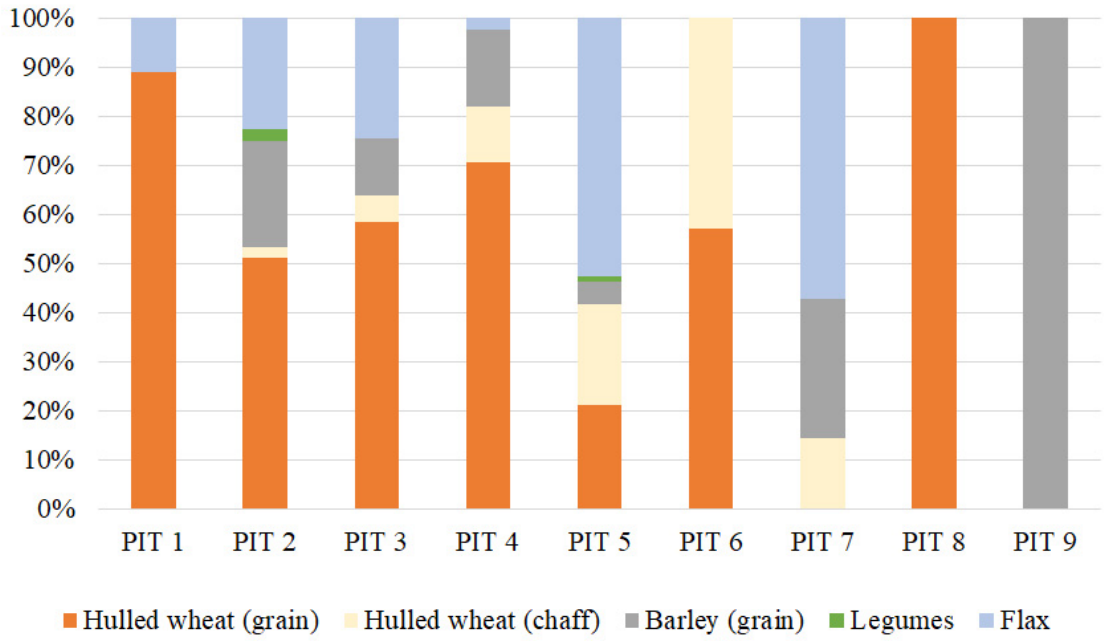

Figure 6. Relative proportions of crops in pits.

The most important cereals appear to be hulled wheats—einkorn and emmer—and, to a lesser extent, barley (**Figure 5; Figure 6**). The assemblage is grain dominated, which may suggest processing and consumption of clean stored products. Perhaps most of the dehusking and cleaning of grains was done in some other (unexcavated) area or outside the settlement.

The presence of legumes is minor by both abundance and ubiquity, rendering their importance as cultivated crops ambiguous.

The significant proportion of flax/linseeds in the assemblage is primarily due to their concentration in Pit 5, where over 400 seeds were uncovered (**Table 1; Figure 5**). Notably, linseed seeds are also relatively frequent, occurring in 6 out of the 9 pits (**Figure 6**). The abundance and ubiquity of flax at Divlje Polje is unique, considering that oily seeds generally have a lower likelihood of surviving the charring process (e.g.,

Wilson 1984). Thus, its frequent occurrence may suggest that flax/linseed was an intensively used and staple crop for the inhabitants of Divlje Polje.

The wild/weed taxa

The ruderal/arable taxa are relatively diverse, with the most abundant being: species of the *Silene* genus, various taxa from the Polygonaceae family (*Fallopia convolvulus* (L.) Á. Löve, *Polygonum aviculare* L.), and the Poaceae family (small-seeded *Poa* type and *Setaria* sp.). A substantial quantity of distinctly small flax seeds was tentatively interpreted as wild flax. Given their presence in the same sample as the seed of the cultivated variety, they may have come from a weed type growing within the flax crop.

Fruits and nuts

Wild fruits/nuts include nine taxa: Cornelian cherry (*Cornus mas* L.), hazel (*Corylus avellana* L.), grape – probably wild (*Vitis vinifera* L.) wild apple/pear (*Pyrus/Malus* sp.), bramble (*Rubus* spp.), elderberry (*Sambucus* sp.), bladder cherry (*Physalis alkekengi* L.), wild strawberry (*Fragaria vesca* L.) and water chestnut (*Trapa natans* L.). More than 900 fragments of hazelnut shells were found within the Late Neolithic pits at Divlje Polje (**Figure 7**). The majority of these fragments came from Pit 5, while hazelnut shells were also encountered in Pits 1, 2, and 3. As a result of the fragmentation, the quantity may be misleading in terms of the actual number of nuts consumed and the relative importance of hazelnuts compared to other gathered fruits. However, their relatively frequent presence in pits suggests significant use.

Pit 5 contained over 250, mostly intact, Cornelian cherry stones, some still with remnants of fruit attached (**Figure 8**). Cornelian cherry stones were also found in five other pits, typically as single finds, except in Pit 2, where 10 were discovered.

Seeds of bladder cherry (*Physalis alkekengi* L.) were found in five pits. Besides the discovery of approximately 150 seeds of bladder cherry (*Physalis alkekengi* L.) in Pit 5, many were also found in Pit 2.

In Pit 5, a significant amount of bramble and grape remains were recorded (c. 50). *Rubus* was detected in three pits (Pits 2, 3 and 5), while grape pips and pedicels were found only in Pit 5.

Another relatively frequently occurring taxon is elderberry (*Sambucus* sp.), including both *Sambucus nigra* and *Sambucus ebulus*, although the latter is an herbaceous perennial sometimes considered an arable weed. Its remains were found inside five pits, and the most numerous finds were again noted in Pit 5, while in other pits, the maximum number of items did not exceed six.

Three taxa are represented by fewer than ten remains: wild apple/pear, wild strawberry and water chestnut. While the remains of the former two were found in at least two pits, fragments of water chestnut were found exclusively in Pit 5.

DISCUSSION

Rescue excavations in the West Morava Valley provided an opportunity to carry out the first ever archaeobotanical sampling at many sites located along the route of the future highway, including the site of Divlje Polje.

Compared to other Late Neolithic sites in Serbia, Divlje Polje exhibits certain differences, evident principally in the somewhat narrower range of crops. Specifically, Timopheev's wheat (*Triticum timopheevii* s.l.) and free-threshing wheat (T. *aestivum* L./*durum* Desf.) are absent among the cereals, as is bitter vetch among the legumes (e.g., de Vareilles *et al.* 2022; Filipović, Obradović and de Vareilles 2022). In contrast, a surprisingly large and well-preserved quantity of flax seeds was discovered. To date, such a quantity of flax remains from the Neolithic period in Serbia has only been registered at Vinča-Belo Brdo in the context of burned houses (Borojević *et al*. 2020; Filipović 2004; Filipović, Marić and Tasić 2023).

When comparing the quantities of crops, wild/weed taxa, and gathered fruits/nuts, it appears that the latter played a significant role, as they make up over 50% of the analysed plant assemblage from Divlje Polje. This stands out as an exception, since, at other Late Neolithic Vinča sites, fruits and nuts account for less than 15% of the assemblage (e.g., Borojević 2006; Filipović 2021a, 2021b; Обрадовић 2020). In the case of Divlje Polje, abundance as a quantitative parameter is misleading for several reasons. First, the high fragmentation rate of hazelnut shells

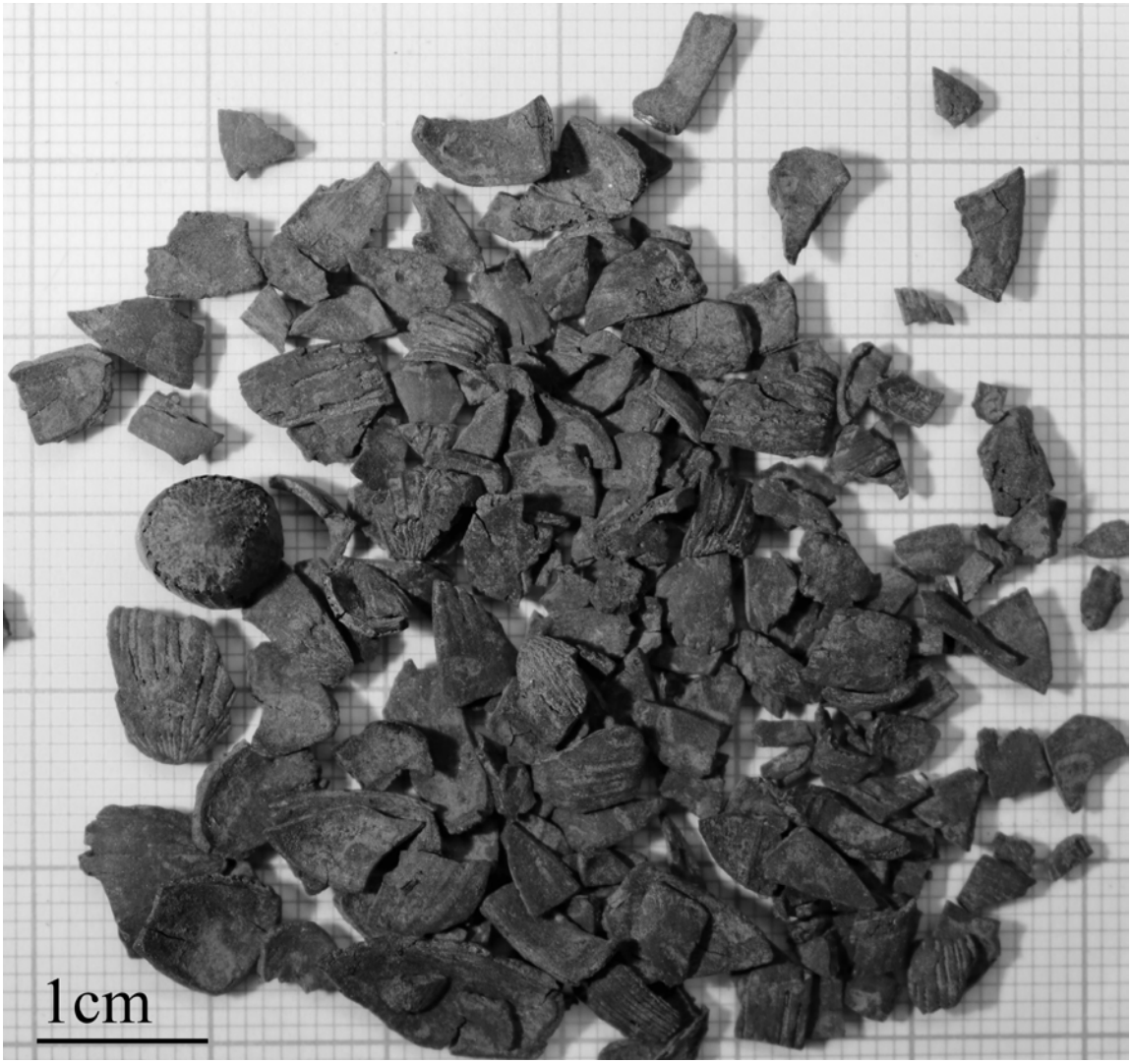

Figure 7. Fragments of hazelnut shells (photo taken by Đurđa Obradović).

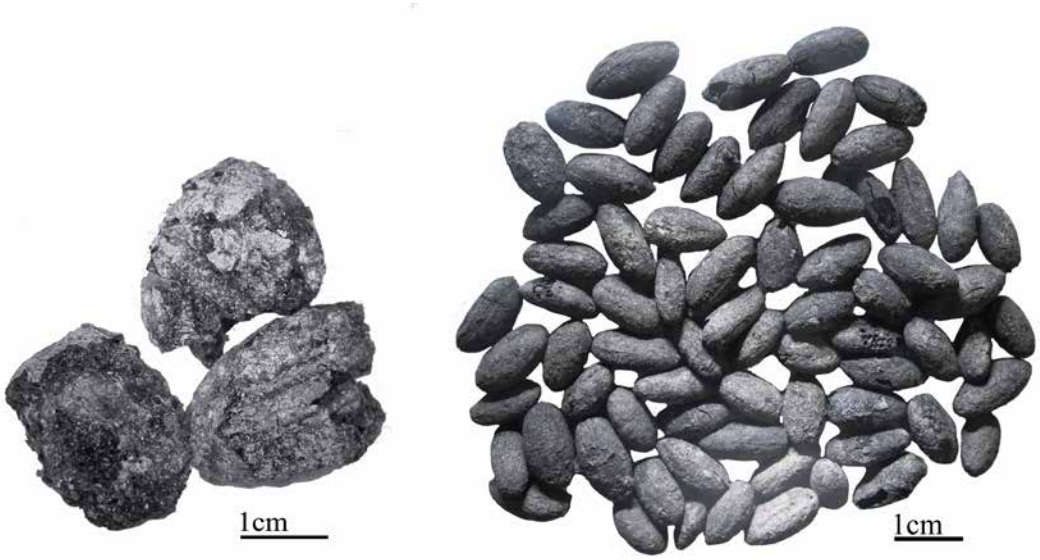

Figure 8. Charred Cornelian cherry fruits and fruit stones from Divlje Polje (photo taken by Đurđa Obradović).

distorts the proportions, as the number of hazelnut fragments does not equate to the number of whole items, impeding a direct comparison of the results between different categories or taxa. This will be addressed in the detailed analysis that is to follow; for now, it prevents fully quantitative considerations. Second, most of the fruits and nuts originate from a single context (Pit 5), indicating specific activities and deposition of the remains in this pit, which cannot be taken as an indicator of the overall importance of wild-gathered plants in the diet. The context is associated with food preparation and discard – a fire pit that was used briefly before being infilled. Therefore, this relatively short episode does not necessary reflect general and long-term procurement strategies. Another factor is the poor preservation and low number of remains in contexts other than Pit 5, where the density of plant remains ranges from less than one to two remains per litre (**Table 1**). Although crop remains were found in every pit, the quantity, especially of chaff of hulled wheats, is lower than in the majority of well-sampled Vinča sites. The limited presence of crop remains, with the exception of flax, is likely due to specific processing and discard activities in this area of the site or differential preservation conditions, rather than a reflection of a restricted use of cultivated plants. Since the structure of the single context affects the overall result, ubiquity, rather than the absolute number of remains, is a better indicator of the role of crops and wild plants in the diet and economy. Thus, while the structure of the Divlje Polje assemblage differs from those of other contemporary sites, there is sufficient evidence to suggest that the inhabitants practiced a similar mixed economy, relying on both crop husbandry and the gathering of wild resources. The fact that there is a greater presence of wild fruits and nuts in the Divlje Polje assemblage does not imply that the wild resources were any more or less important than cultivated plant foods.

Finding such a large amount of wild fruit taxa at Divlje Polje, including a variety of species, is a particularly rare and valuable find. Few comparative examples exist from Vinča sites. At the eponymous site of Vinča-Belo Brdo, wild fruits were discovered inside burnt buildings – wild pears, elderberries, sloe, Cornelian cherry, and water chestnut, with wild pears being particularly abundant, totalling nearly one hundred (Borojević *et al*. 2020; Filipović, Marić and Tasić 2023). At Pavlovac-Gumnište, numerous seeds of bladder cherry, elderberry, and bramble were found in open-air fireplaces (Обрадовић 2020). There are also reports of crab apple concentration near an oven at the site of Gomolava (Van Zeist 2001/2002) and a cache of bladder cherry seeds in an ashy deposit at Pločnik (Filipović 2021b). All these findings provide evidence of deliberate wild fruit gathering, with some sites indicating storage practices (e.g., Vinča-Belo Brdo) and potential processing activities, such as drying of wild pears and crab apples (e.g., Vinča-Belo Brdo and Gomolava). Across all sites, a more or less similar repertoire of species is represented, with the exception of water chestnut, whose use was limited to settlements located near its natural habitat. *Trapa natans* has been documented at the Neolithic sites of Opovo, Gomolava and Vinča-Belo Brdo (Borojević 2006; Van Zeist 2001/2002; Filipović *et al*. 2019). At Gomolava and Vinča-Belo Brdo, only a few fragments were found, in contrast to Opovo, where more than 350 fragments were discovered. Given the abundance and ubiquity of findings at Opovo, Borojević suggested that water chestnut may have played an important role in the diet, especially during years of poor crop yields (Borojević 2006, 2009).

In the case of Divlje Polje, the two most ubiquitous and abundant wild fruits are hazelnut and Cornelian cherry. It has been suggested that Cornelian cherry trees may have been managed (Borojević 2006: 139). Whether this management involved intentional clearing of woodland to promote the growth of these light-loving trees or was a by-product of agricultural expansion is unclear, but it appears that Cornelian cherry fruit were regularly consumed during the Neolithic and the trees were a common element of the vegetation around the sites. The findings from Divlje Polje may support this idea, but it would be both beneficial and necessary to develop a more nuanced reconstruction of the palaeovegetation using other proxies (such as pollen and wood charcoal).

The charred hazelnut shells from Divlje Polje represent the largest such deposit recorded in the Neolithic of the Central Balkans. Although hazelnut shells have been identified at other Vinča

sites, they were not found in large quantities. At Pločnik, only two hazelnut shell fragments were recorded (Filipović 2021b: Table 1, 410), while there were 13 at Belovode (Filipović 2021a: Table 1, 239) and 20 at Potporanj (de Vareilles Sommières 2017: Table 1.6). The results from Selevac were reported as a percentage ubiquity, with hazelnut shells occurring in 8% of the 47 samples (McLarren and Hubbard 1990: Table 7.3); no further details were provided regarding the level of fragmentation or the quantity of hazelnuts in those samples. The scarcity of hazelnut finds in this region is surprising, given their frequent recovery from prehistoric sites in western and northern Europe, where they are even considered a staple food in early prehistory (e.g., Bishop 2019). Their absence or low quantities cannot be attributed to unavailability, as the presence of hazel has been documented through charcoal or pollen remains (Filipović, Challinor and Andrič 2017: Table 2). This may suggest that hazelnuts did not hold the same value for prehistoric communities in the Balkans as they did in other regions of Europe, or that they were consumed exclusively raw, thus avoiding the charring process. It is possible that hazelnuts were valued by the inhabitants of Divlje Polje for their long shelf life and high caloric content, serving as a critical resource during times of scarcity. Alternatively, the large quantity of charred remains may result from heat treatment, such as roasting, prior to consumption. While it is possible that hazelnut shells were simply discarded into the fire, roasting would have intentionally enhanced their flavour and improved their preservation, thus increasing their representation in the charred plant record.

The diversity of wild-gathered plants from various habitats at Divlje Polje indicates a good knowledge of wild resources and intensive procurement activities by its Neolithic inhabitants, while also providing the first insights into the vegetation surrounding the settlement. Most of the gathered taxa grow along woodland edges and in forest clearings/open spaces, while some, like grapes, point to the presence of riparian forests and moist soils, which may have existed along both rivers. The current vegetation of the site seems quite different, as it is now a densely populated area with houses surrounded by small gardens and fields along the edge of villages. In the context of these environmental changes, the finds of water chestnut warrant further investigation. *Trapa natans* is an annual floating-leaved macrophyte that thrives in stagnant and slow-running, usually eutrophic, water basins. It is particularly well-developed in warm ponds and oxbow lakes. The presence of water chestnut this far south is quite unexpected, as it has been documented primarily in the Vojvodina province, both in prehistoric times and today (Janković i Blaženčić 1973; Borojević 2006; Filipović *et al.* 2019). Outside Vojvodina, the now-extinct *Trapa annosa* used to grow in the Ostrikovac pond (Jovac village, near Ćuprija), an old meander of the Great Morava river (Janković i Blažetić 1973). Its relatively recent spread in the Danube Gorges and the Međuvršje reservoir on the West Morava river is linked to the construction of dams, which have altered local ecosystems and created favourable conditions for the growth of water chestnut (Marković, Vićentijević-Marković and Tanasković 2015; Marković, Brković and Đelić 2021; Šinžar-Sekulić and Tanasković 2018). The disappearance or invasive spread of this species is closely related to environmental, climatic and anthropogenic factors. Therefore, the discovery of *Trapa* remains at Divlje Polje is important for studying the history of water chestnut and the alterations in waterscapes and climate over time. We can assume that water chestnut thrived in the area near the Late Neolithic settlement of Divlje Polje, but identifying possible locations of its growth requires more research.

CONCLUSION

The unexpectedly well-preserved and abundant remains of charred fruits and nuts found at Divlje Polje have initiated a discussion about the significance of wild resources in the diet of Late Neolithic farmers. Typically underrepresented in the charred record due to their minimal or non-existent processing involving fire, wild plants have often been overlooked in research. Although the charring process in this case was favourable, attempts to reconstruct the relative importance of wild plant foods remains challenging.

The extraordinary finds from Pit 5 offered valuable insights into the diversity of procured wild fruits and the variability of the environment and vegetation surrounding the settlement. Since

the analysis of the macrobotanical assemblage is ongoing, a fuller understanding of the range of gathered plants and a more nuanced view of past vegetation are still forthcoming.

The growing corpus of archaeobotanical data from this region, combined with the development of new methodologies, is advancing our understanding of how plant foods were processed and consumed. Historical records and recent ethnoarchaeological studies have shed light on various methods of fruit consumption, including roasting, drying, pressing, cooking, and fermentation. Although records remain patchy, there are indications of potential fruit drying practices for wild pears and apples at sites like Vinča-Belo Brdo and Gomolava, as well as the possible roasting of hazelnuts at Divlje Polje. Given that various treatments of plants can significantly alter taste, extend storage life, and create valuable commodities (e.g., wine or other (non)alcoholic beverages), the remains of gathered fruits and nuts certainly warrant further investigation.

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REZIME

ISTRAŽIVANJE UPOTREBE DIVLJEG VOĆA U ISHRANI NA PRIMERU KASNONEOLITSKOG NALAZIŠTA DIVLJE POLJE – RATINA

KLJUČNE REČI: DIVLJE SAKUPLJANE BILJKE, KASNI NEOLIT, VINČANSKA KULTURA, DIVLJE POLJE – RATINA, CENTRALNI BALKAN, ZAŠTITNA ISKOPAVANJA

Dobro očuvani i brojni ostaci voća i orašastih plodova pronađeni na lokalitetu Divlje Polje podstakli su istraživanje značaja divljih resursa u ishrani neolitskih zemljoradnika. Divlje biljke su slabo zastupljene na nalazištima gde je primarni način očuvanja ugljenisanje, jer se plodovi obično konzumiraju sirovi, bez termičke obrade. Sasvim iznenađujuće, ostaci divljeg voća sa ovog nalazišta bili su brojniji od gajenih vrsta. Detaljna analiza brojnosti, učestalosti, načina formiranja arheobotaničke zbirke i konteksta nalaza ukazala je koliko moramo biti oprezni pri interpretaciji, te da sama procentualna zastupljenost ne ukazuje i nužno da su divlje biljke imale značajniju ulogu na Divljem Polju nego na drugim istovremenim naseljima.

Pronađeni su ostaci devet vrsta divljih voćki: drenjine, lešnika, vučje jabučice, divljeg grožđa, divlje kupine/maline, zove, divlje jabuke/kruške, šumske jagode, vodenog oraška, među kojima su tri prvonavedene najbrojnije i najčešće. S obzirom na brojnost nalaza ljuski lešnika u odnosu na ostatke drugih vrsta na ovom nalazištu, kao i u odnosu na druga istovremena nalazišta, postavlja se pitanje da li je to posledica naročitih preferencija stanovnika Divljeg Polja ili je brojnost rezultat drugačijeg načina pripremanja hrane – pečenja lešnika. Iako su pronađena samo dva fragmenta vodenog oraška, ovaj nalaz je od izuzetnog značaja, jer do sada nije bilo podataka da je ova vrsta rasla u ovoj oblasti; svi do sada poznati nalazi vodenog oraška iz neolitskog perioda se vezuju za sever Srbije, prvenstveno regiju Vojvodine.

Prikupljanje raznovrsnih biljaka iz različitih habitata ukazuje da su neolitski stanovnici Divljeg Polja vrlo dobro poznavali neposredno okruženje i na intenzivne prakse sakupljanja divljeg voća. Osim što su doprineli razumevanju raznovrsnosti ishrane u prošlosti, ostaci divljih biljaka pružili su važne podatke o izgledu paleovegetacije.

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Use of tools based on large language models and generative AI: ChatGPT (initial proofreading); Grammarly (initial proofreading).

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GEOMAGNETIC SURVEYS AND ARCHAEOLOGICAL EXCAVATIONS OF TWO PREHISTORIC SITES IN NORTH--WESTERN SERBIA: PRELIMINARY RESULTS AND NEW METHODOLOGICAL QUESTIONS[1]

ABSTRACT

The study is based on the geomagnetic prospection and subsequent archaeological excavations of two prehistoric sites in north-western Serbia, the sites of Spasovine and Cikote. Comparing prospection and excavation results provides an insight into the advantages and limitations of geomagnetic prospection in the aforementioned territory. At the site of Spasovine, where geomagnetic prospection pinpointed two archaeological features, those features have proved to be the remains of burnt Late Neolithic/Early Eneolithic dwellings containing a large amount of portable archaeological material and architectural elements, all with traces of burning. At the Bronze/Iron Age site of Cikote, geomagnetic prospection yielded positive, yet significantly lower, values concerning the possible archaeological features, but was able to identify a burnt rampart dated to the transitional period between the Bronze Age and Iron Age. The excavations did not register any remains of possible Bronze Age dwellings. The study supports the conclusion that the character of the Late Neolithic/Early Eneolithic architecture likely differs from that of the Late Bronze Age, the latter being more superficial and of lighter construction. Thus, the complete absence of preserved Late Bronze Age settlements in north-western Serbia may be explained by the poor preservation potential of Bronze Age settlements.

KEYWORDS: GEOMAGNETIC PROSPECTION, EXCAVATIONS, DWELLINGS, LATE NEOLITHIC/ EARLY ENEOLITHIC, LATE BRONZE AGE, NORTH-WESTERN SERBIA.

[1] The authors would like to dedicate this paper to our dear friend and colleague Aleksandar Veljanović, who passed away far too early.

INTRODUCTION

For more than 70 years, one of the key archaeological problems of north-western Serbia has been the complete lack of settlements and settling locations that could be connected with a number of the rich Late Bronze Age (1450-1100 BC) mound necropolises in the wider region (Булатовић *et al*. 2017: 53-54).[1] In addition to the decade-long surveys, new isotopic research has confirmed that tin in the bronze objects from the aforementioned necropolises most likely originate from placer deposits on the south-eastern slopes of Mt. Cer (Bankoff *et al*. 2013; Huska *et al*. 2014; Mason *et al*. 2016; Powell *et al*. 2018; Mason *et al*. 2020; Powell *et al*. 2020). Given that numerous sites recorded and excavated in the course of the Jadar project[2] failed to confirm the existence of a period-related settlement, geomagnetic prospection was undertaken in 2018 on two sites that have so far displayed the highest potential of containing remains of residential structures. The potential is based on the results of surveys at the site of Spasovine and small-scale excavations at the site of Cikote.[3] Both of the sites are located in western Serbia, which represents the primary area of interest for the Jadar project. The sites in question are the prehistoric settlement of Spasovine and the Cikote hillfort (**Figure 1**), which were excavated in two successive field campaigns, in 2018 and 2019.[4]

The main goal of this paper is to compare the results of geomagnetic measurements with the results of subsequent archaeological excavations. The paper will, therefore, provide relevant data on different parameters (dimensions, depths, amount of archaeological material, the degree of burning, etc.), in order to present a solid comparison between the measurements and excavations. Such an approach will inform future geomagnetic surveys in the area, as well as highlight potential archaeological features and remains on the site during the subsequent archaeological excavations.

MATERIALS AND METHODS

Magnetometry is a proven method for the detection of buried archaeological features from different periods. Although such methods have long been utilised in archaeology, services based on remote sensing have become more available in Serbia in the last decades.[5] The increased pace of rescue archaeological excavations in Serbia have provided the means for the acquirement of new equipment and training of experts in the field of remote sensing.[6]

The equipment used for the prospection of the sites of Spasovine and Cikote was the fluxgate gradiometer FM256 with sensitivity 0.1 nanoTesla (nT), made by the Geoscan Research Company. The corners of the surveyed areas were georeferenced using a Trimble Pathfinder ProXT GPS receiver with sub-meter precision. All survey areas were measured using a sampling interval of 1 x 0.25 m and subsequently interpolated to a grid of 0.25 x 0.25 m. GeoPlot software was used for data downloading and processing, and Surfer software for interpolation, using the Nearest Neighbour method. The results are displayed in a range from -10 to 10 nT for better visibility. Projection to the map was done using ArcGIS software.

The geomagnetic surveys on both sites were conducted using the same equipment and settings, the same operators, and under identical atmospheric conditions across a three-day period.

[1] The results of the archaeological research of the Late Bronze Age necropolis in north-western Serbia were collected and presented in Филиповић 2013, offering interpretation accepted today.

[2] Joint multidisciplinary international project *Archaeological Investigations of the Settlement Systems, Burial Customs, and Mining Resources in the Bronze Age of Northwestern Serbia*, which was realised by the Institute of Archaeology in Belgrade, Serbia, and Brooklyn College CUNY from New York, USA.

[3] *Cf.* Bankoff *et al.* 2013, 61-65; Булатовић *et al.* 2017.

[4] The authors would like to thank colleagues Rada Gligorić, Jasminka Bogić, Mirko Vranić, and Nikolina Manojlović who were members of the excavation team. Our thanks also go to Sofija Krstić, Lazar Marković and Andrej Zlatović.

[5] *Cf.* Bogdanović 2009; Milošević *et al.* 2011; Филиповић 2013, with complete cited literature; Medović *et al.* 2014; Horejs *et al.* 2018; Ninčić 2023.

[6] The longest continuous tradition of using geophysical methods in archaeology in Serbia can be connected with the company Center for New Technology Viminacium, and research conducted in Viminacium *Cf.* Korać i dr. 2006; Bogdanović 2009; Miletić i Miletić 2012; Korać 2019: 71–100.

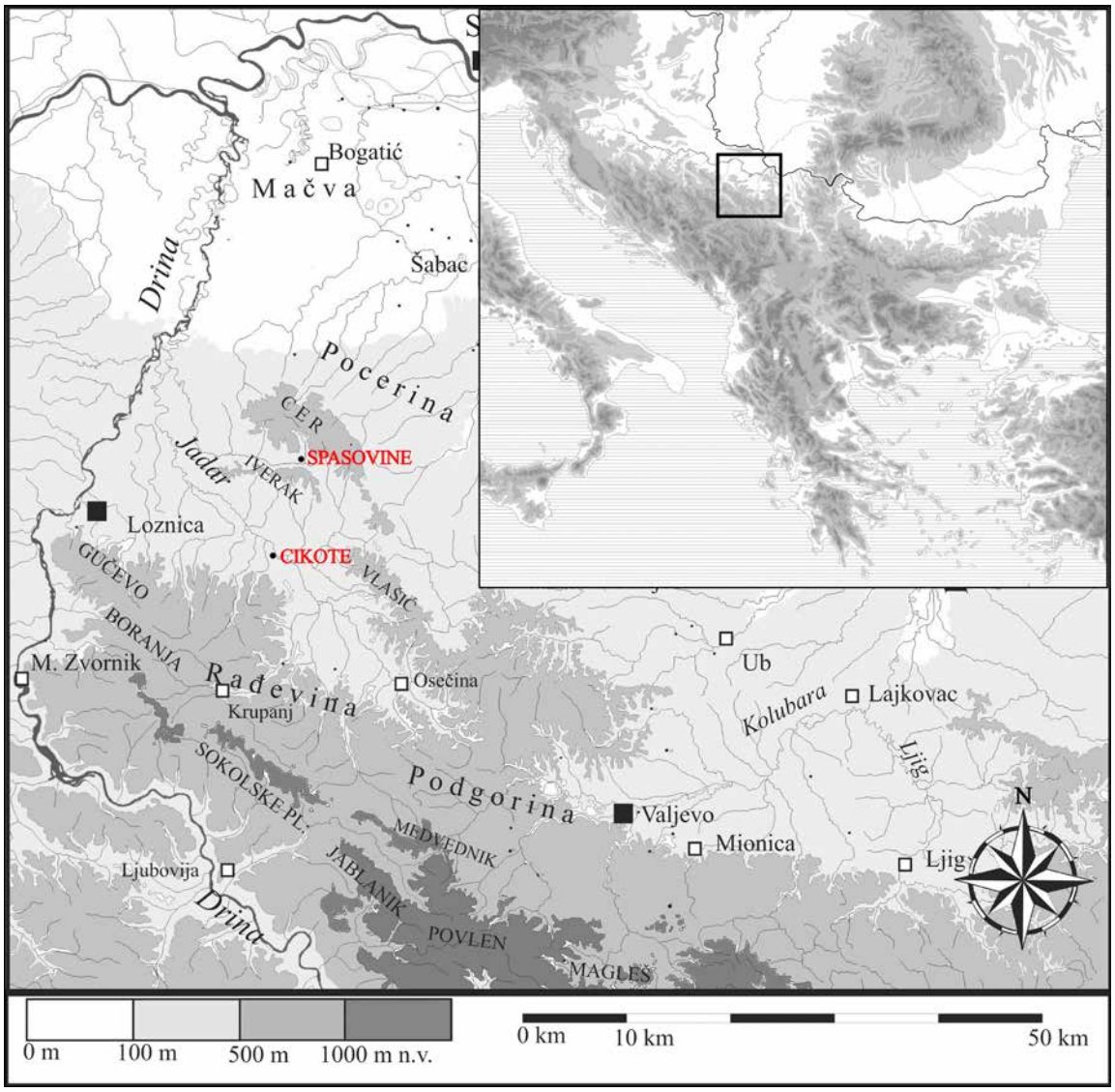

Figure 1. Location of Spasovine and Cikote sites in north-western Serbia (map modified from Филиповић 2015).

SPASOVINE SITE - RESEARCH RESULTS

The site of Spasovine is located in the village of Milina in the Mačva region of north-western Serbia (**Figure 1**). The site itself is positioned on a gentle slope of the right bank of the Milinska river, which flows from Mt. Cer (44.34'36"N, 19.27'60"E) (**Figure 2**). The first archaeological survey and test excavations of the site were conducted during the 2010 and 2011 campaigns. A total of five test trenches were excavated on those occasions, providing the basic chronological, cultural, and stylistic and typological determination of the site (Bankoff *et al*. 2013: 63).

Scarce finds of potsherds, chunks of daub, lithics and several finds indicative prehistoric metallurgy (a fragment of a stone mould, crucible fragments with vitreous coatings or metallic crusts) (Huska *et al*. 2014: 485-487; Pacifico *et al*. 2022), were all recorded either on the surface or exclusively in the upper layers, and their surface distribution was recorded within an area of approximately 5 hectares. Based on the stylistic and typological characteristics of the potsherds, the site was preliminarily dated to the Early Eneolithic and the Bronze Age (Булатовић *et al*. 2017: 213-214), as well as to the Roman period. In 2018, a geomagnetic scanning of several sites

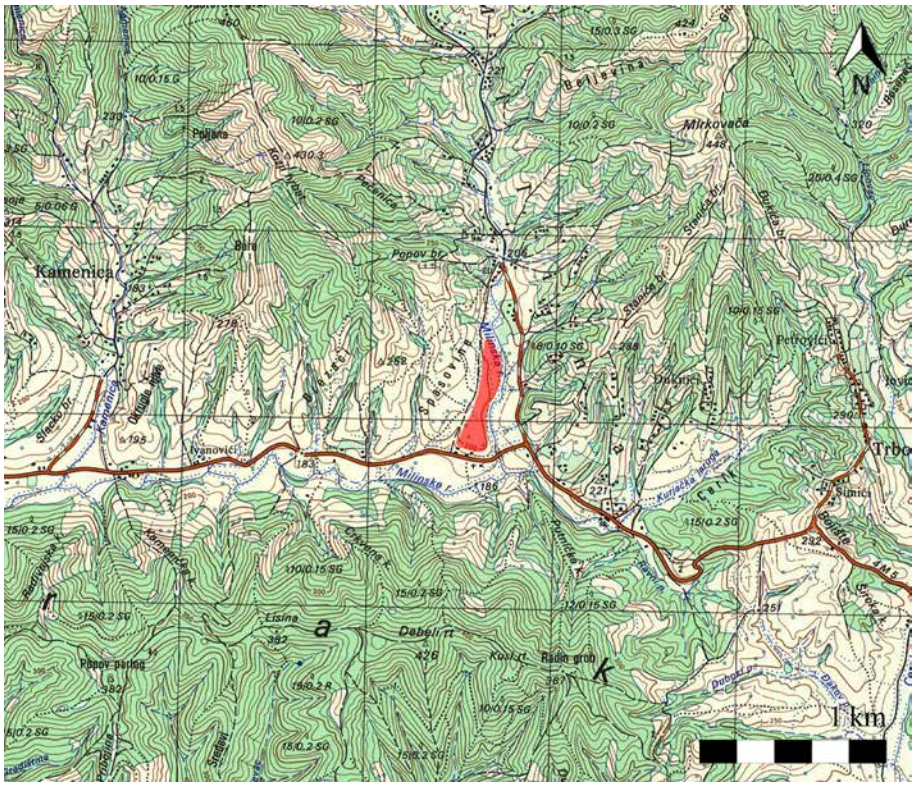

Figure 2. Position of the site of Spasovine (marking by the authors on the topographic map of Serbia 1:25,000).

in north-western Serbia,[7] including the site of Spasovine, was conducted.[8] Due to the promising results of the scanning at the site of Spasovine, two archaeological trenches were subsequently excavated (trenches 1/18 and 2/18). Both trenches yielded archaeological features and archaeological material (potsherds, daub, and lithics), which, once again, confirmed the existence of the Late Neolithic/Early Eneolithic horizon at the site.

Geomagnetic prospection

An area of about 1 ha was measured using magnetometry at the site of Spasovine in June 2018. Two clusters of significant magnetic anomalies, designated as sites A and B, were identified (**Figure 3**). At site A, two anomalies were recorded. The larger one reached positive values of up to 62 nT in its centre, suggesting the presence of metal or heavily burned material since most prehistoric sunken features do not exceed 5 – 10 nT. The feature was later excavated in trench 1/18 (**Figure 4**).

Site B consists of two rectangular features oriented in a southwest/northeast direction. These features reached magnetic values of 10 – 15 nT. The smaller part of the northernmost feature was later excavated in trench 2/18 (**Figure 5**). Both features can be preliminarily interpreted as remains of semi-sunken houses. Other less magnetic rectangular structures have been recorded in the space between the semi-sunken houses, matching their size proportions (the northern one is smaller than the southern one). In this case, they could be the remains of above-ground dwellings.

[7] The geomagnetic scanning was carried out by J. John and O. Chvojka from the Faculty of Arts, University of South Bohemia in České Budějovice, Czech Republic.

[8] All of the scanned sites were previously researched within the aforementioned project, either by archaeological prospection or archaeological excavations. For a detailed overview of researched sites refer to: Bankoff *et al.*, 2013, Filipović, 2013, Huska *et al.*, 2014, Булатовић *et al.*, 2017, Bulatović *et al.*, 2018.

Figure 3: Prospected areas at the site of Spasovine (overlaying the results with the Google Earth photo).

Excavations

Trench 1/18 (Spasovine). The trench was laid out in order to encompass the entire anomaly previously recorded by the geomagnetic survey (**Figure 6**). The dimensions of the trench were 5 x 5 m, and the orientation was north-south. Surface finds, comprised solely of lumps of burnt daub, indicated the existence of larger lumps of daub beneath the surface.[9] After the removal of the surface layer with vegetation and recent soil, chunks of burnt daub, larger than those on the surface, were recorded in a layer of compact greyish soil. Further excavation led to the discovery of an area comprised of burnt red soil, burnt stone, and large lumps of burnt and shaped daub. This area was marked as Feature 1. Most of the feature was positioned in the northern and north-western portion of the trench and had an irregular circular shape. The feature was shallow and narrowed towards a circular bottom. The borders of the feature were defined by sterile compact yellow soil (virgin soil), in which the feature was buried. In terms of borders, the south-eastern border of the feature was hard to define, as the boundary between the red burnt soil and compact yellow soil was not sharply defined and, therefore, the south-eastern portion of Feature 1 was marked as Feature 2. This feature could either represent archaeological material that eroded from Feature 1 or another individual feature.[10] The internal stratigraphy of Feature 1 is comprised of two distinct layers. A 10-30 cm thick layer of burnt red soil mixed with a considerable number of large lumps of daub with imprints of wattle and wooden beams. This layer yielded some prehistoric pottery, chipped stone tools, fragments of a grindstone, and a weight made of baked clay. Beneath this layer, a thin layer comprised of ash and soot was recorded in the north-western, central, and southern portions of the feature. This layer contained numerous prehistoric potsherds, of which some belong to the same vessels. A small pit (post hole?), with a diameter of 12 cm, filled with soot, was recorded within the south-western portion of the layer.

Trench 2/18 (Spasovine). This trench was laid out east of Trench 1/18, on a slight slope above the right bank of the Milinska river, covering a part of the recorded anomaly (**Figure 7**). The dimensions of the trench were 5 x 3 m, and the orientation was east-west.[11] The vertical stratigraphy was composed of the surface layer, with sporadic finds of prehistoric pottery, followed by a 25-40 cm thick layer of loose brown soil with prehistoric pottery and chipped stone artifacts. This layer lay directly above a layer of compact yellow soil (virgin soil). An area (pit) that penetrated the northern and eastern cross-section in the north--western corner of the excavated portion of the trench, buried into the virgin soil, was comprised of loose brown soil mixed with prehistoric pottery, burnt daub, and pebbles. This area was marked as Feature 3. The western border of the feature was defined by large stones and daub, and the southern border was defined by burnt daub

[9] The area in which the trench was laid out is cultivated and, therefore, the surface finds were brought to the surface by constant ploughing.

[10] The terrain on which the trench was laid out is quite steep, and the idea of erosion from higher ground seems highly plausible.

[11] Due to several factors, including the number of professional archaeologists, and time limits, only the eastern half of the trench was excavated.

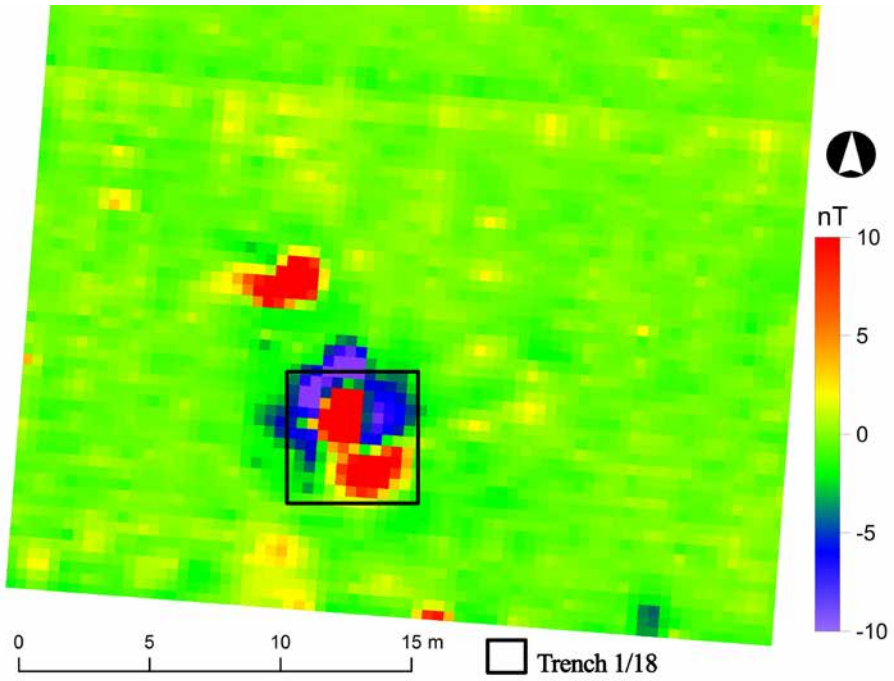

Figure 4. Results of prospection and the outline of Trench 1/18.

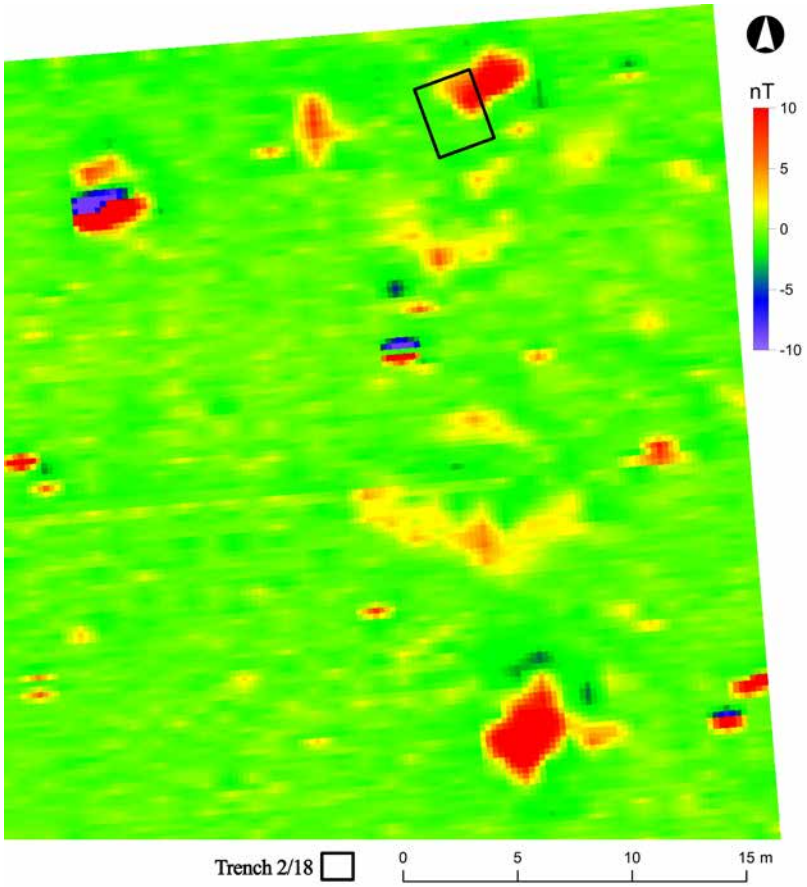

Figure 5. Results of prospection and the outline of Trench 2/18.

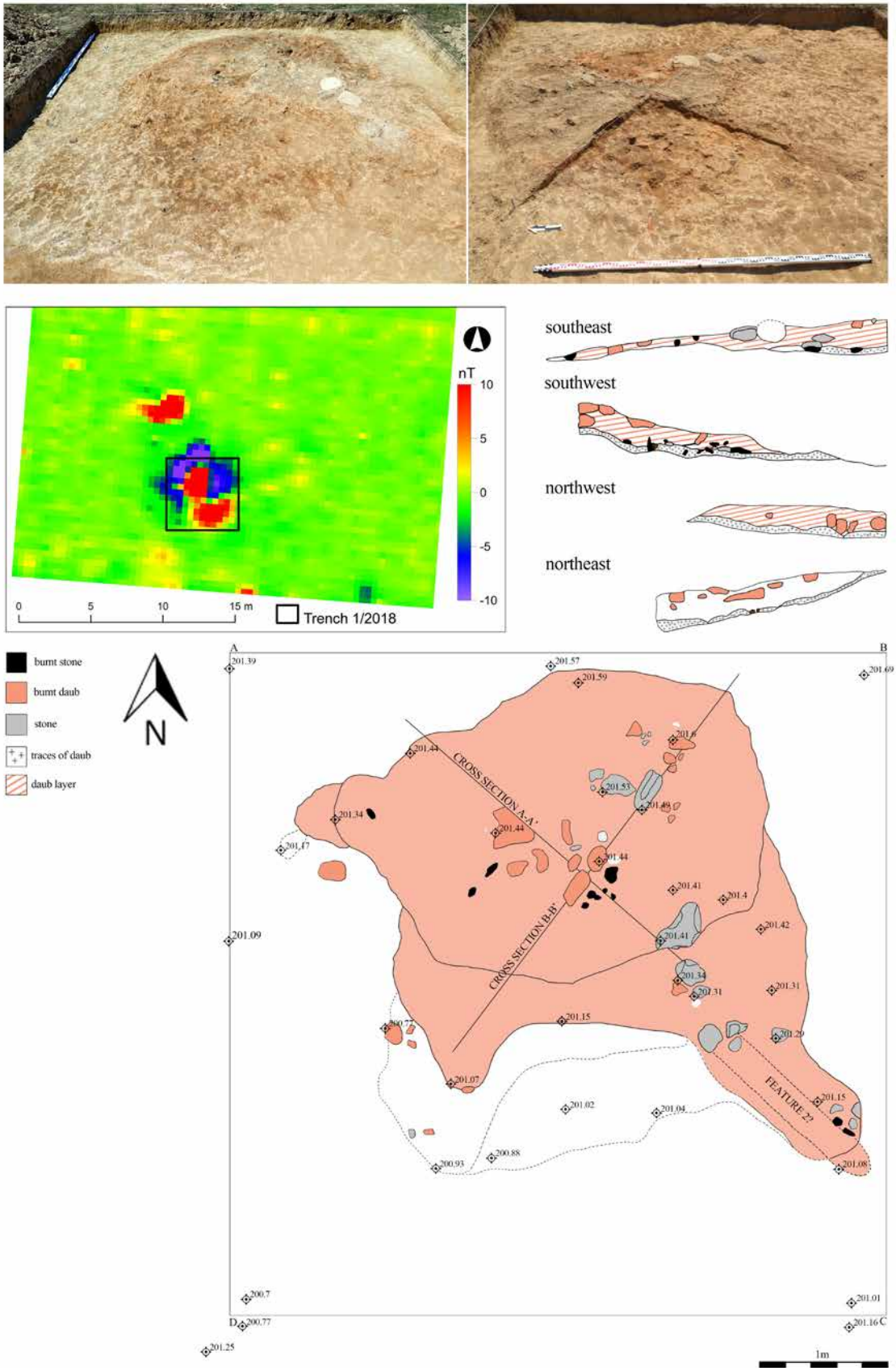

Figure 6. Composite representation of Trench 1/18 (drawings and photo by the authors).

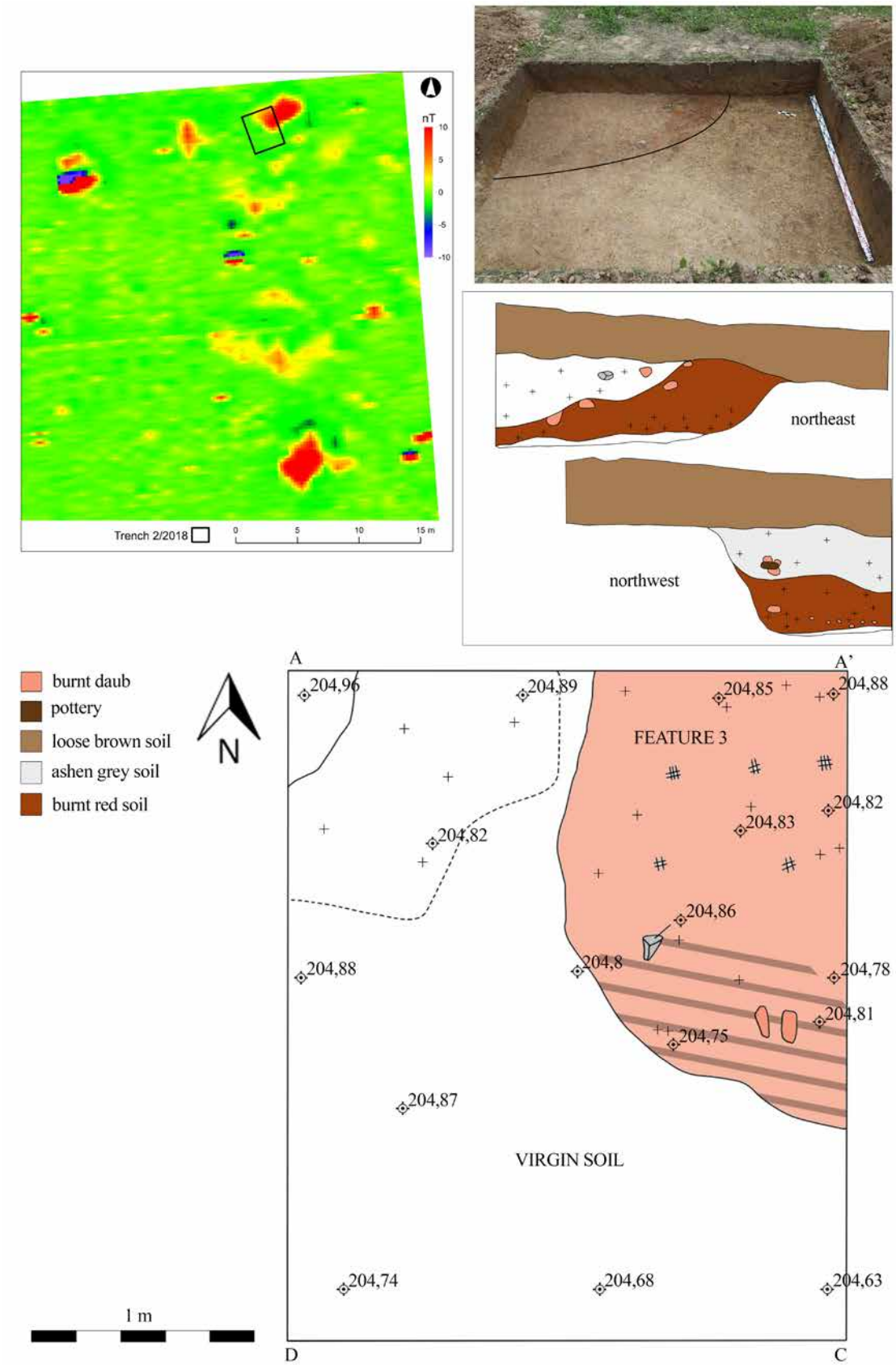

Figure 7. Composite representation of Trench 2/18 (drawings and photos by the authors).

and burnt red soil. The shape of the excavated portion of the feature was irregularly elongated, in a north-south orientation.[12] The infill of the pit was comprised of several distinct layers. First, a layer of loose brown soil with larger fragments of prehistoric pottery, lumps of daub, soot, and pebbles in the central part, which represents the continuation of the previously described layer that occurs throughout the trench. Beneath this layer, a 40 cm thick layer of loose ashen grey soil was recorded. This layer contained larger fragments of prehistoric pottery, traces of soot, and carbonised wood, while chipped stone tools, a grindstone, and a spindle whorl made of baked clay were also recorded in it. This layer is followed by a 20-40 cm thick layer of burnt red soil mixed with large lumps of burnt and shaped daub. The layer of burnt red soil lies directly on virgin soil. The pit narrowed towards the bottom, and the total depth was around 80 cm.

The portable archaeological material recorded during the excavations of the Spasovine site comprised primarily of potsherds, chipped stone tools, and other objects of everyday use, which were made of stone and baked clay. The stylistic and typological characteristics of the potsherds have provided us with a relative chronological span of the features excavated during the 2018 campaign. Biconical bowls with an inverted rim, decorated with button-shaped applications and small tongue-shaped handles, a conical plate with a semi-circular thickened inner side of the rim, a beaker with small arched handles in line with the rim and numerous tunnel-shaped and large arched handles indicate that the excavated features at the site of Spasovine should be attributed to the so-called Benska Bara III phase (Трбуховић и Васиљевић 1983), meaning the Late Neolithic/ Early Eneolithic of western Serbia (Mladenović i dr. 2021) or the transitional phase/horizon from the Late Neolithic to the Early Eneolithic (Bulatović *et al.* 2020). Based on the absolute date acquired from charcoal from Feature 3, which is 5706 ±25 BP, meaning 4561-4411 calBC (with a probability of 95.4%) or 4528–4444 calBC (with the probability of 68.2%),[13] this object can be dated to a period covering the mid-5th millennium BC (Bulatović *et al*. 2020).

CIKOTE HILLFORT (GRADAC, CIKOTSKI GRADAC, MALI GRADAC) - RESEARCH RESULTS

The Cikote hillfort is located in the eponymous village of Cikote (Vasiljević 1980), some 17 km by air from the city of Loznica (**Figure 1**). The site is located in the eastern portion of the village, on a dominant and difficult to access plateau with an elevation of between 300 and 307 m and an area of approximately 5 hectares (N44°29.343‘E19°25.432‘) (**Figure 8**). Archaeological excavations, which have been continuously conducted since 2014, were concentrated on the south-eastern fringe of the site, where a series of trenches have confirmed the existence of a rampart made of stone and wood (Булатовић *et al*. 2017: 64, fig. 47). A defensive platform more than 5 m wide, positioned at the entrance to the site, which continues into the rampart, is located on the most accessible side of the site. A shallow trench with a width of around 5 m is located in front of the platform. The stylistic and typological characteristics of the recorded archaeological material indicate that the hillfort was utilised during the Late Bronze Age, the so-called Transitional Period[14] and the Roman Period (Булатовић *et al*. 2017: 259–262).

Geomagnetic prospection

A relatively small area of approximately 0.2 ha was measured using magnetometry in the sloping terrain of the site of Cikote, as other parts of the hillfort were inaccessible due to grown crops or forests (**Figure 9**). Two irregular anomalies reaching values of 4 nT were identified and both later excavated in the northern part of the measured area. These could have represented the remains of prehistoric features severely damaged by erosion or, alternatively, local changes in the geological subsoil.

[12] Approximately 1/4 of the pit was excavated in total.

[13] The AMS analysis was conducted by the University of Arizona AMS Laboratory in Tucson, USA, and the laboratory number of the sample is AA 113502.

[14] The absolute date acquired at the site falls within the Ha B period.

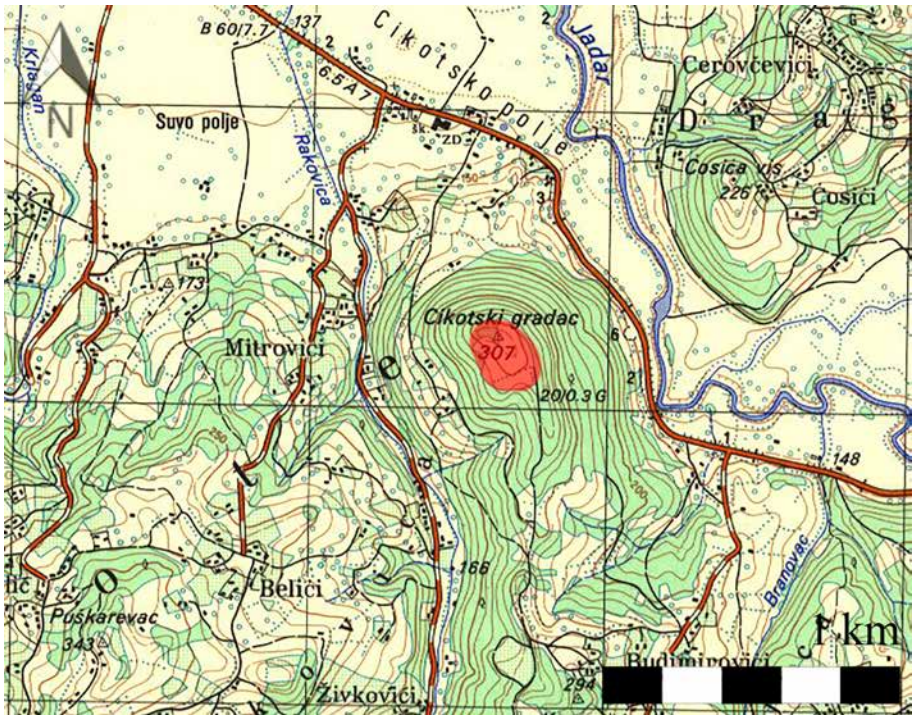

Figure 8. Position of the site of Cikote (marking by the authors on the topographic map of Serbia 1:25,000).

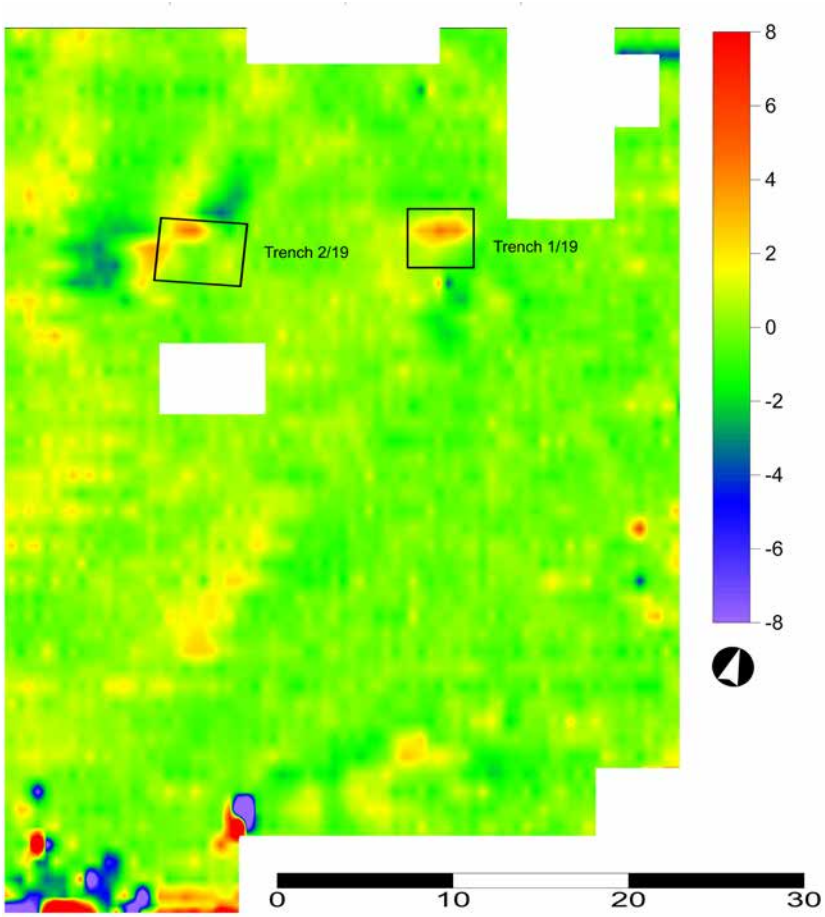

Figure 9. Results of prospection and the outline of trenches 1/19 and 2/19.

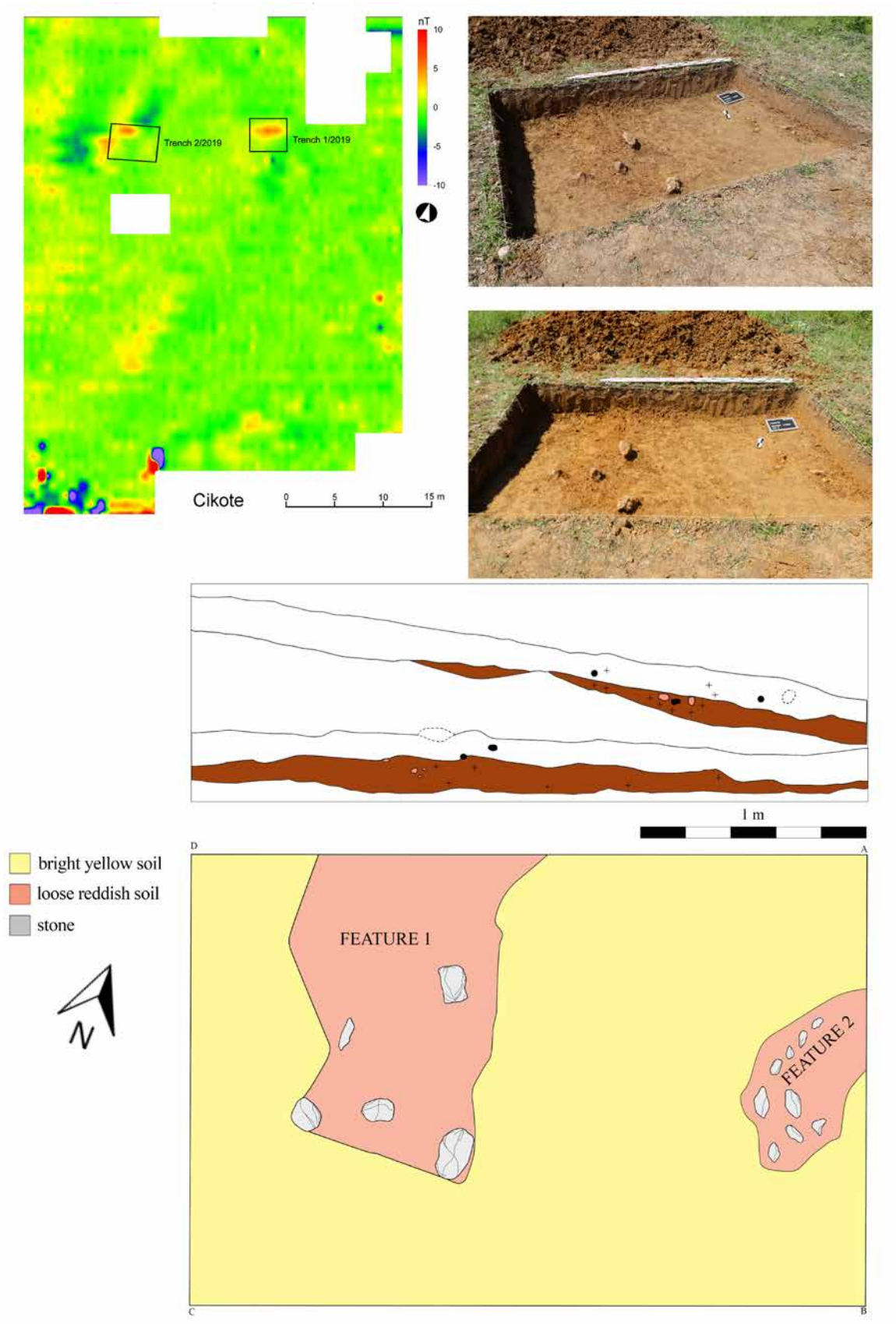

Figure 10. Composite representation of Trench 1/19 (drawings and photos by the authors).

Excavations

Trench 1/19 (Cikote). The 3 x 3 m trench covered the recorded anomaly in the eastern portion of the prospected area (**Figure 10**). It should be highlighted that the trench was located on a steep slope, which affected both the cultural layer and the finds. The vertical stratigraphy was comprised solely of a surface layer composed of bright yellowish soil, and compact yellowish virgin soil.[15] Two clusters of small and medium-sized rocks mixed with loose reddish soil were recorded within the layer of bright yellowish soil. One of the collections was recorded in the central part of the trench (Feature 1), and the other was located in the central line of the eastern portion of the trench (Feature 2). Both features lay directly on the aforementioned virgin soil, and no patterns were noted in terms of the position or internal structure of the stone collections. The layer contained small amounts of atypical prehistoric potsherds and stone flakes.

Trench 2/19 (Cikote). The trench was located several dozen meters west of Trench 1/19, in a position that covered one of the recorded anomalies (**Figure 11**). The trench measured 4 x 3 m. The vertical stratigraphy of the trench was similar to that recorded in Trench 1/19. A 20 and 35 cm thick layer of brown soil mixed with traces of daub and soot concentrated in certain areas was recorded beneath the surface layer. Two such areas, abundant in soot mixed with greyish soil, were marked as Feature 1 and Feature 1a. Feature 1 was located in the eastern portion of the trench and covered approximately one third of the total surface of the trench, and Feature 1a was located in the western portion of the trench, next to the south-western corner. Both features lay directly above the virgin soil. Sporadic potsherds and flakes were recorded in both features, as well as the layer of brown soil.

The portable archaeological material recorded at the Cikote hillfort during the 2019 campaign consists of sporadic potsherds and flakes. All of the recorded potsherds were hand-thrown, yet do not possess any of the stylistic or typological elements that could provide a relative chronological frame. Traces of erosion, such as rounded edges, were registered on all of the potsherds and, therefore, they may have been secondarily deposited into the trenches and originated from higher points of the site.

DISCUSSION OF THE RESEARCH RESULTS

At Spasovine, approximately 260 kg of daub covering an area of around 20 m^2 was recorded in Trench 1. Significantly, the area containing archaeological material is relatively shallow compared to the present level of terrain. According to the fragmentation of portable archaeological material, the impossibility of piecing together most of the potsherds, and clear traces of secondary burning of archaeological material, it is assumed that the area represents a waste disposal location containing the remains of a Late Neolithic/Early Eneolithic house burnt in a fire, which explains its depth.

In the geomagnetic image, photos, and drawings (**Figure 6**), the area of the anomaly is up to 1/3 larger than that of the excavations, but the shape of the anomaly almost completely corresponds to the results of the archaeological excavations. Therefore, it can be assumed that such a strong signal was the result of large quantities of burnt material concentrated in a small area and deposited at a relatively shallow depth under the current surface. The archaeological material was most likely deposited on a slight slope, possibly in a shallow pit, which would imply that the uppermost 20 cm constitutes pedological layering in the last 6,500 years. The configuration of terrain at the site, located on the slopes of Mt. Cer, prevents the formation of thicker pedological layers. Also, relatively poor pedological layering has been indicated by surface collected archaeological material in the past decade, which originates from the Late Neolithic/ Early Eneolithic to Late Antiquity.

In Trench 2/19 of the Cikote site, the geomagnetic image corresponds to the results of excavations, most likely due to the greater depth of the feature and the smaller concentration of daub. Based on the thick layer of shaped daub within the lower portion and a layer of ashen soil mixed with soot in the upper portion of Feature 3, the feature most likely represents a semi-sunken

[15] This corresponds to the virgin soil recorded during the previous excavations at the site.

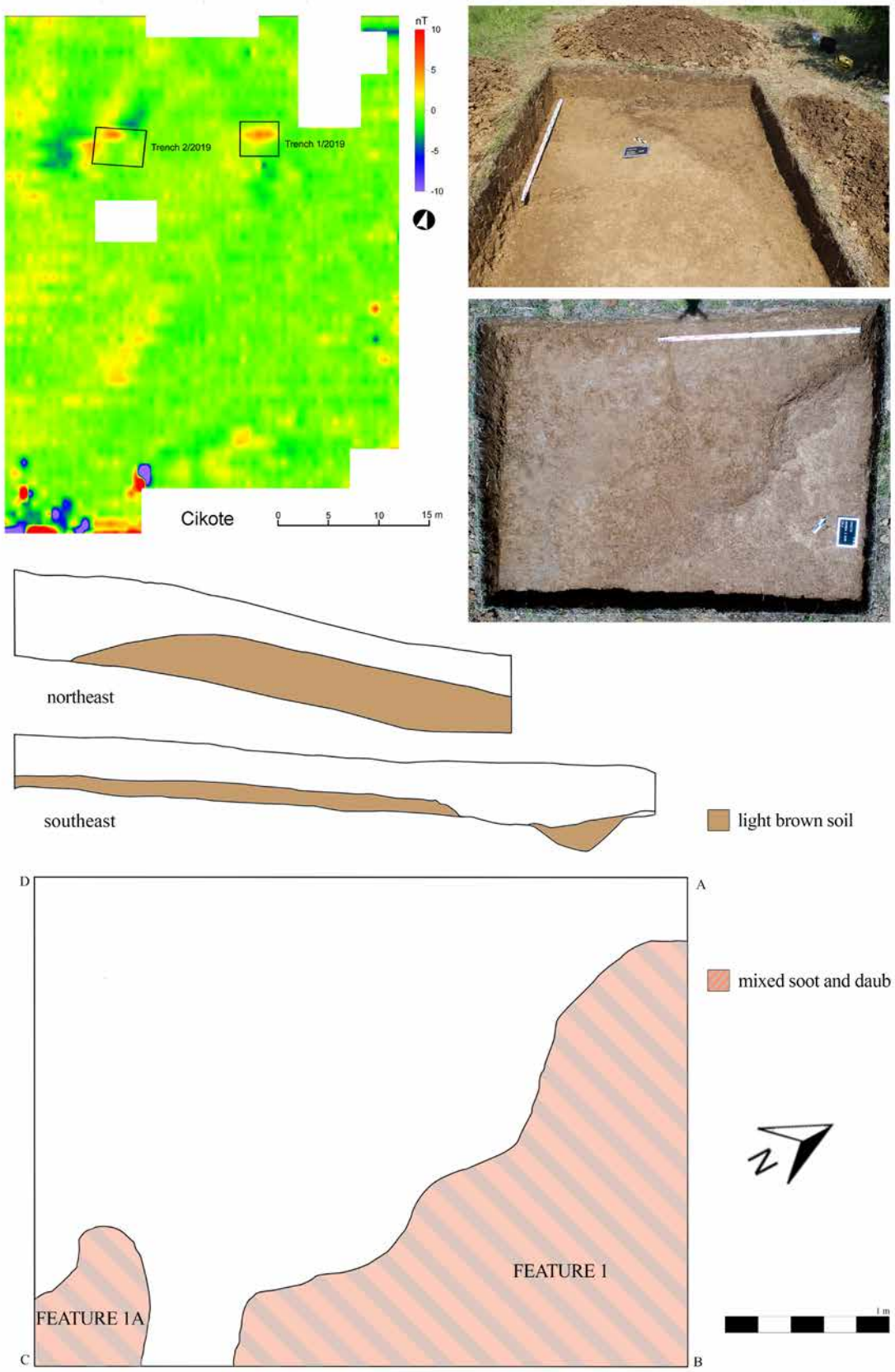

Figure 11. Composite representation of Trench 2/19 (drawings and photos by the authors).

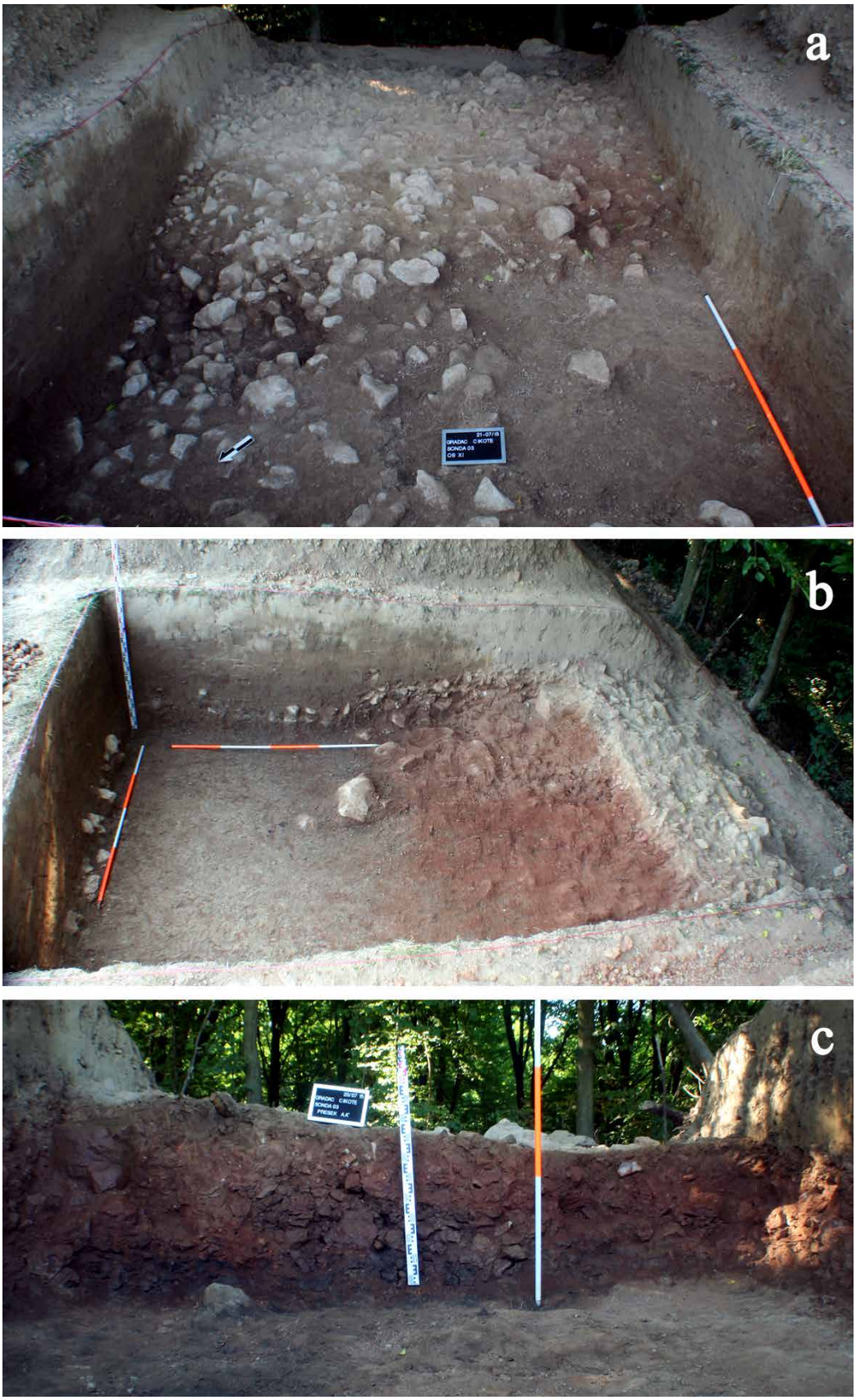

Figure 12. Burnt rampart at the site of Cikote (photos by the authors).

dwelling with the upper portion built using the wattle and daub technique.

Unfortunately, the results of the geomagnetic measurements from the site of Cikote were relatively poor. It is likely that the geological or pedological setting could have reduced the outcome of the geomagnetic signal at the site, or that the signal was influenced by some other source of interference.

Considering that the geomagnetic survey registered the remains of the stone rampart with wooden cassettes that was researched in 2014 and 2015 at Cikote (**Figure 12**) with positive values of up to 50 nT (**Figure 9**, SW corner), the poor signal cannot be attributed to potential disturbance factors. The wooden cassettes of the rampart were destroyed in a fire (**Figure 12c**). Based on the absolute dates from charcoal of 2950–2785 BP, (1000–835 calBC) with the probability of 70.8%,[16] the rampart can be dated to the first two centuries of the 1st millennium BC, i.e., to the transitional period between the Bronze Age and the Iron Age. The results of the geomagnetic measurements display a relatively good signal for the period-related object, which corresponds to the results of the burnt Late Neolithic/Early Eneolithic objects at the site of Spasovine.

On the other hand, detected and archaeologically excavated anomalies in trenches 1/19 and 2/19 indicate a certain amount of activity during the aforementioned period, which unfortunately cannot be properly interpreted and explained with the current degree of archaeological field methods.

An additional consideration of the presented results for both researched sites is that it seems the geomagnetic methods cannot adequately detect houses and settlements from the Late Bronze Age in north-western Serbia. This raises the question of a shift in settlement concepts, life, and residential architecture during the aforementioned period within the hilly-mountainous area of the Central Balkans. The Late Bronze Age and Early Iron Age residential architecture in the area remain practically unknown, and the rare examples are mostly located on slopes either beneath or within hillforts. Those represent light residential architecture, which, compared to the preceding periods, displays a reduction in construction quality and durability of the objects (Kapuran 2009: 129–142). Those are often dugouts of light construction or above-ground objects, whose archaeological traces and geomagnetic signature is different from that of the Neolithic and Eneolithic houses. Assuming residential objects and parts of settlements were intentionally burned as a part of social practices and beliefs of the Neolithic (Stevanović 1997: 387) and Eneolithic societies partially accounts for why geomagnetic surveys clearly and precisely register objects from those periods, which is the case with Spasovine and concurrent surrounding sites (Crnobrnja 2014: fig. 2; Perić *et al.* 2016: figs. 3, 5, 7, 9), while objects from later prehistoric periods remain invisible to geomagnetic measurements, at least in the region of western Serbia.

CONCLUSION

The geomagnetic measurements and subsequent archaeological excavations of the sites Spasovine and Cikote in north-western Serbia have improved our knowledge of the chronology and spatial concepts of these two sites, as well as raised some new questions.

A comparison of the prospection, which covered significantly different areas, and the excavation results provided a preliminary insight into the advantages and limitations of geomagnetic prospection in the aforementioned territory. Structures made using the wattle and daub technique, usually burnt in a fire, provided higher values during the geomagnetic prospection, most likely due to the high concentration of burnt materials. On the other hand, the geomagnetic prospection failed to register any residential structures at the site of Cikote, which could indicate the nature of architecture during the period of habitation at the site, possibly marked by light construction and undisturbed by secondary processes, such as fire. Hence, such structures could prove to be undetectable through geomagnetic prospection. However, other factors such as natural erosion caused by the slope of the terrain might have played a role in the lack of registered features at the site of Cikote. These could include the fact that during the

[16] The AMS analysis was conducted by the Beta Analytic Laboratory in Miami, USA, and the laboratory number of the sample is BETA 419886.

excavation campaigns at the site, high quantities of archaeological materials, such as pottery and daub, were recorded next to the rampart, yet without the existence of an archaeological feature from which the materials would have originated. This could indicate that the artificial rampart served as a sort of collector for eroded materials at the site.

The results of the research conducted using both prospection and excavation and their later interpretation and comparison have, once again, indicated the possible existence of differences in architectural concepts during the various phases of prehistory. Although the wattle and daub technique represent the most common building technique in the Central Balkan prehistory, the data from north-western Serbia so far does not confirm the same for the Bronze Age. Hence, it remains unclear whether the results of the prospection were caused by natural processes, such as erosion, or indicate the aforementioned differences in architectural concepts.

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REZIME

GEOMAGNETNA PROSPEKCIJA I ARHEOLOŠKA ISTRAŽIVANJA DVA PRAISTORIJSKA LOKALITETA U SEVEROZAPADNOJ SRBIJI: PRELIMINARNI REZULTATI I NOVA METODOLOŠKA PITANJA

KLJUČNE REČI: GEOMAGNETNA PROSPEKCIJA, ISKOPAVANJA, STAMBENI OBJEKTI, KASNI NEOLIT/RANI ENEOLIT, KASNO BRONZANO DOBA, SEVEROZAPADNA SRBIJA

U radu su prikazani rezultati geomagnetne prospekcije na dva arheološka lokaliteta na teritorji severozapadne Srbije, Spasovine i Cikote, kao i rezultati arheoloških istraživanja koja su realizovana na osnovu dobijenih rezultata.

Geomagnetnom prospekcijom na lokalitetu Spasovine registrovane su dve koncentracije anomalija (klasteri A i B), koje su prema svojim vrednostima ukazivale na postojanje arheoloških objekata. Prilikom istraživanja koja su usledila, u okviru dve sonde (1/18 i 2/18) otkriveni su ostaci objekata koji su stradali u jakom požaru. Od posebnog je značaja Objekat 3, koji sudeći prema pokretnim nalazima i stratigrafiji predstavlja ostatke poluukopanog stambenog objekta. Na osnovu stilsko-tipoloških karakteristika ulomaka keramike, objekat je opredeljen u fazu Benska Bara III, odnosno sam prelaz između kasnog neolita i ranog eneolita. Apsolutni datum dobijen iz ovog objekta potvrdio je takvo opredeljenje, smestivši ga u sredinu 4. milenijuma pre n. e.

Na lokalitetu Cikote geomagnetna prospekcija ukazala je na postojanje dve nepravilne anomalije, doduše manjeg intenziteta nego što je to slučaj sa lokalitetom Spasovine. Prilikom arheoloških istraživanja u okviru dve sonde (1/19 i 2/19) nisu registrovani ostaci objekata, već manje promene u boji i kvalitetu zemlje, kao i sporadični tragovi gorelog lepa.

Rezultati geomagnetne prospekcije i pratećih arheoloških istraživanja na lokalitetima Spasovine i Cikote još jednom su ukazali na postojeće razlike u arhitekturi tokom različitih perioda praistorije. Objekti zidani u tehnici pletera i lepa, koji su stradali u požaru, daju veće signale usled veće količine gorelog materijala. Sa druge strane, geomagnetna prospekcija nije registrovala ostatke objekata na lokalitetu Cikote, što bi moglo da ukazuje na samu prirodu arhitekture tokom kasnije praistorije, odnosno kasnog bronzanog doba, koju nije moguće registrovati geomagnetnom prospekcijom.

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RE-OPENING THE QUESTION OF THE USE OF A RARE ROMAN ARTEFACT: THE IVORY OBJECT FROM VIMINACIUM

ABSTRACT

Ivory objects from Viminacium are few (nine pieces) and are generally simple in design and utilitarian in purpose. However, one find stands out due to its specific function. It is currently the only known example from Viminacium and is among the thirty-five finds known from literature, among which twenty-five are from graves.

A flat ivory object – a plaque in the shape of a pelta, was found with two bone rods in the grave of a deceased person, interred in a lead coffin, along with other items that date the burial to between the 2nd and 3rd centuries AD. The unusual appearance and rarity of similar objects has long been the subject of debate among scientists. It was believed that they were elements of a small cabinet, a stringed instrument, a papyrus-scroll winder, an implement used for fine embroidery or a miniature weaving loom. This paper presents three of these interpretations, and stands by one of them, thus recognising the Viminacium find as a loom. Based on the grave goods, among which is the one we present in this paper, it was concluded that the deceased person was a woman. This rare item belongs to the luxury products that could not be afforded by everyone, but only members of high society.

KEYWORDS: IVORY PLAQUE, *VIMINACIUM,* ROMAN GRAVE, GRAVE GOODS, ROMAN WOMAN, WEAVING LOOM, EMBROIDERY, PAPYRUS-SCROLL WINDER, PELTA.

INTRODUCTION

The Romans made objects from the tusks and teeth of wild animals for various purposes. These items represented a luxurious version of cheaper products that were more commonly made from the teeth and horns of domestic and wild animals. Elephant tusks are commonly referred to as "ivory" for this type of material. However, although ivory was indeed the most prevalent among such products during Antiquity, some items were also made from the tusks and teeth of mammoths, hippopotamuses, walruses, and from whale bones. It is believed that ivory reached the Italian Peninsula through the Phoenicians, whose products Etruscan craftsmen imitated in the 7th century BC. Pausanias notes that the Greeks obtained this product from Ethiopia and India (Frazer 1898: XII, 254; Hrnčiarik 2017: 16). The scarce availability of raw materials led to the high price of these luxury products during the ancient period.

Ivory finds are extremely rare in *Viminacium*. This is likely due to the high cost of this type of material. Unlike most other materials, there is no evidence that it held any symbolic meaning for the

Romans, other than being treated as a luxury due to its exotic appearance (Deschler-Erb 1998: 87). Seven of the nine securely identified unpublished ivory objects from *Viminacium* are simple and lack any special artistic treatment (a buckle, a token, two bracelets, a ring and two belt buttons).[1] They were found in the layers of public buildings and structures, as well as in ditches and graves. Two examples stand out: an anthropomorphic plaque[2] and a flat ivory object in the shape of a pelta. The first stands out due to its exceptional artistic treatment, and the second has a specific purpose. This paper focuses on the second find – the flat ivory object, which was discovered in the grave of a deceased individual interred in a lead coffin, likely an adult female. The object requires special attention primarily due to the complexity of its function, which has remained unclear within the scientific community.

Samples from ivory finds excavated in *Viminacium*, together with some other for which it was not sure whether they were made of bone or ivory, have been sent for analysis, which will confirm the material and origin of the tusks from which they were made.[3] Roman craftsmen used African and Asian elephant tusk (Deschler-Erb 1998: 26–27). We expect to find out the species of elephant and a reliable chronology of the objects from *Viminacium* based on DNA and radiocarbon dating.

[1] The fragmented ivory buckle is shaped like the Latin letter 'U,' while the domed token has a depiction of crossed lines intersecting at right angles within an engraved circle on its flat side. Both finds are from the Castrum site (C-447 and C-1783). Two closed-type bracelets, ribbon-like in appearance with a rectangular cross-section, were found in the grave of a child from the eastern necropolis of Pirivoj (C-433 and C-434; Grave G-161). A large ring with profiled edges and a ribbon-like appearance was found in a disturbed grave of a buried individual from the first half of the 3rd century (C-13445; Grave G-2407) at the southern necropolis of Više Grobalja, along with two domed belt buttons from the damaged grave of a buried individual from the same necropolis (C-14343; Grave G-2819).

[2] The *en face* relief-carved head of a bearded man was found in the grave of a cremated individual of unknown gender and age from the southern necropolis of Pećine, dated to the 2nd century (C-14300; Grave G-1190).

[3] The samples were given for analysis within the project – *TuskTrace: Early Globalization and Ecosystem Change from Ancient Elephant DNA in Ivory*. PIs: Anselme Cormier (UCO France), Kyle Harper (Oklahoma), Courtney Hofman (Oklahoma).

DESCRIPTION AND CONTEXT OF THE FIND

The flat ivory plaque in the shape of a pelta with volutes (dimensions: 11 x 8 x 1.5 cm), and a central form with carefully rounded details, was found in a deformed lead coffin (southern necropolis of Pećine, grave G-6024; C-14568; **Figure 1**). There are two square perforations that differ in size (1.6 x 1.1 cm and 1.1 x 1 cm) on the lower part of the object. This difference occurred later due to the rapid drying of the ivory, which caused the object to "flake" into layers and become somewhat deformed. Two circular perforations, with a diameter of 0.7 cm, are located at the upper ends ending in the shape of volutes. The upper central part of the plaque is decorated with irregular carvings. The distance between the bottom square perforations is 2.5 cm, while the distance between the top circular ones is 7.3 cm.

Accompanying the object there were two bone rods of a rectangular cross-section (length 12.7 cm; cross-section: 1.1 x 0.8 cm). Neither rod is completely preserved, and their original length is unknown. The rods match the dimensions of the square perforations on the plaque, through which they can pass, and we can, therefore, consider them integral parts of this find (**Figure 2**). Those rods mutually joined and kept the plaques at a certain distance depending on their length, also allowing the stability of the artefact. Although only one flat plaque has been preserved, it is assumed that there were two, along with two more cylindrical rods passing through the upper circular openings of the finds. The absence of these parts, which would make the find complete, is likely a result of the work carried out within the current Kostolac B thermal power plant complex, where the grave in the southern necropolis of *Viminacium* was excavated. The grave was damaged during the digging of a water channel, which also damaged and deformed the lead coffin along with the skeletal remains, while most of the other grave goods were preserved (Milovanović, Golubović and Mikić 2023: 94–96).

At *Viminacium*, there are around thirty well-preserved lead coffins, along with numerous fragmented examples. The many burials in lead coffins suggest that there was likely a workshop in *Viminacium* for their production. The proximity

Figure 1. a. The lead coffin from the southern necropolis of Pećine at Viminacium; **b.** A flat ivory object in the shape of a pelta with volutes and hairpins (?) of bone in situ; (grave G-6024, photo documentation of the Institute of Archaeology, Belgrade).

of galena mines, which provided silver and lead, undoubtedly influenced their abundance. However, the practice of burying the deceased in lead coffins cannot yet be attributed to a specific ethnicity or cult. It is certain only that, based on the preserved grave goods, they belonged to members of the higher social class, most often young females, including children (Milovanović 2017: 167–170). Lead coffins in Serbia are not uncommon. Besides *Viminacium*, they are found in all major urban centres of the then Roman provinces (*Naissus*, *Sirmium*, *Singidunum*), but also in smaller settlements near mines where lead was exploited (Milovanović 2017: 121–124).

Near the flat ivory object from *Viminacium* about 50 whole and fragmented thin bone hairpins or knitting needles (?) with pointed ends, three sewing needles made of bone[4], a bone spatula, and a glass *balsamarium* were found **(Figure 3).** Several objects were found outside of the coffin: another *balsamarium,* four other glass toilet bottles, and several bronze plaques with a handle and a lock. All the objects were close together, even two bottles one inside the other, indicating that they were all

[4] About the different uses of bone needles, you can see in: Flemestad *et al.* 2017: 270.

Figure 2. A flat ivory object in the shape of a pelta with volutes and two rods of bone from the grave G-6024 (photo by Goran Stojić).

Figure 3. Hairpins (?), sewing needles, a spatula of bone, and a *balsamarium* from the grave G-6024 (photo by Goran Stojić).

placed within a wooden chest, of which only the bronze plaques, the lock, the handle, and iron nails remained (**Figures 4a and 4b**). Nearby, a shell, and a ceramic oil lamp of the *Firmalampen* type, with an image of a theatrical mask on the discus and a stamp FORTIS on the base, were found (Loeschke IXc; Korać 2018 Vol I−II: 610−611; 355, Type IX c, 1139A). All grave goods belong to the period between the 2nd and 3rd centuries AD. A bronze coin of Domitian (AD 85/86) was also found (**Figure 5**). The coin is worn and had been in use for a long time (Milovanović, Golubović and Mikić 2023: 94–96).

Figure 4a. Grave goods outside of the lead coffin from the grave G-6024 (photo by Goran Stojić).

Figure 4b. A toilet bottle, *balsamarium*, and remains of a chest from the grave G-6024 (photo by Goran Stojić).

Figure 5. A shell, ceramic oil lamp and bronze coin of Domitian from the grave G-6024 (photo by Goran Stojić).

DISCUSSION

The flat ivory object with two bone rods represents the only find of this type, not only in *Viminacium* but also in the territory of present-day Serbia, which was part of the Roman province of *Moesia Superior*, later *Moesia Prima*. Analogous examples found in pairs – artefacts consisting of two identical plaques with rods of rectangular and circular cross-sections, are known from sites in Italy, Germany, the Netherlands, and France, while finds of individual elements are known from Spain and Romania. An overview of all finds published so far with basic information is presented in **Table I**, divided by Roman provinces according to the catalogue from J. C. Béal's paper (Béal 2017: 301–309). We added the find from *Viminacium* to these sites.

Looking at the analogous examples from the aforementioned sites, the most similar to the one from *Viminacium* is one of three such finds from Nîmes (France, **Figure 6**). The object is almost completely preserved and differs from the *Viminacium* example in that the upper ends are shaped like stylised bird heads, while the middle area is almost flat with a central notch. It was found in a stone sarcophagus containing the cremated remains of a female individual[5], in an alabaster urn. In addition to the two ivory plaques with two pairs of bone rods, a spindle with a distaff, amber items, and a gold ring were found. The grave is dated to the 1st – 2nd century AD (Béal 2017: 293, fig. 5, 306–307, N°16; Wood 2001: 30, fig. 9).

The find from Nîmes, like the one from *Viminacium*, belongs to simpler examples, while more luxurious ones made of ivory and bone are decorated with mythological scenes in deep or shallow relief, not only on the outside, but also on the inside. Among the most luxurious are the finds from Pompeii and Cologne, with figural depictions from ancient mythology on both sides (Pompeii: plaque A – the birth of a hero (Meleager or Achilles?) and the death of a hero; plaque B – the rape of Persephone and Demetra, Artemis, and Athena pursue the chariot of Hades; Cologne: plaque A – Eros, Dionysus and Silenus, the infant Dionysus, and nymph; plaque B – Semele with Hermes and two Erotes and Aphrodite bathing with Eros) (Wood 2019: 414, 420–421, fig. 2; Christof 2010: 344–346, fig. 1–4 a, b; Wood 2001: 24–25, figs. 1, 4; Schneider 1990: 256-267; Groh 1990: 88–89, Taf. 17/32 a, b, c). Mythological depictions related to a scene of Bacchanalians, or a Centauromachy are shown on fragments of plaques from Ostia (Wood 2019: 434–435, cat. 6; Christof 2010: 347–348). The finds from Apt, Nijmegen, and Mangalia (*Callatis*) were worked using the openwork technique (Béal 2017: 292–293, figs. 1, 3, 4; 301–302, figs. 1, 2, 3), simple vegetal motifs from the previously mentioned Marennes example were executed using engraving, while concentric circles are known on one of the three examples from Nîmes (Béal 2017: 295, figs. 8, 10–11).

Figure 6. The object from Nîmes (artefact 906.10.16). Photograph copyright © Cécile Carrier, Musée de la Romanité, Nîmes – All rights reserved. Published by permission of Cécile Carrier, Musée de la Romanité, Nîmes, given in 2024.

The find in relation to its context and affiliation

To date, only 35 artefacts of this type of object are known. The rarity of such finds can be explained using other cheaper and porous materials, such as wood for their production, which have not been preserved due to their fragility. This may be why most of the surviving artefacts are made of bone (23 specimens) and ivory (nine specimens), with fewer examples made of wood (two specimens)

[5] The gender has been determined based on a study of the grave goods and an osteological analysis, see in F. Mazauric, Le Musée Archéologique de Nîmes, Recherches et acquisitions, Années 1906 et 1907. *Mémoires de l'Académiede Nîmes*, VIIe série, t. XXX, année 1907, 300–302.

	SITE	CONTEXT OF FIND	FIND	GRAVE GOODS	GENDER	DATING
1	Cologne (North Rhineland-Westphalia/ Germany	Eigelstein necropolis, tomb indeterminate	2 ivory plaques			25 BC-25 AD
2	Nijmegen (Gelderland/Netherlands)	Probably in a grave	2 bone plaques with rectangular bone rods	2 pyxides, about 15 fragments of bone hairpins, a spindle and a whorl		1st and the beginning of the 2nd century
3	Lyon (Rhône/France)	In a pit in a residential sector or public building	a bone plaque and 2 rectangular bone rods			Augusto-Tiberian period
4	Lyon (Rhône/France)	Gallo-Roman dump	a rectangular bone rod			1st - 2nd century
5	Lyon (Rhône/France)	Gallo-Roman dump	a rectangular bone rod			1st - 2nd century
6	Sainte-Colombe-lés-Vienne (Rhône/ France), ancient Vienna		a bone plaque			Gallo-Roman
7	Marennes (Rhône/France)	Cremation tomb Nº 6100 or contemporary tomb Nº 6319	2 ivory plaques	Tomb 6100 - terracotta, glass dishes, gold and bronze objects, terracotta statuettes, coins, an element of a funeral bed Tomb 6319 - a hooked spindle	Tomb 6100 - a child, probably 3-4 years old Tomb 6319 an adult of undetermined sex	Second half of the 1st century - beginning of the 2nd century
8	Voiron (Isére/France)	Funeral pyre from La Brunerie	a deer antler plaque	131 ceramic vases, 10 glass vases, 3 terracotta statuettes, 8 coins, food offerings, bronze and glass dishes, and a gold ring	An adult of undetermined sex	Second half of the 1st century
9	Saint-Paul-Trois-Châteaux(Drôme/France)	Valladas necropolis, cremation tomb Nº32	2 bone plaques and 2 cylindrical bone rods		A young adult of undetermined sex	60-100 AD
10	Saint-Paul-Trois-Châteaux (Drôme/France)	Valladas necropolis, cremation tomb Nº70	2 bone plaques and one or two cylindrical bone rods		An adult of undetermined sex	40-70 AD
11	Saint-Paul-Trois-Châteaux (Drôme/France)	Valladas necropolis, cremation tomb Nº27	a rectangular rod		A young adult of undetermined sex	40-60 AD
12	Vaison-la-Romaine (Vaucluse/France)	Necropolis in the Maraudi district. A glass funeral urn Nº13.399	2 bone plaques	fragments of box, bone pin, glass melted, bronze fragments and an iron nail		Between Tiberius-Claudius and the end of the 2nd century

Table I. Overview of all plaques published so far with basic information taken from Béal's catalogue (Béal 2017: 301–309) with added find from Viminacium.

	SITE	CONTEXT OF FIND	FIND	GRAVE GOODS	GENDER	DATING
13	Orange (Vaucluse/France)	Terracotta cinerary urn N°9073	a bone plaque			Gallo-Roman
14	Apt (Vaucluse/France)	Eastern necropolis cremation tomb?	2 bone plaques, 2 restangular bone rods (and 2 cylindrical bone rods ?)	pyxides and a small handle of bone		1st and the beginning of the 2nd century
15	Nîmes (Gard/France)	Necropolis of the Porte d'Auguste	2 bone plaques and 2 rectangular bone rods			Gallo-Roman
16	Nîmes (Gard/France)	Oriental necropolis Stone chest with funerary urn in alabaster	2 ivory plaques, 2 rectangular ivory rods and 2 cylindrical bone sticks	a spindle with whorl, amber objects and a gold ring	Female (according to the grave goods)	Gallo-Roman
17	Nîmes (Gard/France)	Residential and public thermal baths	a bone plaque			250-400 AD
18	Gulf of Fos-sur-Mer (Bouches-du- Rhône/ France)	Underwater in the cove	a wooden plaque			Gallo-Roman
19	Saint-Gilles ((Gard/France)	Burial incineration in funeral urn	a plaque	an oil lamp, a mirror, a hairpin, a glass balsamaria and a bone comb		
20	Narbonne (Aude/France)	Northern necropolis from Narbonne, on the Domitian way	a bone plaque			Gallo-Roman
21	Albenga (Liguria/Italy)	Necropolis south of Albenga, tomb 3	a bone plaque and 2 rectangular bone rods	a strigil; bones and metal elements, lock elements and key of box	Female (according to the grave goods)	The end of the 1st century
22	Rignano Flaminio (Lazio/Italy)	Tomb	2 bone plaques and a rectangular bone rod	ceramics vessels		1st century
23	Ostia (Latium/Italy)	Tomb on the Via dei Sepolcri	2 ivory plaques	fragments of funeral bed and various bone objects		2nd century BC- beginning of the 1st century BC
24	Pompeii (Campania/Italy)	In a small wooden cabinet	2 ivory plaques			50 BC – 1st century of AD

Table I. (continued).

	SITE	CONTEXT OF FIND	FIND	GRAVE GOODS	GENDER	DATING
25	Pompeii (Campania/Italy)	Necropolis of the Porte de Nocera, cremation area	a bone plaque			60-79 AD
26	Pompeii (Campania/Italy)	Necropolis of the Porte de Nocera, tomb Nº207	a bone plaque and rectangular rods		Female	0-40 BC
27	Pompei (Campania/Italy)	Region VI, 15,9	1 rectangular rod			Before 79 AD
28	Taranto (Apulia/Italy)	Necropolis at the arsenal, burial XXV	6 bone plaques, 3 rectangular bone rods (and a cylindrical bone rod ?)		Female (according to the grave goods)	First half of the 1st century AD
29	Taranto (Apulia/Italy)					
30	Taranto (Apulia/Italy)					
31	Taranto (Apulia/Italy)	Santa Lucia necropolis, tomb 48, marble urn	2 ivory plaque and a rectangular rod		Female (according to the grave goods)	Between the Augustan era and the middle of the 1st century AD
32	Italy? (Fitzwilliam Museum)	Funerary cist	2 ivory plaques, 2 rectangular rods and 2 cylidrical rods	ivory combs, pixides, jars, mirror, knife and writing tablets		Beginning of the 1st century AD
33	Catalonia/Spain		?			
34	Mangalia (Dobruja/Romania)	Necropolis of the Callatis, in sarcophagus	2 wooden plaques and a rectangular wooden rod	glass objects, two coins of Faustina the Elder (141-147), rods, wooden and leather shoes, pyxides, comb, spindle with whorl, a pair of earrings, 3 necklaces and 2 rings, a box in gilded bronze, a mirror, a basket and a glass situla	Female	Middle of the 2nd century
35	Viminacium (Kostolac/Serbia)	Southern necropolis of Viminacium (Pećine), grave G-6024, lead coffin	an ivory plaque and 2 rectangular bone rods	around 50 bone hairpins (?), 3 bone sewing needles, a bone spatula, 2 balsamariums, 4 glass bottles, a ceramic oil lamp, a bronze coin, a shell, and bronze and iron remains of the elements of a wooden chest	Female (according to the grave goods)	2nd century

Table I. (continued).

and deer antler (one specimen). The scarcity of these finds is probably one of the main reasons for the lack of a consensus on their function. What connects most of these finds is that they are generally discovered in graves; twenty-five out of a total of thirty-five examples (including the one from *Viminacium*) have been found in such contexts (**Table I**).

Cremation graves dominate (ten graves), while only two graves belong to inhumated individuals. The burial ritual of the others is unknown (Béal 2017: 301–307). The prevalence of these types of artefacts in cremation graves during the 1st century BC and the 1st century AD are generally from those graves where the deceased were placed in urns or cists (**Table I**: 12−13, 16, 19) (Béal 2017: 306–307, N°12, 13, 16, 19). In one case, the find was discovered together with the remains of the funerary bed (**Table I**: 23) (Béal: 2017: 307, N°23). One of the urns is made of precious alabaster material (**Table I**: 16) (Béal: 2017: 306–307, N°16). The finds from *Viminacium* (Milovanović, Golubović and Mikić 2023: 94–96) and *Callatis* (**Table I**: 34) (Béal 2017: 307, N°34) are the only ones known for certain to be from the graves of inhumated individuals, and they belong to the 2nd century, or 2nd and 3rd centuries. Only two finds come from public buildings (**Table I**: 3, 17) (Béal 2017: 301, N°3, 307, N°17).

The predominance of cremation graves is entirely understandable considering they come from necropolises in the western provinces of the Roman Empire, chronologically dated to between the 2nd and 1st century BC, and the 1st century AD and, very rarely, in the 2nd century AD. Chronologically, the oldest example of all artefacts dated so far is from Ostia and belongs to the 2nd century BC and the beginning of the 1st century BC (Béal 2017: 307, N° 23). Most others are dated to the transition from the old to the new era and the 1st – 2nd centuries AD (Béal 2017: 301–308). The latest example is from the baths in Nîmes, dated from 250 to 400 AD (**Table I**) (Béal 2017: 307, N°17). However, the noticeable absence of such artefacts after the 2nd century AD cannot simply be accepted as a temporary state caused by insufficient site exploration or unpublished materials from museum storage facilities where other such artefacts might be hiding, but that the artefact's function became obsolete and simply "fell out of fashion" during the late antique period.

Although the gender and age of the deceased in these graves are not always known, where determined, they are women of a younger age and, in one case, a child aged between 3 and 4 years (**Table I**: 7, 16, 21, 26, 28, 31, 34) (Béal 2017: 306–307, N°16, 21, N°26, 28, N°34 and N°7). In most cases, gender was determined only based on the grave inventory attributed to women. In addition, most of graves were discovered at the end of the 19th and in the first half of the 20th century and, consequently, anthropological analyses were not performed. The modest osteological material from the damaged lead coffin from *Viminacium*, based on physical anthropological analysis, belongs to an adult of undetermined gender and age (Milovanović, Golubović and Mikić 2023: 98, Table 2). However, based on the previously mentioned grave goods, it can be assumed that the deceased was female.

The grave goods in all graves where these finds were found are numerous and can be roughly grouped into toiletry and sewing/spinning tools. The function of these artefacts could also indicate that the deceased were female, even in cases where no anthropological analyses were performed. The grave goods were chosen to highlight not only gender, but also the role of women in Roman society, especially those from respectable families. A woman's role was, among other things, to showcase refinement and elegance, which was achieved through neatness, elegance, and body care. Therefore, they used luxurious cosmetic and toiletry items for beautification and storing cosmetics (Danković and Marjanović 2022: 216).

The find in relation to its possible function and use

The function of finds similar to the one from *Viminacium* has long been the subject of debate among scientists. There are different interpretations of the use of this item. It was believed that it was a small cabinet, a papyrus-scroll winder (Wood 2001: 23–40), a stringed instrument, a tool for fine embroidery (Béal 2017: 296), a miniature wagon, a jewellery or needle container (Schneider 1990: 271–272) or a miniature weaving loom (Schneider

1990: 271-272; Christof 2010: 349–356; Wood 2019: 411–420).

Until recently, three opposing opinions dominated. Two of them were supported by S. Wood. The first one, published in 2001, considers the find to be probably used for unrolling or securing a papyrus scroll during reading, that is, as a papyrus-scroll winder (Wood 2001: 23–40). In 2019, she expressed an opinion according to which she favoured the artefact being a weaving loom (Wood 2019: 411–420), as it was also considered in 1990 by B. Schneider among other possible purposes (Schneider 1990: 271–272), as well as E. Christof in 2010 (Christof 2010: 349–356). Some authors shared the same opinion at the end of the 19th and the beginning of the 20th century, but in the meantime that interpretation has been neglected (Béal 2017: 296). The third opinion, in some ways similar to the second one, since being connected to the textile/fabric making, was supported by J. C. Béal, who interpreted the find as an object used for braiding or decorating fabric bands with fine embroidery (Béal 2017: 291–313). All authors have detailed their views, using the accompanying finds with which this one was discovered, possible reconstructions and ethnographic data supporting its function for the stated purposes.

In this paper we wanted to consider all three interpretations to acquaint the readers with all the pros and cons that the mentioned authors and ourselves encountered while considering the function of this artefact. Since the interpretation of the artefact as a papyrus-scroll winder was given as the most detailed among all others by Susan Wood, and raised many questions, consequently being neglected even by the author herself, we have tried to apply it to the *Viminacium* find, with an aim to further analyse this possibility.

The papyrus-scroll winder

According to S. Wood, while reading texts, readers often need to gesture to the audience to emphasize and dramatize certain sequences, especially when reading poetry. This tool allowed the reader to free one hand occasionally and address the audience directly (Wood 2001: 29). She mentions two different ways of using this artefact with papyrus, depending on whether it has cylindrical rods in the upper or lower part of the plaque. If the circular perforations are in the lower part, where rectangular ones are also located for the rods connecting the two plaques (the examples from Pompeii, Fitzwilliam Museum (**Figure 7**), Ostia, Cologne, and Taranto), the use of this artefact would be as follows: cylindrical rods would pass through small circular perforations, allowing the papyrus to slide underneath them and over the square ones which do not rotate. In this way, the scroll could be easily replaced by simply pulling out the cylindrical rods (Wood 2001: 26–29, fig. 8) (**Figure 8a**).

The usage, according to S. Wood, would be somewhat different in the case of other finds, such as the *Viminacium* example, which has circular perforations in the upper part and square or rectangular perforations in the lower part, but whose plaques were also shaped so as to have curves that form the beds for rods. In this case, the cylindrical rods threaded through the scrolls were put in the beds and could have been removed from them without dismantling the artefact. The part of the papyrus being read was stretched

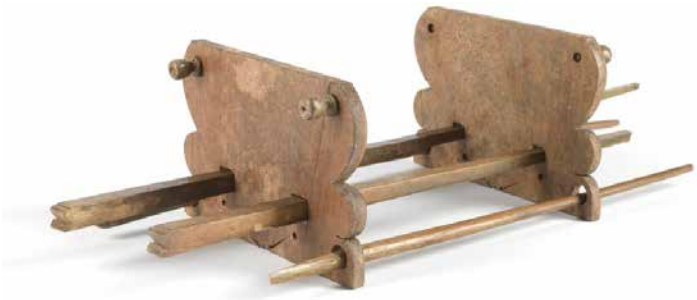

Figure 7. The object from The Fitzwilliam Museum, University of Cambridge (photo taken from https://collection.beta.fitz.ms/id/image/media-209616) Photograph copyright © The Fitzwilliam Museum, University of Cambridge – CC BY-NC-ND (accessed on October 21st, 2024).

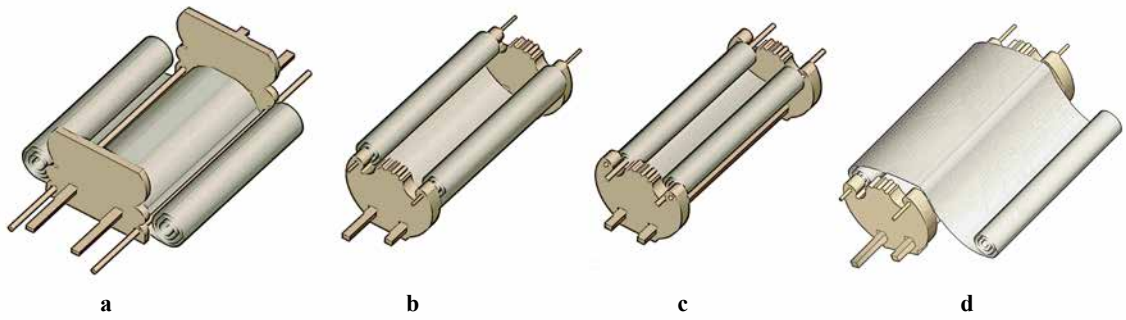

Figure 8. The ideal reconstruction of the use of the *Viminacium* artefact as a papyrus scroll-winder: **a.** the object from the Fitzwilliam Museum (after S. Wood's description and model of Pompeian object); **b.** *Viminacium* object (after the modification of S. Wood's description); **c.** *Viminacium* object (after S. Wood's description); **d.** *Viminacium* object (additional option of use) - (reconstructions-3D models created by Emilija Nikolić).

(hung) between the left and right scrolls, and over the square rods at the bottom. Again, the scroll could be easily replaced by simply taking out the scrolls with the cylindrical rods from the beds. A schematic reconstruction of this method, on the basis of its description given by S. Wood while reconstructing the Nîmes artefact (Wood 2001: 31–32), is shown on the *Viminacium* example (**Figure 8c**). bermore, since the circular perforations in the *Viminacium* example are larger than those in the Nîmes artefact, they allow the thick cylindrical rods with threaded scrolls to be put through them instead of being laid in the plaque beds and offer us a somewhat different reconstruction (**Figure 8b**), which slightly changes the S. Wood method in the *Viminacium* case. However, it must be agreed that both ways are unsuitable for reading, because the space between the plaques is too narrow, the size of the papyrus would have had to be llimited and, thus, the reading space between the covers would be extremely small. Thus, the size of the papyrus would have had to be limited to smaller examples containing columns of poetry (Wood 2017: 28).

However, most representations on wall paintings, or stone reliefs, statues or tombstones, show closed scrolls of papyrus being held in the hand (Grüll *et al*. 2023: Figs. 1−5, 7, 9, 13, 15). According to J. W. Clark, the method of reading when both halves of the scroll are turned inwards, as is the case in these reconstructions, was mostly used (Clark 1901: 27–28; Birt 1907: 135), as can be seen in some depictions (e.g., **Figure 9**; an example from Viminacium - Pilipović 2022: cat. 38). Another method of papyrus reading, where one half of the scroll is turned inwards and the other is turned outwards, such as the one presented

Figure 9. A drawing of a papyrus reader, traced from a fresco from Herculaneum
(photo taken from Birt 1907: 165, Abb. 103).

Figure 10. A drawing of a papyrus reader, traced from a fresco from Pompeii
(photo taken from Clark 1901: 28, sl. 9).

in **Figure 10** (Clark 1901: 28, fig. 9), offers us the possibility of a different use of the *Viminacium* artefact, which is shown on another reconstruction, where one cylindrical rod is used for threading through the scroll, while the other one supports the papyrus while reading (**Figure 8d**). Again, this case does not seem entirely plausible, mostly since the mutually opposite directions of papyrus rolling and unrolling would probably lead to damage. We can also assume that the presentation of the reader given in **Figure 10**, schematically presents the holding of the papyrus while reading and does not reflect its real, at least, not its prevailing use.

The embroidery tool

J. C. Béal based his opinion that an artefact of this type could be used for fine embroidery on the find from a grave excavated at Roman *Callatis* (Dobruja, Romania). Together with two wooden plaques and a rectangular wooden rod, a cylindrical woven straw basket covered with remnants of fabrics was found, which he interpreted as a kind of "pillow" on which these two plaques connected with a rod would rest, acting like frames holding the stretched fabric for embroidery (Béal 2017: 298–299, figs. 16–18, 308, N°34) (**Figure 11**). He believed that this artefact was used for luxurious embroidery with gold thread, the remains of which are rarely represented in the western provinces of the empire, while they are much more abundant in the eastern provinces. According to him, the presence of artefacts for embroidery in graves does not symbolise the skill of a woman who was expected

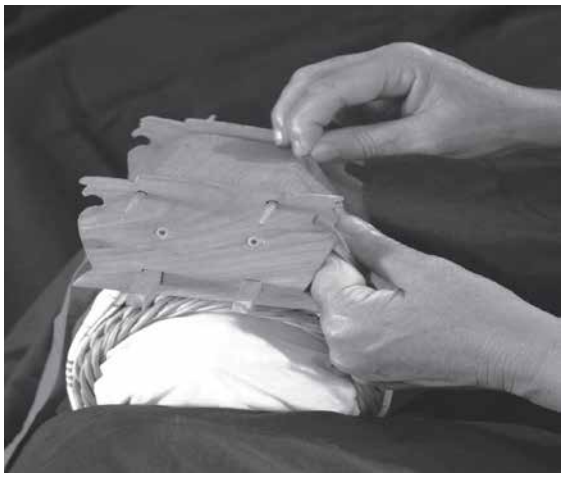

Figure 11. Interpretation of the object as a tool for embroidery given by J. C. Béal (Béal 2017: 299, Figure 19). Photograph copyright © Revue archéologique de Narbonnaise – CC BY-NC-ND (accessed on October 21st, 2024).

to be familiar with this activity but indicates the luxury and high social status to which the woman belonged (Béal 2017: 300–301). However, while considering the possibility of the artefact´s use as an embroidery tool, even while decorating narrow bands we can say that the artefact is too small, but also too unstable to hold the fabric taut for such precise work using gold thread. Besides, we are not clear what could have kept the fabric taut. Béal´s reconstruction does not show that.

An iconographic depiction of this type of find has so far only been known from the stela of a married couple from *Heraclea Pontica* (Turkey; **Figure 12**), where a possible plaque with one rectangular rod, similar to a find at *Callatis* (Béal

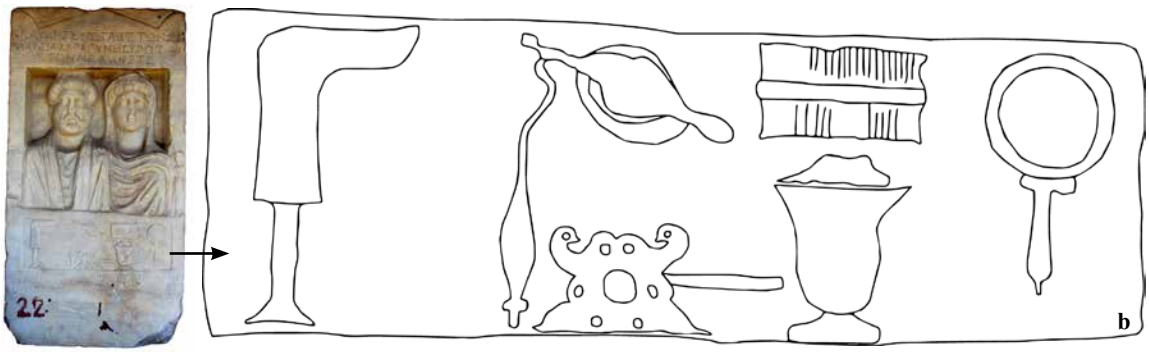

Figure 12. The stela of a married couple from *Heraclea Pontica*: **a.** Overview of the stela (Öztürk 2022: 184. Figure 21). Photograph copyright by © Archaeopress and Bülent Öztürk – All rights reserved. Published by permission of Archaeopress and Bülent Öztürk; **b.** The detail of the representation of various artefacts on stela, among which is a plaque with a rod (drawing created by Emilija Nikolić and Davor Radulj tracing the Figure 21 in Öztürk 2022: 184).

2017: 298, fig. 16), along with artefacts of various purposes: a curved tool, a spindle, a distaff, a comb, a mirror, and a sewing basket with a lid − *kalathos* **(**Öztürk 2022: 184, Figure 21; Béal 2017: 298, fig. 13, 309, N°35) was depicted. The depicted carved tool is presumed to be a billhook used for pruning vines (Béal 2017: 298, fig. 13), and is frequently shown on stelae with married couples, as a symbol of the pruning skills of the depicted husband (Cappelletto 2017: 252–253, fig. 3). All the other artefacts depicted on this stela can be considered symbols of women and are depicted on most stelae of married couples.

Artefacts like distaffs and spindles were common tools essential for preparing yarn, while a special basket, such as the one depicted on the stela and known by the Greek name *kalathos*, was used for storing and collecting raw wool as well as wool processed into yarn. Wool baskets were typically made from willow twigs or similar organic materials (Trinkl 2014: 190−192). Therefore, the basket found in the grave in *Callatis* could simply be a storage basket for wool, rather than, as suggested by J. C. Béal, a basket used as a sort of cushion on which the two wooden plaques served as an embroidery tool. Some of the artefacts depicted on the stela from *Heraclea Pontica* are found among grave goods along with a plaque-like object. Spindles with whorls were found in graves from Nijmegen and Nîmes, and a comb and mirror in graves from Saint-Gilles and *Callatis.* Besides these, all other finds from graves, including the one from *Viminacium*, can be classified as toiletry and sewing/spinning/knitting tools. Typically, these include pyxides, glass, toilet bottles, hairpins, and sewing needles (Nijmegen, Vaison-la-Romaine, Saint-Gilles; Béal 2017: 301, N°2, 306, N°12, 307, N°19).

The miniature loom

B. Schneider had three solutions for using these artefacts, those being a wagon, a container for jewellery or a weaving loom. She was the first to interpret the device as a loom, but she herself was not sure of the exact way to use it (Schneider 1990: 413−420). E. Christof also accepted the opinion that it was the miniature loom, and was the first one to give an example of a modern weaving device whose principle of operation is similar to the Roman artefact (Christof 2010: 343−361). The papers of both authors were of crucial importance for S. Wood, who would, two decades after her first interpretation of the artefact as a papyrus-scroll winder, develop their interpretations and provide the ideal reconstructions of the artefact as a miniature loom. Studying the plaques from Cologne and Pompeii, all three authors had come to the same conclusion about its function as a weaving loom.

S. Wood described it in 2019 as a loom for weaving narrow strips (Wood 2019: 413−420) giving two possibilities of its use. According to the first one, the threads were stretched across the plaques' tops, perpendicular to them and parallel to the rods. Their stable position was assured either by guides or a roughened plaque surface. The notches on the tops of the plaques such as those at the Nîmes (**Figure 13)**, Albenga and Saint-Colombe, could have been used to guide the threads (Wood 2019, 415; Béal 2017: 295, fig. 8; 303, fig. 1−2; 304, fig. 9), while the shallow crisscross incisions were used for roughening the surface and creating friction, such as those at the plaques, from the Cologne, Pompeii and Fitzwilliam Museum (**Figure 8**) (Wood 2019: 413−415, fig. 1−3). The threads were fixed to the plaques either by being wrapped around the plaque knobs (such as could have been the case with the plaques from the Fitzwilliam Museum) or pulled through the plaque holes (as in some other examples). The activity was further conducted by weaving the weft threads through those already fixed, that is, perpendicular to them and the longer axis of the loom, using a needle or a small shuttle. Today's looms for making beaded strips can help to

Figure 13. The object from Nimes (Béal 2017: 295, Figure 8). Photograph copyright © Revue archéologique de Narbonnaise – CC BY-NC-ND (accessed on October 21st, 2024).

visualize this process (**Figure 14).** The second possibility of using the loom was applied to plaques that have the shape of pelta with volutes, bird's heads or similar. The threads were placed perpendicular to the circular rods that passed through the upper circular perforations and parallel to the plaques. These examples did not have rigid heddles, like modern day looms (**Figure 15)**, but they used shed rods to separate the threads. This type includes the find from *Viminacium*, an example from Nîmes (**Figure 6**), as well as those from *Callatis,* Rignano, and probably from Apt, Nijmegen, and Tarent (Béal 2017: 292−293, fig. 1, 3-5; 298, fig. 16; 302, fig. 3-4; 306, fig. 5−7). We can conclude that the first possibility of using the loom was for weaving along its length, so only for narrow strips, while the second possibility allowed weaving along the width, for wider strips. Multiple perforations on some plaques, on some finds, probably offer the use of the loom in both ways.

* * *

Based on everything stated so far, and along with the prevailing interpretations we can hardly interpret the objects from *Viminacium* as elements of a papyrus-scroll winder, neither as elements of a tool for embroidery. We indeed believe that those objects were probably elements of a miniature weaving loom.

The three bone sewing needles found in the *Viminacium* grave alongside the ivory plaque, which could support the idea that the artefact was used as an embroidery making tool, do not seem suitable for fine embroidery. Embroidery needles needed to have extremely sharp tips, which is not the case with the *Viminacium* examples, where the end with the hole is pointed while the other end is not. Although we know little about embroidery needles from the period of the Roman Empire, it is known that three types of needles existed in Egypt. One type was short with both ends pointed and a hole at one end, another had one pointed end while the end with the hole was flat, and the third type had one pointed end and the other bent to form a thread eye. It is also known that these needles were made of wood, bone, bronze, or iron (Droß-Krüpe, Paetz gen. Schieck 2014: 207−209). The needles from *Viminacium*, however, have tips that are insufficiently sharp for piercing fabric, unlike the other end, which is extremely pointed but features a hole for the thread. Therefore, we assume that these needles were used for sewing but, in addition, they could have been used for threading on the loom (Flemestad *et al.* 2017: 270). Furthermore, about 50 bone pins with both pointed ends found in the *Viminacium* grave could have been used for hair but could also have been knitting needles or used for some activity connected to weaving. However, in the context of prevailing interpretations of the artefact purpose given above - as those used for textile/fabric making (though by different techniques) - we can assume that their use was for weaving.

Among analogous plaque objects, there are certain differences in the shape and in the position of the circular openings, as previously mentioned. Some of them are rectangular or in a volute, or pelta shaped. The perforations can be in the upper part (*Viminacium*, Nîmes, Apt) or in both the upper and lower part of the plaques (Cologne, Pompeii, Fitzwilliam Museum, Taranto). Additionally, some of the specimens have several pairs of circular openings (Taranto, Lyon, *Callatis*, Nîmes, Albenga), while some have only one rectangular perforation (*Callatis*, Mangalia, Rignano, Narbonne) (Béal 2017: 302−304, 306). All of this is important regarding the method in which the weaving object is used. The artistic representations of women using small weaving looms through history (**Figure 16**) that are also preserved in the museum ethnographic collections (**Figure 17**), along with the contemporary miniature home table looms previously presented (**Figure 14; Figure 15**), though they all differ in shapes and dimensions, may help us better understand the possible use of each element in the construction of the presented artefacts as well as the artefacts themselves.

The special skills and creativity of women were emphasised through knowledge of handicrafts such as spinning, sewing, weaving, braiding, and embroidery. Decorative items like spindles and distaffs were important elements during wedding ceremonies and remained in the matron's home as symbols of the marital bond (Lindgren 2013: 137). They were used for traditionally female work, which was performed even by women from wealthy families, without shame (Clark 1981: 198; Danković 2020; Danković and Marjanović 2022: 213). The ivory plaque, interpreted as a miniature loom, would represent yet another item

Figure 14. A modern home bead weaving loom (photo taken from: https://www.flickr.com/photos/preciosa-ornela/7751569694/in/album-72157630998259160/). Photograph copyright © Preciosa Ornela– CC BY 2.0 (accessed on December 12th, 2024).

Figure 15. A modern home rigid heddle loom (photo taken from: https://www.flickr.com/photos/origamichan/3639603898/). Photograph copyright © Tokyotogo – CC BY-NC-ND 2.0 (accessed on December 12th, 2024).

Figure 16. A detail from 15th century miniature (illuminated manuscript *L'Epistre d'Othea* by Christine de Pisan) (photo taken and modified from: https://manuscripts.kb.nl/zoom/BYVANCKB%3Amimi_74g27%3A059v_min). No copyright photograph © House of the Book & Royal Library, The Hague – PDM 1.0 (accessed on December 12th, 2024).

Figure 17. A traditional weaving loom from Norway (Vev. Bandvevstol. Betegnelse som er brukt i eldre museumsprotokoller. Båndvev) (photo taken from: https://digitaltmuseum.no/011023227011/vev). Photo by Anne-Lise Reinsfelt. Photograph copyright © Norsk Folkemuseum – CC BY-SA 4.0 (accessed on December 12th, 2024).

confirming not only the woman's skill, but also her belonging to a higher social class that could afford such a luxurious ivory artefact, which could be richly decorated with carvings (Wood 2019: 413–414, fig. 1–2).

CONCLUSION

The ivory plaque presented in this paper with the additional bone elements is an important discovery as it is first one of its kind found in *Viminacium*, as well as the second known similar example from this geographical area, alongside the specimen from *Callatis* (Romania). Both come from the graves with goods connected with women. Among all published finds of this type, only these two came from a grave clearly determined as an inhumation. Chronologically, they belong to the later examples, which were likely imported, as the scarcity of ivory finds in *Viminacium* does not support the existence of a local workshop for their production. Such workshops can be expected in the western provinces of the empire (Italy, France), where the majority of these artefacts have been found. Most of the artefacts of this kind mentioned in this paper (and given in the **Table 1**) were discovered during excavations conducted in the late 19th and early 20th centuries. According to the research so far, these items were prevalent in the western provinces during the early centuries of the empire and almost unknown in the eastern provinces.

Through the analysis of the *Viminacium* find, two of the most plausible interpretations of the use of similar objects from the Roman period found so far have been analysed, concluding that each has their own strengths and weaknesses. The use of the *Viminacium* artefact for unrolling and reading from papyrus, as first interpreted by S. Wood, seems theoretically possible, but it is practically non-functional with a limited reading area, which we have tried to prove with graphical reconstructions. The J. C. Béal theory that the artefact was used as an embroidery tool, for decorating bands using gold thread, exhibits similar shortcomings, being small and unreliable for precise work. Bearing in mind examples of similar artefacts for weaving – from later historical periods, folk art remains, or modern arts and crafts looms, but also the second interpretation of S. Wood, previously given by B. Schneider and E. Christof, we can support the opinion that the ivory plaque and rods from *Viminacium*, like other similar objects, were part of an artifact used as a miniature loom for weaving. The differences among all objects of this type found so far can lead us to further research of the existence of variants of weaving techniques used by Roman women, depending on the type of fabric they intended to make. An attempt to reconstruct the activity by a modern weaver using a replica of the *Viminacium* artefact, additionally using the knowledge of different textile remnants found in *Viminacium* so far, can be one of the solutions for proving our conclusions of determining the artefact from *Viminacium* as a weaving loom and could offer us detailed insights in the weaving process.

The finds presented in this paper were predominantly found in the graves of cremated individuals which, based on the grave inventory, can be related to women from the higher social classes. The weaving loom from *Viminacium* was accompanied by tools used for sewing and probably knitting and weaving, along with typical artefacts used by Roman women for beautification, suggesting that the buried woman was skilled in different textile/fabric making crafts. It is also important to emphasise that each artefact we accepted as a weaving loom is unique, not only in shape but also in its decorative motifs, which along with fact that they most of them were made of ivory, confirm that these were luxury goods that not everyone could afford. This conclusion can lead us one step closer to understanding more about the unknown lady buried in grave G-6024 who lived in *Viminacium* between the 2nd and 3rd century.

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REZIME

PONOVNO OTVARANJE PITANJA UPOTREBE RETKOG RIMSKOG ARTEFAKTA: PREDMET OD SLONOVAČE IZ VIMINACIJUMA

KLJUČNE REČI: OPLATA OD SLONOVAČE, *VIMINACIUM,* RIMSKI GROB, GROBNI PRILOZI, RIMSKA ŽENA, RAZBOJ ZA TKANJE, VEZ, PREDMET ZA ODMOTAVANJE PAPIRUSA, PELTA.

Predmeti od slonovače iz Viminacijuma su malobrojni. Nalaz neobičnog izgleda, od oplate pločastog izgleda u obliku pelte za sada je jedini poznat primerak iz Viminacijuma i jedan od tridesetak poznatih iz literature. Uz oplatu su nađena i dva štapića od kosti u grobu inhumiranog pokojnika sahranjenog u olovnom kovčegu. Na osnovu antropološke analize pokojnik pripada odrasloj osobi neodređenog pola i uzrasta. Kovčeg je oštećen i deformisan, dok su grobni prilozi uglavnom sačuvani. Na osnovu njih, grob je opredeljen u period između 2. i 3. veka.

Nalazi iz rimskih provincija analogni viminacijumskom sastoje se od dve identične pločaste oplate sa dve kvadratne, češće pravougaone perforacije u donjem delu i najmanje dve, a često i više kružnih perforacija u gornjem delu. Sastavni deo predmeta su činila i dva štapića neujednačenog četvrtastog ili pravougaonog preseka i dva ili više štapića kružnih preseka.

Pravougaoni štapići su prolazili kroz donje perforacije oplata, držeći ih na određenom rastojanju u zavisnosti od svoje dužine i omogućavajući stabilnost predmeta. Cilindrični štapići u gornjem delu su prolazili kroz kružne perforacije. Najsličniji viminacijumskom je jedan od tri nalaza iz Nima.

O nameni predmeta ovog tipa u literaturi postoje oprečna mišljenja. U radu su razmatrane tri interpretacije. Prema jednoj, predmet je mogao biti korišćen kao pomagalo za čitanje, odnosno držač papirusa. Papirus bi bio razvučen između oplata i fiksiran pomoću štapića postavljenih između njih, kako bi čitalac mogao nesmetano da čita ne koristeći ruke. Zbog malog razmaka između oplata, mogao se koristiti samo papirus manjih dimenzija sa uskim kolonama na kojima su ispisana poetska dela. Prema drugoj, predmet je mogao biti korišćen kao pomagalo za vez. Preko njega bi se prebacila uska traka koja je ukrašavana finim vezom. Treća interpretacija koja je među prvima bila aktuelna, ali ne odmah i prihvaćena, svrstava predmet u minijaturni razboj na kome su tkane trake za ukrašavanje tkanina. Nedoumice kod autora postoje i stoga što se predmeti ovakvog izgleda ne pominju u istorijskim izvorima, niti su prikazivani na spomenicima, freskama i sličnim medijima. Jedini prikaz nalazimo na steli iz Herakleje Pontske (Turska) zajedno sa ostalim ženskim priborom vezanim za predenje i ulepšavanje. Na osnovu prezentacija žena sa razbojima u umetnosti, sličnih primeraka iz etnografskih muzeja i savremenih predmeta ove funkcije koji su danas dostupni na tržištu, kao i na osnovu interpretacija autora koji zastupaju ovo mišljenje, predmet iz Viminacijuma smo opredelili u minijaturni razboj za tkanje.

Predmeti ovog tipa su najčešće nalaženi u grobovima, od kojih je pouzdano da su deset pripadali kremiranim, a svega dva inhumiranim pokojnicima. Najstariji nalaz ovog tipa je iz Ostije i pripada 2. veku p. n. e. i početku 1. veka p. n. e. Većina ostalih je datovana u vreme prelaza iz stare u novu eru i u 1−2. vek n. e. Najmlađi primerak iz termi u Nimu potiče iz sloja široko datovanog od 250. do 400. godine n. e. Iako nisu uvek poznati pol i uzrast pokojnika, tamo gde je to utvrđeno reč je o ženama mlađeg uzrasta, a u jednom slučaju o detetu starosti između 3. i 4. godine. Prilozi iz većine grobova, uključujući i viminacijumski, mogu se grupisati u toaletni pribor i predmete za predenje, šivenje i tkanje. Skroman osteološki materijal iz oštećenog olovnog kovčega iz Viminacijuma, na osnovu fizičko-antropološke analize, pripada odrasloj osobi neutvrđenog pola i starosti. Međutim, na osnovu prethodno navedenih grobnih dobara može se pretpostaviti da je pokojnica ženskog pola.

Materijal od kojeg je predmet iz groba u Viminacijumu izrađen i njegova retka zastupljenost potvrđuju da se radi o luksuznoj robi koju nije mogao svako da priušti već samo viši staleži, kojem je pripadala i žena iz Viminacijuma, koja je verovatno poznavala različite tehnike izrade tkanina.

* * *

Use of tools based on large language models and generative AI: ChatGPT (translation).

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FURTHER RUDIMENTS OF TRADITIONAL MORTAR PREPARATION AND USE. AN INQUIRY INTO TRADITIONAL DRY SLAKING

ABSTRACT

This paper represents a somewhat deeper inquiry into traditional lime slaking methods as detailed in numerous historic texts, and as amplified by the author's recent experience and material science. It will look more specifically at the patterns of dry slaking and at the use of lime and hair only, or very lime rich lime, hair, limestone dust mortars, which were so prevalent prior to the 19th and 20th centuries. It will also question the sense of the unevidenced prejudice of the 'Lime Revival' against the use of dry slaked lime when set against the extensive evidence for such a slaking method being very common throughout time in craft practices, and being included in Roman practice. It will explore the benefits that the crafts may have found in different slaking methods – initial dry or wet slaking – and in the use of very lime rich mortars, according to purpose, and will highlight the advantage and benefit of using similar mortars, prepared in similar ways, for the practicable like for like and compatible repair of traditional and historic building fabrics of all kinds, as well as for, or in association with, new and sustainable buildings of low carbon footprints and comparable performance and potential longevity.

KEYWORDS: DRY SLAKED LIME, WET SLAKED LIME, DRY-SLAKING, WET-SLAKING, LIME PUTTY, LIME AND HAIR, LIMESTONE AGGREGATES, CARBON EMISSIONS, CARBONATION, CARBON SINK.

INTRODUCTION

The primary forms to which lime was initially slaked were either to a dry powder or to a thick paste. The slaking water required to achieve each outcome was specific. 'Just sufficient' water, a common requirement in historic descriptions might be taken literally to mean just sufficient water to satisfy the chemical demand, which would lead to a dry powder; or else 'just sufficient' to deliver a thick paste (Jacques 1860: 168; Higgins 1780: 17). Frequently, the latter outcome was made clear – 'just sufficient to slake to a thick paste', perhaps distinguishing this from the more simply stated 'just sufficient', which meant to a powder.

Limestone burned in a kiln loses around 45% of its weight in CO_2 and 'chemical' water (Rolando 1992: 20). To further continue the lime cycle, it is enough to give back the stochiometric amount of water to the quicklime to slake and further form calcium hydroxide, but it requires more water to become the binding material from which a mortar might be made. The water should amount to around 30% of the quicklime weight, although, strictly

speaking, this may only be sufficient in a sealed chamber. On site, and in practice, some of this water will be lost to the atmosphere in the form of steam and, thus, the amount should be increased during slaking, also depending on whether we aim to make a paste or a powder (Richardson 1897: 78–79).

It was not until 1897 (Richardson), that precise water amounts were offered in building texts, itself illustrating that the crafts themselves had typically controlled the mortar-making and mortar design, and that their knowledge had been largely passed on by word of mouth and shared experience. Typically, Richardson indicated, 1 volume of water to each volume of quicklime would deliver a dry hydrated powder; 2.5 volumes of initial slaking water would deliver a thick paste (Richardson 1897: 101–102). In both cases – and essentially – these water volumes would guarantee the high slaking temperature – a minimum of 100°C, maximising the *power* of the lime produced. It was commonly said that 'drowning' the lime to slake it – initially adding more water than above – would compromise the performance of that material, suppressing the temperature of the slake, and it was always asserted that 'lime which slakes the quickest and heats most in slaking is the best' (Gwilt 1837: 49), indicating the preferred use of pure or nearly pure lime, the slaking behaviour of which such a requirement describes. Such a minimum of 100°C delivers the smallest particle size, with the greatest surface area during lime slaking (Hassibi 1999: 12). Dry slaking guarantees a high temperature in the slake, and a significantly higher temperature than even slaking to a thick paste. For some engineers, this was preferred because it avoided the risk they perceived that the crafts would take short-cuts and would 'drown' the lime to save themselves time and effort in the preparation of the mortar (de la Faye 1777); Fleuret 1807; Vicat 1837). Dry slaked lime, however, is most efficiently mixed with sand (or volcanic ash, or any other essentially dry aggregate) immediately after slaking, and is more readily evenly distributed in this way (**Figure 1**).

As we can see from the historical texts above, lime putty, when made, was not historically recommended to be 'drowned', but might be made by either method described above. It has only become typical to slake lime putty by 'drowning' in the more recent 'lime revival'[1] and this material has somewhat different characteristics than a lime putty made from initially dry-slaked lime or from quicklime slaked with around 2 (to 2.5) volumes of water in the first instance. It tends to exhibit an excess of free water and to be sloppy in a way that even a diluted but traditionally slaked lime putty is not. Up to 60% of its volume (and even higher, depending on the putty age) may be free water (Margahla *et al.* 2013: 1525–1526). When stored or set aside, water will rise from it without even the encouragement of motion, to be regularly tipped off. Based on the author's experience, even a putty made to the 1951 British Standard Code of Practice (BS CP 1951), with lump quicklime poured into a given volume of water up to half the level of this water (the water for most of history having always been added to the quicklime, as a rule – Gillmore 1886: 179–180), will deliver a material of bread-dough consistency (as lime putty has always been described to be in the past (Copsey 2019b: 41) that exhibits minimal free water, which may be modelled and shaped in the hand and which will not 'bleed' water from its mass, with none rising from it in a bucket or other container, even when transported. This difference speaks of the quality of the bonds created when lime is slaked at a minimum of 100°C, a character that is also displayed by hot mixed sand and lime mortars.

In both methods of slaking, the lime may be mixed with the sand or other aggregate whilst it is still very hot from the slake; in particularly dry slaking methods, the lime may be left within the sand to cool before this mixing takes place – in which case, it will be sand slaking, rather than hot mixing in its definition. A cooled lime paste will be significantly more difficult to mix with the sand than a hot paste will be, so that, if for no other reason, the tendency would naturally have been to mix whilst the lime paste was hot – hot lime flows in a way that cooled lime does not. There were other methods, of course (see Marshall below).

[1] See more on the lime revival and the lime-based technology revival in: Henry and Stewart (eds.) 2011: 24–25; Zacharopolou 1998.

Figure 1. a. A reduced scale dry slake of calcareous sand and lump quicklime after striking of the formwork and **b.** 24 hours after slaking (normally slaked within a 3.5 metre square formwork, each layer of sand saturated before adding a layer of quicklime, at a proportion of 1 quicklime: 3); **c.** Damien Condon and Michael Masterton turning the lime and sand together (photos taken by Nigel Copsey).

THE PREVALENCE OF DRY SLAKING

"Lime, whether it be intended for cement or for manure, ought to be reduced entirely to a *dry powder*. Also, for cement, it ought to be mixed, in this state, evenly and intimately with the sand. It is difficult, if not utterly impossible, to reduce lime entirely to powder with water alone; some part of it will always be supersaturated, and thereby be reduced to a *paste*; while the outsides…will (unless the stone be extremely fine) fall into granules, not into powder. But if, instead of water, *wet sand* be used in slaking the lime; (piling it with the lime in knobs, layer for layer, and covering up the heap with it) those evils are avoided: no part is supersaturated, nor are any granules formed by the action of the outward air. Besides…the two ingredients, by being repeatedly turned over, and by passing through the sieve together, necessarily become intimately blended; more intimately, perhaps, than they could be mixed by any other process, equally simple. If the sand be *washed* (and all sand mixed with lime for cement ought to be washed) the labour of preparation is, by this method of slaking the lime, considerably lessened" (Marshall 1788: 113).

A hot mixed lime mortar might be used hot, or it might be used cold. As observed in recent experience, dry slaking in sand – either in a ring of sand, or in alternate layers of quicklime and sand – may readily reach temperatures of 350°C or more[2]. Adding cold water to a lime at this temperature would 'chill' it – arresting any further slaking at this point, which, especially with larger lump lime, would rob the mix of lime and leave it 'short' and 'gritty', although typical residual lime clasts are not generally the result of such 'burning' and subsequent 'chilling'. Biston (1828: 200) says that if, when making lime putty, insufficient water is given and the lime becomes too hot, the masons must step away and leave it to cool before the addition of more water. Mixing dry slaked lime with the sand, however, and before adding any further water, which was always the norm historically (De Villanueva 1827: 13), brings down the temperature of the lime. Heaps of dry slaked lime and sand were frequently mixed and turned several times before being made into a mortar. They might also be sieved, or screened, to remove larger unslaked lime clasts. They might be made into a mortar whilst still hot; or left to cool before the final mortar mixing, having been initially hot mixed. Alternatively, the sand slaked lime might be left overnight before first mixing with the sand or other aggregate; piled, and similarly turned and moved sideways several times, before the final

[2] Pers. comm. Eoin Madigan, stonemason and Damien Condon, plasterer, April 2024.

Figure 2. Turning and wetting a dry slaked mortar made using the 'ring of sand' method (photo taken by Nigel Copsey; Copsey 2019a: 150; Copsey 2022: 215, Figs. 19–22).

addition of the necessary mixing water (**Figure 2**). In this process, some previously unslaked quicklime would likely slake, 're-heating' the mortar, at least in part, and a layered sand, lime slake would still retain significant heat after being left overnight or for a day or so. Deep pits of lime putty (common in the 20thC), often 3 metres deep, would retain heat for weeks, and were typically mixed with sand (or not) after 2 weeks (Copsey 2019b: 41 (Copsey 2019b: 41).

"As it takes about a quarter of an hour for the lime suffocated under the sand to be reduced to powder, we prepare several piles at the same time next to each other… that the mixture of the first can be done. The mortar from the first pile being still hot, a labourer takes it to the masons who use it without ever adding water. While they are working on it, the companions prepare another pile, and so on, always having two or three piles in front of their hands, in order to give the lime time to dissolve well before being made up (to a plastic mortar). Workers must never leave work, either at meal times or at the end of the day, until all the mortar from the last pile that has been prepared is completely used, because it would harden to the point that we could no longer handle it with the trowel without adding water: then the same effect would result as if, after having spoiled the plaster, we diluted it with water a second time. However, this is what masons do every day very inappropriately, and what they call refreshing ('sweetening' in English parlance) the mortar" (Fleuret 1807: 31).

Similar processes applied to lime dry slaked for use on its own – for plasters, pointing mortars and for the bedding of very fine stone ashlar or very tightly jointed brickwork. For finely-jointed gauged brickwork and stone ashlar, evidence from the UK in the 19th century would suggest the lime would be slaked to a thick paste, immediately diluted to the 'consistency of mud', pressed through a sieve to remove larger unslaked lumps, and then used immediately – whilst still hot (Langley 1750: 132). It would seem most unlikely that lime putty, 'matured' under water was ever used for bedding mortars, even by the Romans, being rather reserved for fine plaster finish coats, although lime slaked with just sufficient water and then held in a pit under a covering of sand or earth and maintained in an 'unctuous' condition (De L'Orme 1567: 29), may well have been used for such purposes.

"The Mortar in which rubbed and gauged Bricks are set is called Putty, and is thus made: Dissolve in any small Quantity of Water, as two or three Gallons, so much fresh Lime (constantly

stirred with a Stick) until the Lime be entirely slacked, and the whole become of the Consistency of Mud; so that when the Stick is taken out of it, it will but just drop; and then being sifted, or run through a Hair Sieve, to take out the gross Parts of the Lime, is fit for Use" (Langley 1750: 132).

If dry hydrate was to be stored for later use, it might be slaked by immersion – held briefly underwater and then tipped into barrels, to slake and to cook, as Vicat (1837: 28; De la Faye 1777: 34) describes in detail. It might be similarly slaked for immediate or prompt use; or else slaked by aspersion – just sufficient water drizzled over the quicklime on the ground or in a shallow container. Both methods are routinely set out by most writers on lime and mortars historically.

(In) the first (method of slaking), and that commonly performed in Spain, the quicklime is reduced by sprinkling the heaps with water so that it ferments and crumbles and is reduced to powder. To this end, the heaps must be turned over and cut with paddles and beaters so that it is homogenous, leaving all the 'bones' (lime lumps) and stones not penetrated by the fire, so that the mix is clean, and is then set aside. Do this two or three times. The lime is then piled up and covered and, *if possible*, mixed with the sand or mixed later (De Villanueva 1827: 13).

Higgins, in 1780, makes clear that dry slaking of plasters (in this case with sand addition) was the norm in London at the time (and that historic prescriptions that lime and sand surface finishes were not plasterers' but bricklayers' materials had lapsed): "The plaisterers, who use a finer kind of mortar made of sand and lime, observe that their plaster or stucco blisters when it contains small bits of unslaked lime; and as their purpose is to work their stucco to a smooth surface, and to secure it from cracking, or any such roughness… and as the hardness of the stucco is not their chief object, they very properly *keep their MORTAR a considerable time before they use it, to* the end that the bits of imperfect lime, *which passed through the screen*, may have time to slake thoroughly (Higgins 1780: 40–41, **Figure 3**).

Figure 3. Backing plasters, Schumacher House, c 1870. Haifa, Israel. Maximum size of lime clasts 5mm, indicating sieving of initially dry-slaked lime (photo taken by Nigel Copsey).

Probable ancient practice

The evidence – of descriptions in old texts, as well as conclusions of mortar analyses (Copsey 2019b, Appendix 11), is that the majority of plaster mortars were initially dry slaked, before hot mixing with sand as above, or before cooling overnight and mixing with sand or another aggregate. The maximum size of residual lime clasts in most plaster backing coats was often around 5mm. This is a clear indication that a dry slaked lime has been sieved, either before or after mixing with any aggregate. This is as true of Roman plaster backing coats as it is of 19th century backing coats, and of all of those in between.

Contemporary practice in the Yemen, for example, in the author's opinion, may very well reflect the common Roman method, and is enlightening in regard to the preparation of lime pastes for use on their own for plaster finishes, for limewashes, as well as, in this case, for sand-lime mortars.

"The process comprises burning the stone in large mud brick kilns…Limestone quarried from the neighbouring mountain is burnt for three consecutive days.…The stone becoming very soft to a crumbling point, it is then removed from the kiln to a shaded area. There it is cooled with water (slaked) and then broken down completely by a process called 'sbatah' i.e., beating it down with long rods. Two or more workers may engage in this stage in an alternate synchronised movement of lifting the rods up to shoulder level and back to 180 degrees, and down in order to hit the ground again. The process, requiring force and perseverance, becomes rhythmical rather than monotonous, with (a) singing verse that is repeated by the same workers to accompany the beat of their rods to the ground. *(Similar to(the) threshing of wheat or other grain crops)...* The burnt lime is thus converted into a fine powder, and removed to special water basins in order to soak and, in their terms, 'cool down'. The cooling is more relevant here (than) in the case where the hot burning (burnt) stone is removed and immediately soaked, eliminating the first sbatah course. This cutting down on the labour stages of treating the limestone is seen as desirable for producing commercial quality nurah (as opposed to high quality nurah that requires to be purified to a very fine degree), which can be sold more cheaply.

A second sbatah course takes place, where the lime paste is now subjected to the same beating operation in order to turn it into a consistency that is smooth and free from any undissolved molecules (lumps)" (Damluji Salma Samar 1992: 378–379).

Notably, the quicklime is first dry slaked, then soaked in a pit, whilst remaining sufficiently thick that it may then be extensively beaten into the form of a thick paste. This is quite unlike modern methods, which are much more like those criticised in the text above, and condemned by De la Faye (along with others) in the 18th and 19th centuries (De la Faye 1777: 32; Millar 1899: 42–43). In his comprehensive summary of 19th century British plastering practice, De la Faye describes a very similar method to that of above – the lime is initially dry slaked before being run to a paste, as well as the 'drowning' method of lime slaking noted to produce an inferior material in the Yemeni text and regularly condemned in the past:

"Fused lime: We crush quicklime in a tub by submerging it in water until it has no longer any heat and it is completely soaked. This material turns into a paste after 24 hours, then we add sand without any real proportions and we will add again some water. This drowned lime produces a mortar that dries up slowly and will never reach a good consistency, because this drenched lime has lost its aptitude to stick to other materials" (De la Faye 1777: 32).

A recently excavated Roman kiln and adjacent lime processing area (a 'lime house') at the archaeological site of Masada in Israel was presented in Copsey (2022: 204). It was assumed that dry slaked lime was found in the kiln itself. New data revealed that the finding place was actually part of the lime house, and that the lime had been already processed. Also within the lime house was a shallow, built pit, its outer margins stained with what must have been a more liquid lime (**Figure 4**; **Figure 5**) It would seem reasonable to deduce that the initially dry slaked lime would have been wetted and soaked in the basin, prior to pounding and use, perhaps for the finishes of frescos, some of which survive in situ within Herod's Palace (**Figure 6**). It is important to note that, in our opinion, whilst Vitruvius speaks of lime preparation for plastering (Vitruvius 1999: VII.2) he does not describe the initial slaking method, which may very well have been one of initial dry slaking. When he discusses slaking and mortar mixing, he uses the term 'extincta' (Vitruvius 1999: II.5; Vitruvius 1912: 36), while he uses the term 'macerata', while writing on finish plasters, for the soaking and softening of slaked lime (Vitruvius 1999: VII.2; Vitruvius 1912: 153), which is not a description of a slaking method.

That the Romans typically prepared and used hot mixed mortars (routinely with initially dry slaked lime) is becoming more accepted, especially after the research that was done in natural sciences (Seymour *et al.* 2023: 3, 8; Jackson *et al.* 2012: 57), supporting the experience from the traditional craft practice (Copsey 2019 a; Copsey 2019b), after many years in which the "lime world" has laboured under the notion that the Romans used only aged lime putty. As may be concluded from

Figure 4. 'Lime House', Masada (excavated dry hydrated lime in the foreground) (photo taken by Nigel Copsey, published by permission of Tal Hayut).

Figure 5. Probable 'maceration' basin, Masada (photo taken by Nigel Copsey, published by permission of Tal Hayut).

Figure 6. Plasters within Herod's Palace, Masada (photo taken by Nigel Copsey, published by permission of Tal Hayut).

the experiment conducted during the ROMACONS project (Oleson in Oleson *et al.* 2014: 103–119) in the early 2000s, where aged lime putty was used (Oleson in Oleson *et al.* 2014: 109–110) - mixing matured lime putty with dry volcanic ash demanded a heavy expenditure of labour and energy, with the distribution of lime and seawater over dry volcanic ash being problematic, making the mixture very stiff. Mixing freshly slaked dry hydrated lime with the same volcanic ash before wetting to a mortar, on the other hand, would be swiftly and efficiently achieved. It is highly probable that the typically higher temperature of slaking and, therefore, of freshly slaked dry hydrate, mixed with volcanic ash during or immediately after slaking and rapidly placed as a mass within the formwork, in which it would retain heat over a lengthy period, additionally contributed to the development of the aluminous cementitious hydrates in the mortars of Roman concretes, for the evolution of which sustained high temperatures were required (more on the development of hydrates, in Oleson and Jackson in Oleson *et al.* 2014: 9–10; Jackson in Oleson *et al.* 2014: 166–170; Jackson *et al.* 2012: 67–70; Jackson *et al.* 2018: 24–26). This unique chemistry did not completely evolve in 'replica' volcanic ash maritime concretes made with matured lime putty during the ROMACONS research project, although the concrete itself performed well enough (Oleson and Jackson in Oleson *et al.* 2014: 10; Jackson in Oleson *et al.* 2014: 141–142, 183–184). Almost all original Roman concretes researched in the project display residual lime clasts (of a maximum size that may indicate sieving or screening); in the 'replica' they were generally absent (Jackson Ibid: 164; though Oleson explains the absence of this with more thorough mixing in modern mortars in comparison to ancient ones - Oleson *et al.* 2014: 110). Roman mortars at Viminacium, in modern Serbia also (Nikolić and Rogić 2018: 43). Sieves were an essential part of a Roman mason's tool-kit (Oleson *et al.* 2014: 12–14, 32), as they have been on building sites ever since, routinely and regularly being listed in medieval and later building accounts (Copsey 2019b, Appendices).

Dry slaking will tend to leave a greater volume of residual lime lumps than will wet slaking (Davy 1839: 159), and when there is a regular maximum size to these (as in the East Yorkshire plasters discussed above, and in many plasters in situ around the world) this can be an indicator of the sieving of dry slaked lime before use. Initial dry slaking, followed by a period of repose of the moist coarse mixture was common plastering practice historically (Higgins 1780: 37). However, as Köberle has demonstrated (2019; 2022[3]), hot mixed mortars used immediately after slaking ("hot applied mortars") - even whilst still slaking, and certainly when initially wet-slaked, or wetted up as slaking proceeds - will stiffen very quickly in situ, to a strong initial set, due to the uniquely rapid growth of Portlandite crystal structures through their mass. Blue Lias concrete footings for buildings in London and elsewhere in the 19th century were typically poured whilst still slaking, to maximise this potential (Burnell 1850: 75–76). Blue Lias was a hydraulic lime, but with a typically high free lime content. Burnell also advocated the use of limestone aggregate for concretes to take advantage of the 'affinity' between lime and limestone (1850: 77). The large concrete medieval city wall of Valencia, of which only two gate-houses survive, 'smoked' during construction, according to contemporary accounts[4], clearly indicating the hot use of hot mixed mortar, and very likely reflecting Roman practice (**Figure 7a; Figure 7b**).

Cetius Flavinius, abridging Vitruvius in around 300 AD, and occasionally amending, in the light of subsequent experience, some of Vitruvius's apparent prescriptions (although these were questioned in their leanness of lime proportion by many later French and British writers then unaware of Flavinius's contribution (e.g. De la Faye 1777; Ware 1756)), counselled that when building with bricks, 1:2.5 (suggested by authorities) would lead to later expenses, which obviously means it would lack durability and that the leanest a lime mortar should be mixed would be 1 slaked lime: 2, thus leading to a stronger bond between the lime mortar and concrete aggregate (although initially more expensive being richer in lime). He also stated explicitly that slaked lime for building should be mixed to a mortar immediately after slaking (Flavinius, as cited in Oleson et al 2014: 33–34), although he neglects to mention whether this should be to an initial dry or wet slake.

Analyses of two Roman mortars from Viminacium in Serbia[5] are of interest here, both having moderate to moderately high porosity. The first, a cocciopesto plaster mortar (**Figure 7c**) from the bath house, of remarkably similar appearance to that which survives at the bath house in Ravenglass, Cumbria (**Figure 7d**) was most probably made by premixing quicklime with the aggregate (brick) prior to slaking. The second, a brick-laying mortar (**Figure 7e**), was wet-mixed with a lime in the form of a 'crudely prepared lime putty[6], retaining multiple lime clasts, and perhaps used after cooling. Notably, the cocciopesto mortar displayed minimal hydraulicity, but for all that, it had ingredients with the potential to react with the lime. The lime in both samples was non-hydraulic and high in calcium, and both mortars were binder-rich. According to the report of the analyses, the plaster mortar was mixed at a proportion of 1 lime : 0.6 aggregate, and the bricklaying mortar at 1:1 (hot mixed at around 1:2, author's comment).

Recent analysis of a wall core mortar from the Roman bath house at Ravenglass[7] showed moderate porosity and full carbonation. According to the report of the analysis, the binder was non-hydraulic lime, with no pozzolanic or clinker components present. The results indicate that the lime was initially dry-slaked and then remixed with water, to be used cold. And yet the mortar proved eminently durable in one of the wettest places in Europe, with high levels of driving rain (Vesuviano and Stewart 2021).

[3] The presentation named *Processing while slaking? Hot applied lime mortar (HAM) and hot lime wash revisited* was delivered by Thomas Köberle at the *6th Historic Mortars Conference,* held in Ljubljana, Slovenia, from September 21st – 23rd, 2022.

[4] Pers. comm. Fernando Vegas, Universitat Politecnica de Valencia, 2023.

[5] Bill Revie. CMC Consulting, Stirling Report on the Examination and Analysis of a Plaster and Bedding Mortar Sample, Roman Bath House, Viminacium, Stari Kostolac, Serbia (2023) for Nigel Copsey of the Earth, Stone and Lime Company.

[6] Bill Revie. CMC Consulting, Stirling Ibid.

[7] Bill Revie. CMC Consulting, Stirling. Report on the Examination and Analysis of Mortar Samples. Roman Bath House, Ravenglass, Cumbria (2023) for Historic England Technical Conservation Team.

Figure 7. Most probably dry slaked and sieved or screened mortars: **a.** building and **b.** first coat plaster of Roman masonry preserved beneath the Gothic cathedral in Valencia (photos taken by Nigel Copsey); **c.** Cocciopesto plaster mortar, Viminacium Bath House, sawn surface (photo taken by Bill Revie); **d.** Cocciopesto plaster mortar, Ravenglass Roman Bath House (photo taken by Nigel Copsey); **e.** Bricklaying mortar, Viminacium, sawn surface (photo taken by Bille Revie).

It is the author's own recent experience (**Figure 8**; **Figure 9**; **Figure 10**), and, thus, growing conviction, that the key to frost resilience and long--term durability is the use of very lime rich mortars of high effective porosity. Additionally, dry slaking makes such very lime rich mortars practicable to use in ways that a wet-slaked or lime putty mortar with a similar lime richness would not (see below).

Lime plasters from a recently excavated 4th century Roman villa site in Harpham, East Yorkshire (Maw 2021) display multiple lime clasts in their backing coats, in the observation of the author of this paper, but with none of these larger than around 5mm, indicating sieving. The finish coat was of exceptional fineness, being no more than 2mm in thickness, including the pigmented limewash decoration. Such fineness would allow for not even the smallest residual lime clasts in the lime putty finish coat. The geology of East Yorkshire is predominately of chalk (Gale and Rutter 2006).

Very recent analysis of similarly painted three layered plasters from another 4th century villa site, in Verona, Italy, has demonstrated the use of pure, non-hydraulic lime and fine, mainly quartz river sand, aggregate. The topmost plaster layer was mixed at 3 lime to 1, the middle layer was mixed at 1.5 to 1, while the bottom-most layer, however, was mixed at 1:1, being different from the other two, since the clay was blended with lime binder. All layers contain commonly small residual lime clasts (Dilaria *et al.* 2024: 73–74). Although very detailed, the research does not offer any assumptions or conclusions on the probable slaking method.

Figure 8. Spring View Farmhouse, Pickering, North Yorkshire. Repointed by the author in October 2024 with a dry slaked, hot mixed pointing mortar, 1.5 non-hydraulic slaked lime: 0.5 fine limestone dust: 0.5 sand and hair. Note the dryness of the repointed facade compared to the gable end wall still, at this time, with its cement pointing (photo taken by Nigel Copsey).

Figure 9. Calcareous sandstone building repointed in November 2023. Fabric saturated by long-term cement pointing. Within 2 days of completion, and regularly through the winter, overnight temperatures fell to minus 10 and minus 15°C. Mortar ratio 1 lime: 1 sand, dry slaked. No frost damage (photo taken by Nigel Copsey).

Figure 10. Circa 1610 timber framed building, Wakefield, West Yorkshire. Repaired in 2023 by the author and timber-framer Wayne Kirby. Infill panels and internal plasters, like-for-like dry-slaked lime and hair plasters, finished with hot limewash (photo taken by Nigel Copsey).

Lime and hair mortars

For millennia, very many plasters and very many pointing mortars were of lime only (**Figures 11–16**) – with animal hair or other fibre being the only addition (flax was the most common in Palestine and the Levant, Canaan 1933: 49–51; **Figure 17**). According to our analyses of particular mortars from Iberia and Palestine, there was, very often, no added fibre at all, the coats being necessarily thinner in its absence, and likely demanding more assiduous after-care.[8]

Many mortar analyses, historic descriptions and building accounts strongly indicate that these lime and hair mortars were typically dry slaked, allowing for the easy sieving out of unslaked lime lumps. Such mortars were typical over earth-lime bedding mortars (as pointing), over earth or earth-lime base-coat plasters (or solid earthen masonry) and upon lath panels. They were common as plasters over stone and brick, both inside and out, and were typically applied in thin, often single, coats of around 10 mm thickness (Copsey 2019a: 20). When over typically hot mixed bedding mortars, they tended to be more lime rich than these bedding mortars themselves, the latter usually mixed at 1 quicklime to 2 or 3 aggregate (Pasley 1826: 6). Similarly, lime-rich pointing mortars were of greater compressive strength than the earth-lime bedding mortars over which they were laid, the latter being rarely more lime rich than 1 slaked lime to 3 (in Yorkshire, for example,

[8] Bill Revie. CMC Consulting, Stirling. Certificate of Analysis on a Mortar Sample for Binder Type Determination & Mix Composition. Akko, Israel, Pointing Mortar over Earth-Lime Bedding Mortar (2023). For Nigel Copsey of the Earth, Stone & Lime Company.

according to the author's observations and working experience), clay content contributing to the binder in this case.

The case may even be made that such lime and fibre only mortars were, until relatively recently, the 'definition' of plaster, and the manipulation of them the definition of the plasterers' trade. The late 16th century rules of the London Company of Plaisterers are explicit in this regard: "an agreement of 1579 ruled that bricklayers were not to use hair in any plaster. They were allowed to "rough cast, pargett walls with Lyme and Sande so that it be without haire". However, if "the owner will have the same done with Lyme and hayre, Then the Plaisterers to do the same. And if he minde to have it done with Lime and Sande Then the Bricklayers to do it..." (Borstwick 1993: 212).

Such a pattern is demonstrated by building accounts until at least the 17th century. Mapperton Rectory in Somerset, England was built between 1699-1703. Stonemasons laid up the stonework in earth-lime mortars as well as applying the daub, and the earth-lime backing coat plasters within. After this, entries include '10 bushels of white goat's hair…for the white mortar', before plasterers arrive on site to execute the lime and hair finish plastering, as well as to apply lime and hair pointing to the exterior stonework (Machin 1983 in Copsey 2019b Apendices: 425).

Neve, writing in 1726, offers the recipe for such plaster: *Of making other kinds of mortar beside the common mortar (*us'd in laying of stones, bricks and tiles) – …*White Mortar* This is used in plaistering of walls and ceilings, that are first plaistered with lome, and is made of ox or cow-hair, well mixt and tempered with lime and water, (without any sand). The common allowance in making this kind of mortar is one bushel of hair to six bushels of lime. The hair serves to keep the mortar from cracking, binding it, and holding it fast together (Neve 1726: 201).

Almost as common in this, and still in later periods, is the use of typically dry-slaked lime, limestone or chalk dust and hair mortars, always with more lime than calcium carbonate aggregate, most often, in analysis, 2 parts lime to 1 part limestone dust. The limestone aggregate is typically very fine, mostly smaller than 1mm (Copsey 2019b Appendix 11: Mortar Analyses). It is likely that these were encompassed within the definition of 'lime and hair' mortars, whereas lime, sand and hair mortars were not, until the 19th century in the UK, when the term 'lime and hair' included these.

In the York Bridgemasters Accounts (Stell 2003), dating from the 1440s, 'plaster kilns' were fired regularly, and the plasters were intensively beaten and pounded (for at least a day) before application over earth daub coats and timber-framed structures.

Such mortars, therefore, are generally dry slaked, to a high temperature, sieved or screened, brought to a probably bread-dough consistency and then pounded to workability, the extra water addition being kept to a minimum necessary to achieve this plasticity by way of such beating. Keeping the water demand to a minimum would result in much less initial shrinkage in application, and this would inevitably be greater with an initially wet-slaked or lime putty lime only mortar. Clearly, the mortars were used after cooling. Such pounding of minimally wetted mortars was identified by Michoinová and Rovnaníková (2008: 25–27) to decrease the proportion of pores greater in size than 1 micron, lowering the overall porosity, whilst also increasing the rate of carbonation and compressive strength when compared to mortars made with greater water volumes and with minimal pounding, factors that they proposed would increase durability over the longer term. Where not displaced, lime and hair only mortars have proved themselves exceptionally durable, according to our observations (**Figures 13–16**).

Preparation and application of dry slaked mortars

Dry slaking is explicitly prescribed and described by most authors of texts on lime and building historically, including Moxon (1703); Langley (1750); De la Faye (1777); Higgins (1780); Smeaton (1791); Fleuret (1807); Hassenfratz (1825); Vicat (1837); De Villanueva (in Spain, 1827); Searle (1935), and is self-evident within innumerable building accounts from around England and elsewhere (Copsey 2019b Appendices) (**Figure 1; Figure 2; Figure 3**).
Why this seeming preference of the crafts for dry slaking lime, especially for surface finishes? In the author's experience, a wet-slaked lime will be

Figure 11. Lime and hair (no sand) mortar over earth-lime backing mortar (photo taken by Nigel Copsey).

Figure 12. Lime and hair plaster originally applied to riven lath (photo taken by Nigel Copsey).

eminently workable and 'sticky' – highly adhesive and cohesive, and this will be so when mixed at the very common historic proportion (for bedding mortars) of 1 quicklime: 3, or 1 quicklime: 2. (The Viminacium brick-laying mortar will have been hot mixed at 1:2, as previously discussed). A wet--slaked lime only or 2 lime to 1 mortar, however, will be almost too sticky and cohesive for easy use. Common bricklaying mortars in London in 1750 were hot mixed at 2 quicklime: 1 sand, a mortar of 4 slaked lime to 1 sand (Langley 1750: 37; **Figure 18**), aand Neve details a similarly

lime rich lime: sand mortars across the south-east of England in the same period (Neve 1726: 198–199). These mortars were always dry-slaked. At Queen's House in Greenwich in 1616, for example, the building accounts record payments to "Samuel Avery, William Browne and others for slacking, sifting and wetting of lime into mortar at 12d the hundred" (Chettle 1937: 101).

Although a dry slaked lime mortar of 1:3 will be nicely workable, it will not be as much so as a wet-slaked version of the same. However, a very lime rich dry slaked mortar will be much less 'claggy' and 'sticky', without any sacrifice of adhesiveness or cohesiveness. It will be 'easier off the trowel'.

Beyond this, and unexpectedly, the water demand of a wet-slaked lime mortar will be typically higher than will be that of a dry slaked mortar to bring to a similar workability. Water demand is related to particle size (see below).

In the author's experience, a dry-slaked lime, used on its own or with sand or other aggregate addition, will shrink much less than a wet--slaked (or lime putty) mortar; it will move much more rapidly towards an initial set (but without drying too fast) than will a wet-slaked or a putty mortar. This is true even when no fibre is added (**Figure 17**). More surprisingly, perhaps, and as demonstrated at recent mortar trials at Longtown Castle Keep in Herefordshire, lime and hair only mortars will shrink less and move more rapidly towards initial set than may similarly dry-slaked lime--rich, but sanded, mortars (**Figure 19; Figure 20**). This is also true of a lime and hair mortar prepared using the 'Yemeni' method, which is to say, initially dry slaked and then soaked overnight before being mixed with hair and applied, despite it being wetter for soaking than if used soon after dry slaking and mixing to a mortar (it moves more slowly to an initial set, however). This behaviour is due to more than simple water content.

Long-term research by Granada University (Rodriguez-Navarro *et al.* 2005; 2012) into both dry slaked (commercial) and wet-slaked (putty) limes has demonstrated a difference in nano particle size and form of the Ca(OH)2 particle aggregations between the two. Dry slaking results in early formation of the aggregations, of which some are irreversible (they will not dissolve or reduce by being soaked in water), whilst wet slaking leads to a reversible aggregation of plate-like particles, of smaller size (and greater surface area) than those produced by dry slaking (although the platelet may expand significantly and lose surface area after being long-saturated[9]). This difference is clearly of significance to the different behaviours in the use of the two materials. The researchers at Granada concluded that this difference explained better qualities, such as the superior durability and better workability of lime putty mortars (in the lean mixes tested) than the dry slaked mortars. In terms of behaviour, the evidence would suggest that the crafts were of, if not a different, then of a more nuanced opinion, depending upon the purpose to which the mortars were to be put.

PURITY OF LIME AND CARBONATION

Whilst small-scale burning of local limestone may always remain an ideal in terms of precise authenticity and conservation philosophy, as well as being sustainable by some measures of this, particularly in reducing carbon emissions from transportation, it is unclear how possible such small-scale burning will remain in the context of climate change and legislation and necessary action, not only to eliminate fossil fuel and other carbon emissions into the atmosphere, but also to 'draw down' carbon dioxide already in (and still being added) to the atmosphere. The calcination of limestone will always emit CO_2, and in a greater proportion than will the fuel (European Lime Association 2023: 7). The purer the lime, the more efficiently the CO_2 emitted from the limestone will be re-absorbed (European Lime Association 2023: 18–19) (although such re-absorption is not part of typical calculations of carbon footprint). The carbon emissions of the fuel may be significantly reduced by the use of 'bio-mass' fuels, such as olive stones, for example (Lhoist 2021: 25), or, increasingly, by the use of green hydrogen, or by the use of sustainably generated electric rotary

[9] Data obtained from the presentation named *Learning from historic mortars: studies on lime manufacturing and fresco conservation* and delivered by Anna Arizzi at the *1st International Conference with Workshop Science for Conservation of the Danube Limes,* held in Viminacium, Serbia, from the June 27th to July 1st, 2022.

Figure 13. Lime only mortar over earth lime bedding mortars, Akko (Acre), Israel. On analysis by Bill Revie, this was of non-hydraulic lime only and without even fibre. Dry slaked, but used after cooling (photo taken by Nigel Copsey).

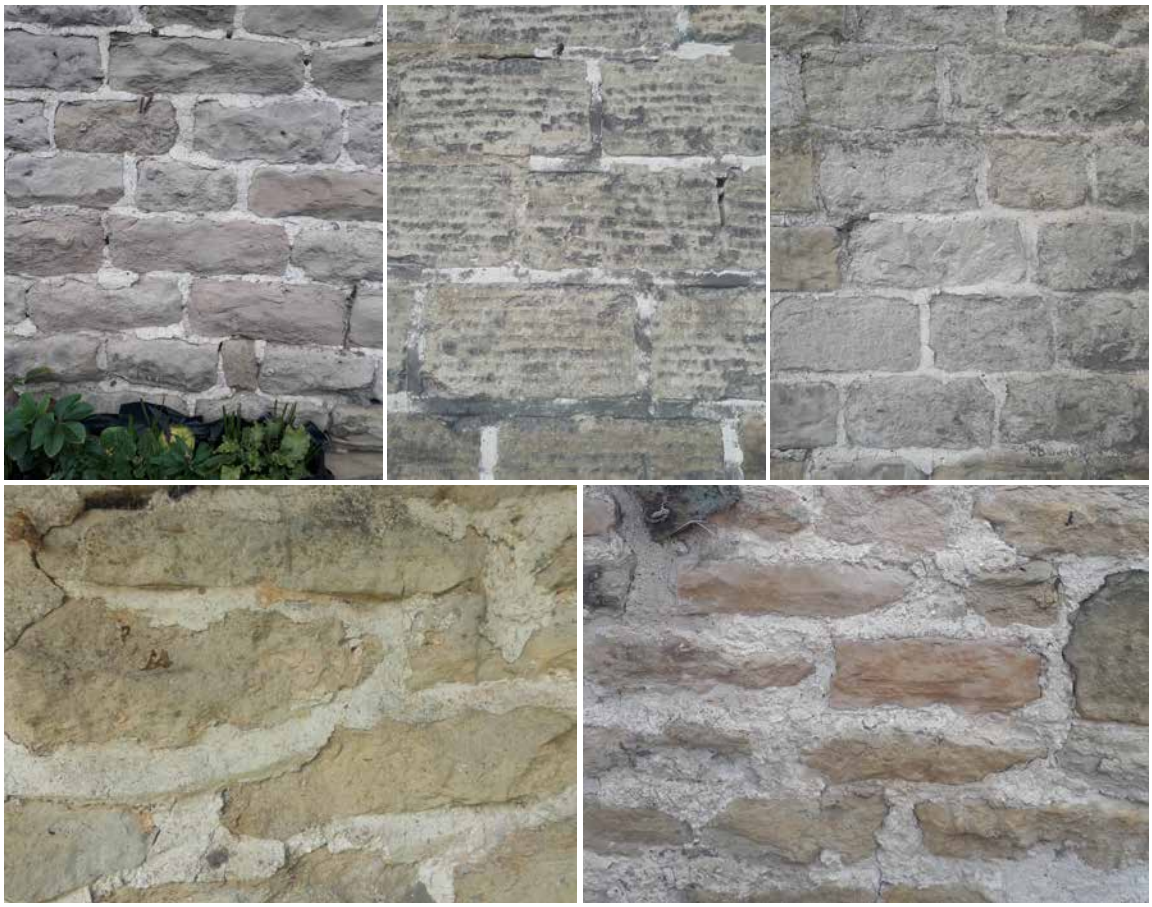

Figure 14. Lime and hair pointing mortars, some with low level limestone addition, Thornton le Dale, North Yorkshire. Around 300 years old (photos taken by Nigel Copsey).

Figure 15. Church of St Clydawg, Clodock, Herefordshire. Very long in situ lime and hair pointing mortars over pit sand bedding mortars, as well as remnant of limewash surface treatment (photo taken by Nigel Copsey).

Figure 16. a. Lime and hair (only) plaster onto sandstone masonry, 17th century building; **b.** its exterior recently repointed with a hot mixed lime mortar, North Yorkshire Moors (photos taken by Nigel Copsey).

Figure 17. Model Farm, Tel Aviv, 1850, **a.** original, very full lime and flax shiv pointing over earth-lime bedding mortars (detail); **b.** reinstatement of the same by Centaur Conservation in 2022. The architect drew the line at limewashing, which would surely have followed (photo taken by Centaur Conservation and published with their permission).

kilns. However, the emission of CO_2 cannot be eliminated by anything other than carbon capture processes. All 'solutions' rely upon extensive, ongoing capital investment, beyond the means of any small-scale lime-burners, increasingly scarce on the ground as these already are (there

are none in the UK, for example). If we are to continue to use lime, it will generally be in the form of industrially produced high calcium lime of between 94-99% purity.

This has been, however, according to the literature, the level of purity preferred and sought out by masons and others throughout time. It is a general principle that has been much clouded and confused after 120 years of using frequently hydraulic binders (whether of Portland cement or, more recently, Natural Hydraulic Limes) above ground. As Champly noted in France in 1910: "We differentiate mortars thus: fat lime, used for raising walls, hydraulic lime for foundations, substructures, basement and works meant to be immersed. Slow or prompt cement for underwater works or in very humid places" (Champly 1910: 45).

Only the nature of the 'cement' has varied over time; the principle has not, with even those engaged in the very early use of lime – the Natufians in the Epipaleolithic and Pre-Pottery Neolithic in the southern Levant – eschewing the immediate dolomitic geology of their site, and carrying pure lime over distances for burning (Friesem *et al.* 2018: 17). Neve discusses the value of ordinary lime mortars infused with linseed oil to produce a cement and notes the use of 'Hog's Grease' (pig fat) in the ancient mortars with which cisterns were lined (1726: 201–202).

Edwin Eckel (1922: 118) lists the primary building lime producers in the USA in 1922, along with analyses of their product. Of 35 producers, all but a few produced limes of over 96% purity. Of those few that did not, the purity was 94%, with just one being as low as 92%.

All available evidence would indicate that pure or nearly pure lime was the material of building construction historically and frequent claims that 'dirty' limes were preferred are firmly rejected in Eckel's analysis: "Lean or poor limes: - A lime containing over 5% of such impurities as silica, alumina, and iron oxide will usually be dark in colour, comparatively slow slaking, and difficult to trowel in working. Such limes are known as 'lean' or 'poor' limes. *In a few cases* the impurities are so evenly and finely distributed throughout the original limestone that on burning the limestone a certain amount of combination takes place between the lime and the impurities. This gives slightly hydraulic properties to the product. Ordinarily, however, no such chemical combination takes place on burning, and the impurities simply serve to depreciate the quality of the lime produced" (Eckel 1922: 119).

A ready availability of pure or nearly pure lime, therefore, is and will remain a benefit in terms of authenticity of performance and compatible repair (**Figure 21**), and the almost complete carbonation of such lime over time is a significant and currently under-estimated benefit in the necessary response to the existential threat of global warming. Pure limes may be essential for the repair of traditional fabrics; they may yet prove, along with clay-bearing subsoils, to be essential for sustainable, carbon-negative future construction, as well as for compatible repair.

A high calcium, pure or nearly pure lime used in a mortar will reach its maximum natural carbonation of 80 % within 100 years, up to a depth of 191mm from the surface (European Lime Association 2023: 19; Campo *et al.* 2021: 228–229, 232). The small thickness mortars for surface treatments, such as rendering, plastering, pointing or limewash, can even reach full carbonation (Schlegel and Shitiza 2016: 936).The life-time carbonation of the hybrid air lime mortars (among which are the three most common cements: lime mortars - 1:1:6; 1:2:9; 1:3:10, but also a natural hydraulic lime mortar), is only 20%, around one quarter of that in a pure lime mortar (European Lime Association 2023: 19; Campo *et al.* 2021: 228-229, 232). The volume of carbonated material will increase as the lime content of the mortar increases. The burning of limestone, however, whether on its own for lime mortars, or in the production of Portland cement mortars or of natural hydraulic lime mortars, is a major source of atmospheric carbon dioxide pollution, although, in the case of pure lime mortars, the emissions from the limestone during calcination will be largely reabsorbed, probably within the lifetime of the mortar.

The presence of hydraulic material will inhibit, reduce and even prevent carbonation of some, at least, of the available lime. Even only 10% cement addition as a proportion of the lime leads to around a 30% reduction in vapour permeability; and a 25% addition, to a 60% reduction in the same (Iglesias Martinez and Alonso Carro 2007: 7–8). This represents a serious densification of the

Figure 18. Sample reproduction of typical 18th C bricklaying mortar, 4 lime: 1 sharp sand, dry slaked and hot mixed. Made by the author (photo taken by Nigel Copsey).

Figure 19. In situ lime and hair pointing trial by the author for English Heritage/Historic England, Longtown Castle Keep, Herefordshire, built with clay-sand mortars c1220 (photo taken by Nigel Copsey).

Figure 20. In situ lime and hair pointing trial by the author for English Heritage/Historic England, Longtown Castle Keep, Herefordshire, built with clay-sand mortars c1220 (photo taken by Nigel Copsey).

pore structure and a reduction in porosity. Whilst vapour permeability is a poor mechanism for the drying of porous materials (Pender, Ridout and Curteis 2014: 46–48; Pender and Lemieux 2020: 5; Wiggins 2019 in Copsey 2019a: 143; Copsey 2021: 78–79; Iglesias Martinez and Alonso Carro 2007: 5–7), it is of pertinence to the initial carbonation, and the mechanisms by which this occurs. 'Most

Figure 21. Reinstatement of lost hot mixed lime renders and limewashes, West Wratting, Cambridgeshire. Not only historically authentic and drying of the fabric but providing a carbon sink (photo taken by Ashley Courtney and published with his permission).

permeable materials will spontaneously absorb water vapour from the ambient air,' but will leave only by surface evaporation from the liquid-phase water drawn to the surface of a capillary-active pore structure, rarely as water vapour itself, there being no physical mechanism by which the latter may move in a similar way (Pender, Ridout and Curteis 2014: 46). The permeability of the mortar, and the presence of an inter-connected, capillary-active pore structure, therefore, will allow optimal ingress of CO_2 and optimal egress of liquid phase water. Hydraulic materials, such as hydraulic lime or cement, are deficient in such a pore structure, and the more so, the more hydraulicity they possess. The poor carbonation rates of hydraulic materials was understood as long ago as the 1880s: "My researches lead me to the same results as those enunciated by Geo. Robertson Esq, in a paper recently read before the Royal Society of Edinburgh, viz "The depth to which carbonic acid is absorbed into mortar in a given time, and, to a certain extent, the induration from that cause, varies inversely with the hydraulic properties of the lime…" (Gillmore 1886: 187). Empirical evidence would also indicate that the pattern of carbonation, when dry or substantially steam-slaked lime is used, is more diffuse through the depth of the mortar, rather than being strictly from the 'outside-in' as seen with lime slaked with an excess of neccessary water.)[10] (**Figure 22**).

As has been discussed above, it was very common historically for mortars for surface treatments to be either of pure lime (and hair) only, or to be lime rich with limestone or chalk aggregates. Such mortars have proved to be very durable and long-lasting. Research by Arizzi *et al.* (2011), among others, has shown that the use of limestone aggregates accelerates the rate of carbonation in non-hydraulic lime mortars (with dry hydrated lime), amplifying any carbon sink effect, as well as making such mortars stronger and, perhaps, more quickly frost resilient. It was also noted that the calcitic aggregates improved the structure, that is the cohesion between the aggregate and the binder

[10] Data obtained from the presentation delivered by Giovanni Pesce at Building Limes Forum, held in Lincoln, England, from the June 27th to July 1st, 2023. See also in: Pesce *et al.* 2021: 14–15. Also, concluded after the analysis of a 10 month-old dry-slaked lime and hair pointing mortar done by Bill Revie CMC Consulting, Stirling. Certificate of Analysis on a Mortar Sample for Binder Type Determination and Mix Composition, 11-Month Old Plaster Mixed From Lime Produced by Burning Local Oolitic Limestone (2021) for Nigel Copsey of the Earth, Stone & Lime Company.

Figure 22. Carbonation of dry slaked lime and hair mortar after 10 months *in situ* (photos taken by Bille Revie).

(we can call it the 'tenacity' in the language of so many old texts) in the mortars over and above that when siliceous was used. Recent research by David Wiggins for Historic England has shown that the inclusion within an otherwise micro-porous matrix of larger macro-porous aggregates (such as coal, sandstone or brick) may accelerate carbonation rates by between 5 and 10 times (Wiggins and Kepczyk 2022: 31–32). It is, in fact, very common to find such macro-porous inclusions (around 5%) in historic lime mortars when the general aggregate (of fine sand or of limestone) is very fine, and the mortars are very lime rich. As with so many recent scientific insights into the properties of traditional mortars, these would seem to have already been long understood by the crafts.

Research carried out by Mike Lawrence (2006), and then by Scannel *et al.* (2014), using commercial dry slaked lime, also demonstrated that mortars made with limestone aggregate were significantly stronger, in terms of compressive strength, than mortars of the same proportion made with siliceous aggregate, and that the chemistry of the limestone influenced the magnitude of this difference, as did the fineness of the limestone aggregate. Additionally, the carbonation level was noticed to be directly proportional to the strength of the mortars. The vast majority of historic limestone aggregated mortars show this to have been typically very fine. Important, and exceptional, research by Lanas and Alvarez (2003) adds to this story. It was exceptional for testing not only 1 slaked lime: 3 mortars (as is so often the norm), but mortars much richer in lime than this. The aggregates used were of silica and calcite origin. Also exceptionally, the mortars were tested even after 365 days. The lime was a commercial dry hydrated lime.

As Midtgaard (2023a: 314–315, Fig. 2, 324) has well demonstrated, the likeness of a 1 lime : 1 hot mixed plaster mortar made as a replica and a 2 lime : 1 of medieval plaster, to a 1 putty lime : 3 mortar is minimal, to say the least, when viewed in thin section. The former absorbs four to six times more water than the latter (**Figure 23**).

This difference confirms the experimental findings of Lanas and Alvarez (2003: 1874, Fig. 5). The 2 lime : 1 limestone mortar, probably the most commonly used historic proportion for plasters (e.g. in Balksten 2007: 74; Copsey 2022: 211–212; Midtgaard 2023a: 314; Midtgaard 2023b: 38, 108–109), reached 5.95 MPa, while the 4:1 was weaker than this maximum (5.40 MPa). The lime on its own (commercial dry hydrated lime) was weaker again, at 4.1 MPa, but was the most porous of all. That said, lime plaster may be less strong than this when limestone aggregate was combined with other materials, such as crushed ceramics or wood ash (e.g., in Late Roman and Byzantine multi- -layered plasters for waterproofing in Jerusalem -Van Zuiden and Asscher 2021: 236–243). All of these lime-rich mortars above significantly exceed the minimum strengths necessary for solid-wall construction, and even those that might be demanded by modern engineers for thin-wall construction. All will have possessed inter-connected pore structures, delivered by the pure lime, and in which pore structure, it would seem, the fine limestone was able become a part of. Lanas and Alvarez (2003: 11) concluded that 1 lime : 1 limestone (5.25 MPa) was an 'optimal' mix proportion, with the highest compression strength (and shrank the least) and this proportion is very commonly found historically and with proven durability over centuries. Whilst the strongest, the 2:1 was also the most porous after the

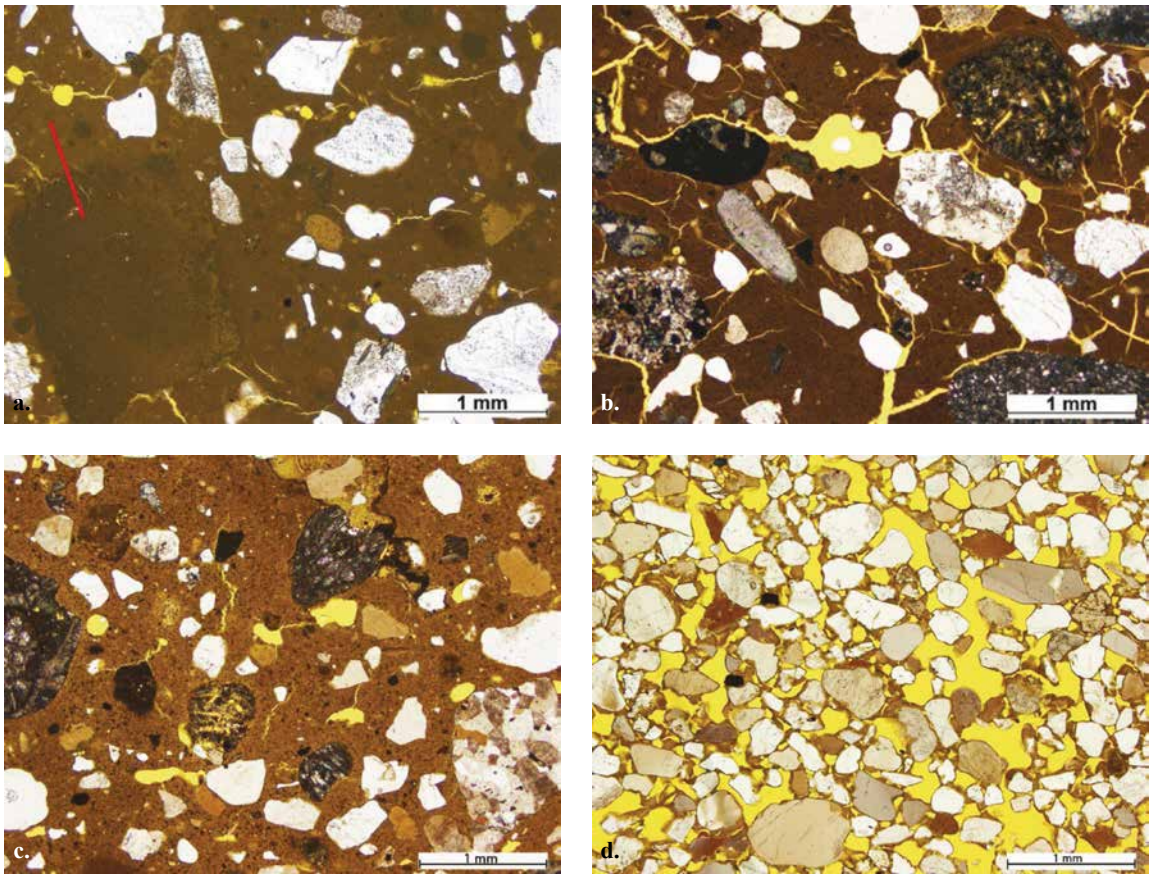

Figure 23. Photomicrographs of plaster thin sections for comparison of the microstructure in: **a.** medieval plaster; **b.** hot mixed 1:1 replica plaster (Midtgaard 2022: 53, Fig. 8.2); **c.** medieval plaster; **d.** lime putty 1:3 replica plaster (Midtgaard 2022: 40, Fig. 5.4).

4:1 and the lime only, and even at 1:1, the mortar had active pores in much higher volumes than the weaker 1 lime : 3 or 1:4 (Lanas and Alvarez 2003: 1873–1877), inverting the normal equation that says that greater compressive strength equates to less breathability and porosity, which in NHL and cement mortars it does. True pozzolanic mortars tend towards lower compressive strength and high porosity derived from nanoscale porous pozzolans (Jackson in Oleson *et al.* 2014: 182-183), and may be considered very different from mortars made with NHL, Natural Cement or Portland cement.

CONCLUSION

In the author's opinion, these days, the tendency might be to wet slake building mortars for their stickiness, especially at a leaner lime proportion (an economic advantage), but always now to dry slake plaster and pointing mortars, using these at an historically very lime rich proportion, allowing for the practicable application of like--for-like and highly breathable mortars, whilst at the same time, and increasingly as industrial high calcium lime production becomes carbon negative in its production emissions, making a positive contribution to the mitigation of global warming and climate change, not only in terms of delivering a dry and thermally efficient building fabric, (that will also require much less frequent repair and renewal of mortars, given the inherent durability of a like for like and compatible repair), but in providing active carbon sinks for the sequestration of existing atmospheric carbon dioxide. The more lime-rich the mortar, the larger will be the carbon sink effect, in the absence of production emissions.

All modern and recent research into traditional mortars that has taken its lead from actual historic practice has so far demonstrated, not only the profundity of the craftsmen's knowledge about their preferred materials historically and the

often unwritten skills of their manipulation, but also the general good sense and sustainability of these materials, the durable performance of which offers to a modern building industry currently responsible for at least 37% of global greenhouse gases, among which is the most present CO_2, generated from cement production that contributes around 7% of carbon emissions (United Nations Environment Programme 2023: ix, xiv), a rational template (given the will) for the future, not only of our built environment, but of the health and well-being of humanity as a whole. Carpe Diem.

Note: Mortar analyses referenced in the text are available at https://www.hotmixedmortars.com.

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REZIME

PRINCIPI TRADICIONALNE PRIPREME I UPOTREBE MALTERA. ISTRAŽIVANJE TRADICIONALNOG POSTUPKA SUVOG GAŠENJA

KLJUČNE REČI: SUVO GAŠEN KREČ; MOKRO GAŠEN KREČ; SUVO GAŠENJE; MOKRO GAŠENJE; KREČNO TESTO; KREČ I DLAKA; KREČNJAČKI AGREGATI; EMISIJE UGLJENIKA; KARBONATIZACIJA; PONOR UGLJENIKA.

Ovaj rad predstavlja istraživanje tradicionalnih metoda gašenja kreča, detaljno opisanih u brojnim istorijskim tekstovima i potvrđenih profesionalnim iskustvom autora ovog rada, kao i savremenom naukom o materijalima. Konkretnije prikazuje načine suvog gašenja kreča i predrasude koje je doneo pokret „lime revival", nastao sedamdesetih godina prošlog veka u Ujedinjenom Kraljevstvu kroz zanemarivanje metoda gašenja kreča

prisutnih u tradicionalnoj zidarskoj praksi. Istražuje prednosti koje su zanatlije oduvek pronalazile u različitim metodama – početnog suvog ili mokrog gašenja kreča, kao i u korišćenju maltera veoma bogatih krečom, u skladu sa namenom. Zalaže se za upotrebu kompatibilnih maltera u konzervaciji tradicionalnih i istorijskih građevina, kao i maltera nalik onim tradicionalnim za gradnju savremenih održivih zgrada sa niskim ugljeničnim otiskom, ali i produženim vekom trajanja.

Primarni oblici gašenog kreča su suvi prah ili gusta pasta (testo). Količina vode za postizanje jednog od ova dva ishoda je različita. Iz istorijskih tekstova saznajemo da nije bilo preporučljivo dobijati krečno testo potpunim potapanjem, kako je uobičajeno sprovođeno u aktivnostima napred navedenog pokreta. Ovako pripremljeno testo ima nešto drugačije karakteristike od onog napravljenog od prvobitno suvog gašenog kreča (živi kreč ugašen sa minimalnom količinom vode u prah – hidratisani kreč) ili mokrim gašenjem (živi kreč ugašen sa manje vode odmah u testo). Tokom ove dve metode gašenja, kreč se može dalje mešati sa agregatom dok je još veoma vruć. U posebno suvim metodama gašenja, kreč se može ostaviti u pesku da se ohladi pre nego što dođe do mešanja. Ohlađeno krečno testo se znatno teže meša sa peskom nego ono vruće, tako da bi, ako ni zbog čega drugog, prirodna tendencija trebalo da bude ka mešanju krečnog testa sa peskom dok je ono još uvek vruće. Po mišljenju autora ovog rada, maltere za zidanje bi trebalo pripremati sa krečom kroz gašenje mokrim postupkom, sa manjom količinom kreča, dok bi maltere za malterisanje i fugovanje trebalo pripremati sa krečom kroz gašenje u suvom postupku, uz upotrebu veće količine kreča.

Dostupnost čistog ili skoro čistog kreča jeste i ostaće prednost u smislu očuvanja autentičnosti i principa kompatibilnosti u konzervaciji, a skoro potpuna karbonatizacija takvog kreča tokom vremena je značajan, ali trenutno nedovoljno cenjen podatak u pripremi neophodnog odgovora na egzistencijalnu pretnju globalnog zagrevanja. Što je kreč čistiji, to će se efikasnije apsorbovati CO_2, koji se emituje prilikom kalcinacije krečnjaka. Što je malter bogatiji krečom, veći će biti efekat ponora ugljenika u odsustvu proizvodnih emisija.

Iako mali proizvođači kreča predstavljaju „ideal" u kontekstu autentičnosti, filozofije konzervacije i održivosti, posebno u smanjenju emisije ugljenika iz transporta, nejasno je koliko će oni opstati u kontekstu klimatskih promena, zakonodavstva i neophodnih aktivnosti – ne samo u cilju eliminisanja fosilnih goriva i druge emisije ugljenika u atmosferu već i ponora ugljen-dioksida koji se već nalazi u atmosferi. Kalcinacija krečnjaka će uvek emitovati ugljen-dioksid, i to u većoj količini nego samo gorivo. Emisije ugljenika iz goriva mogu se znatno smanjiti korišćenjem zelenih goriva ili vodonika, kao i korišćenjem savremenih peći, ali se njhova eliminacija može izvršiti samo hvatanjem ugljenika. Sva potencijalna rešenja u ovom smislu oslanjaju se na obimna ulaganja, što se nalazi izvan bilo kakvih mogućnosti malih proizvođača kreča, kojih je inače sve manje. Stoga, ako nastavimo da koristimo kreč za građevinarstvo u budućnosti, on će generalno biti industrijski proizvod.

Istraživanja tradicionalnih maltera do sada su dokazala ne samo dubinu zanatskog znanja o najadekvatnijim građevinskim materijalima i često nepisana pravila za njihovu upotrebu, već i performanse trajnosti i održivosti ovih materijala. Upravo ovi malteri nude savremenoj građevinskoj industriji, trenutno odgovornoj za veliku količinu globalnih gasova staklene bašte (među kojima je najprisutniji ugljen-dioksid koji nastaje u proizvodnji cementa), jedan racionalan šablon za budućnost ne samo naše izgrađene sredine već i zdravlja i blagostanja čovečanstva u celini.

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CERAMIC VESSELS FROM THE WASTE PIT BY THE ROMAN KILN IN THE KOSTOLAC A THERMAL POWER PLANT NEAR VIMINACIUM

ABSTRACT

Salvage excavations at the Provalije site in the area of the Kostolac A thermal power plant, located near ancient Viminacium in today's Serbia, have significantly contributed to the understanding of ceramic production in the area, uncovering a Roman brick kiln and the accompanying waste pit with fragmented pottery, dated to the period from the mid-2nd to the mid-3rd century. Together with the previous excavations at this site, these have provided evidence for the existence of a new ceramic production centre of Viminacium, which was initially suggested during the old investigations accompanying the nearby diversion of the Mlava river.

The waste pit contained fragments of ceramic vessels, as well as floor tiles and imbrices. The pottery shares the same technological qualities, being made from well-purified clay and fired in red tones, its outer surfaces painted in various shades of red, while their exterior was often decorated with incisions. The majority of the pottery belonged to tableware, with a smaller portion consisting of vessels used for storage. The significance of the found pottery at the waste pit lies in the confirmation of its local origin; they were products of the Viminacium ceramic centre during the above mentioned period, which could offer us new insights into the range of Viminacium ceramic production centres found so far.

KEYWORDS: VIMINACIUM, POTTERY, PRODUCTION CENTRE, WASTE PIT, CERAMIC VESSELS, BOWLS, POTS, AMPHORAE, KOSTOLAC, PROVALIJE SITE.

INTRODUCTION

Ancient Viminacium was located in what is today's eastern Serbia, next to the modern town of Kostolac, close to the right bank of the Mlava river, near its confluence with the Danube (**Figure 1**). It was founded during the second half of the 1st century AD as a legionary camp of the *Legio VII Claudia*, which remained stationed here until the end of Classical Antiquity. Over several centuries, the city of Viminacium developed west of the fortress and grew to become the largest urban settlement and the administrative centre of the province of Upper Moesia (Спасић-Ђурић 2015: 22–26; Korać 2019: 22–31).

During the decades of salvage and systematic excavations of Viminacium and its surrounding areas, which started in 1882 and are still being conducted today (Korać 2019), four separate areas for the production of ceramic building materials and pottery have been detected. These are the sites named Provalije, Pećine, Livade kod Ćuprije, and

Figure 1. Arrangement of kilns for firing ceramic vessels within the investigated locations of Viminacium (Google Earth, accessed on June 20, 2024, map retrieved and supplemented by the authors).

Pirivoj (Ненадовић и Јуришић 1956; Јордовић 1995; Raičkovič and Redžić 2006; Raičković 2007; Jevtović 2022: 134–143; Jevtović and Danković 2022; Jovičić and Milovanović 2017; Jevtović 2023: 214–229) (**Figure 1**).

Among these areas, the one at the Pećine site was recognised as a production centre for ceramic building material and pottery during the salvage excavations that took place in the period from 1977 to 1992, conducted due to the development of the industrial complex of the Kostolac B thermal power plant in the village of Drmno (Јордовић 1995; Raičković 2007). It is situated near the old course of the Mlava river whose course was artificially altered multiple times over the last two centuries. The first modifications began in the late 19th century with minor corrections to advance agricultural productivity and prevent frequent flooding. More major interventions happened when the rapid industrial development in the area of Kostolac started, after the first strip coal mine opened and the Kostolac A thermal power plant was constructed in the town of Kostolac in the 1940s (Влашковић, Славковић 1971: 118–121). These interventions included draining vast swampy areas and redirecting the river's flow. The most significant works were carried out during the industrial development in the 1950s and 1960s, when the old riverbed was drained, canals were dug and embankments constructed to control the river and protect the area from floods (Миљковић, Степановић, Миладиновић 2009: 25–16). These interventions significantly changed the local ecosystem and landscape, leaving a lasting impact that is still visible today. The old Mlava riverbed is, however, still recognisable and is essential for understanding the history of the area. Additionally, many other archaeological traces connected with ceramic production from the Roman period were revealed during the aforementioned industrial works, as well as during the other activities of mining and production of electricity in the wider Viminacium area.

The Provalije site is mostly situated inside the area of the Kostolac A thermal power plant and is located ca 3.3 km to the west of the remains of the city of Viminacium, near the opposite, left bank of the Mlava river (Jevtović 2023: 226) (**Figure 1**). During the construction of the power plant, nine brick and pottery kilns were detected in the period from 1942 to 1944, and unfortunately destroyed (Orlov 1960: 314), while three more brick kilns were noted in 1952 during rescue excavations (Ненадовић и Јуришић

1956). Numerous ceramic moulds for pottery were discovered during the salvage excavations along the Mlava river in its riverbed (Bjelajac 1990: 143), which, along with finds of kilns during 1940s and 1950s at the nearby Provalije site, suggested the existence of a new production centre in this area. This was further proved after the more recent excavations conducted due to the small-scale construction activities within the area of the thermal power plant, when two brick kilns were found in 2015 and one in 2018. The compelling evidence for the existence of the production centre in the proximity of Viminacium and, thus, the spanning of the centres on both sides of the Mlava's ancient riverbed, significantly contributed to the understanding of overall Roman ceramic production in the area.

This study will present and analyse the pottery uncovered in the waste pit found near a brick kiln in 2018. It aims to provide a further understanding of pottery production during the Roman period in Viminacium, while identifying the origin of the various types of pottery found.

FIND CONTEXT

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Of the two brick kilns excavated in 2015 at the Provalije site, only one could be revealed entirely. This kiln is of great significance because the bricks found inside reliably identified the workshop; thus, enriching the knowledge of the activities of the *Legio VII Claudia* in brick production (Danković and Jevtović 2022: 118).

In 2018, an excavator working in the area encountered a substantial agglomeration of bricks and burnt earth, leading to the discovery of yet another kiln (kiln no.3), also designated as a brick kiln (Jevtović 2023: 227–229) (**Figure 2**). Since the salvage excavations of the kiln were limited both in terms of time and space, most of its archaeological features were not excavated in their entirety, although the goal was to acquire as much information as possible. It is not possible to precisely date the kiln, considering the absence of any other datable material, but it can be connected to the brick kilns discovered at the site in 2015 (Danković and Jevtović 2022: 118) and dated to the period from the early 2nd to the middle of the 3rd century (Jevtović 2023: 227). The area in front

Figure 2. Appearance of the excavated kiln (kiln no. 3) with the accompanying waste pit (photo documentation of the Institute of Archaeology, Belgrade).

of the kiln no. 3 was enclosed by walls made of brick and mud mortar. The layer in front of the kiln consisted of dark brown earth with a high concentration of brick fragments, mud brick, burnt earth and ash. The kiln itself was filled with earth and ruined kiln elements as well as with animal bones. It was dug into the surrounding soil on three sides and opened only towards the enclosed working area to the east. It belongs to the type of quadrilateral kilns with a single corridor (type II/b) Its external dimensions are 3.00 x 2.96 m.

Interesting finds were noted in the waste pit (pit no. 2), located next to the southern wall of the kiln chamber (**Figure 2**). The pit was partially excavated, to a dimension of 1.90 x 1.70 m, with the bottom identified at a depth of 0.65 m. It was filled with numerous fragments of ceramic vessels, among which was one deformed amphora originating from Viminacium production, butterfly-shaped floor bricks, and fragments of imbrices. The rest of the pit was filled with earth and admixtures of sand. Since the kiln and the pit do not negate themselves, it is assumed they were used simultaneously and that this pit was used to discard products from the described kiln or potentially from another nearby, as yet undiscovered, kiln (Jevtović 2023: 228–229). The duration of the pit use is also unknown, as is its stratigraphy.

Further in the text the found specimens will be presented, providing us with new insights into the possible range of products from the centres in Viminacium during the period from the mid-2nd to mid-3rd century.

REVIEW OF THE POTTERY FROM THE WASTE PIT NO. 2

The presentation of the found ceramic vessels given here is created according to the order given in the published typology of pottery found in Viminacium so far and based on the forms (Nikolić, Raičković Savić, Mitić 2023: 12-14). The typology has been used at this site for decades. Among 113 different vessels, 25 bowls, 15 pots, 12 plates, 31 flat-bottomed table amphorae, 2 pithoid pots, 2 beakers and 26 jugs were found.

The forms

The Viminacium typology consists of the following forms: (I) bowl; (II) pot; (III) plate; (IV) amphorae; (V) lid; (VI) pithos; (VII) strainer; (VIII) bottle; (IX) beaker-cup; (X) censer; (XI) prosopomorphic and anthropomorphic vessel and vessels in the form of a human head; (XII) jug; (XIII) coin bank; (XIV) miniature vessel; and (XV) *patera* - casserole, which all have their own types.

The most numerous finds of pottery in Viminacium belong to kitchenware, tableware is also very frequent, less numerous are amphorae, while the vessels for storage are the least presented (Nikolić, Raičković Savić, Mitić 2023:14). All fragments found in the waste pit described in this paper belong to the tableware forms: bowls, pots, plates, beakers-cups, and jugs - even those that were parts of flat-bottom amphorae, except pithoi, more specifically pithoid pots, which were used storage. There are no fragments that belonged to vessels used exclusively as kitchenware.

Most of the fragments found in the waste pit no. 2 at the Provalije site belong to the already recognised Viminacium types among these forms, but there are also those that were parts of vessels found at a Viminacium site for the first time.

(I) Bowls

Twenty-five bowls have been documented in this waste pit, classified into nine types already found in Viminacium.

The most numerous bowls are those with a ring-profiled rim and a calotte receptacle on a low foot. Four bowls of this type have been found. These bowls are made from well-sifted clay, fired to red (2.5YR 6/6, 6/8), and have red-painted outer surfaces. They have been found both in settlement horizons and as grave goods in cremation burials of Viminacium, presenting the most commonly used tableware during the period from the 2nd to the middle of the 3rd century Viminacium (Nikolić, Raičković Savić and Mitić 2023: 101). Rim diameters of the found bowls range from 23 to 36 cm, and the base diameters range from 9 to 10 cm (Nikolić, Raičković Savić and Mitić 2023: 121, **type I/10,** 101).

Two small bowls with an indented rim and a calotte receptacle on a low, narrow foot were also discovered in the pit (**Table I.1**). They are made from well-sifted clay, fired to red (2.5YR 6/6, 6/8), with red-painted, polished outer surfaces. Their rim diameter ranges from 8 to 13 cm, and they are very common at all Viminacium sites (Nikolić, Raičković Savić and Mitić 2023: 130, type **I/29**).

Another bowl type (**Table I.2**) was noted in the pit, with a short, curved rim and conical receptacle on a narrow, flat base. The outer rim edge has a deep groove, and the central part of the receptacle has incised lines. These types of vessels were modelled on form Drag. 46[1], from well-sifted clay, fired to red (5YR 7/6), with red-painted outer surfaces. The rim diameter of these bowls is about 10 cm (Nikolić, Raičković Savić and Mitić 2023: 141, type **I/59**).

Four medium-sized bowls found in the pit are represented by a shape with an obliquely cut rim and a high belly on a low foot (**Table I.3**). The receptacle is decorated with groove-incised lines and made from well-sifted clay, fired to red (5YR 5/8, 6/8), and red to brown-painted outer surfaces. The rim diameter of these bowls is up to 22 cm (Nikolić, Raičković Savić and Mitić 2023: 133, **type I/39**).

A bowl shape very commonly found at all Viminacium sites and discovered in the waste pit is one with differently profiled rims, a biconical receptacle on a low foot, and a relief band or ring rib in the middle of the receptacle (Nikolić, Raičković Savić and Mitić 2023: 129–130, **type I/27**) (**Table I.4**). Three specimens of this bowl shape have been found and are made from well--sifted clay, fired to red (2.5YR 6/8; 5YR 7/8), and have red-painted, polished outer surfaces. Their rim diameter is 24 cm. This type is, along with the bowls described at the beginning of the section (Nikolić, Raičković Savić and Mitić 2023: 121, type I/10), is the most commonly found tableware in Viminacium during the mentioned period from the 2nd to the mid-3rd century (Nikolić, Raičković Savić and Mitić 2023: 101).

Among the larger bowls found in the pit are five with a short, horizontal rim and a rounded bent belly (**Table I.5**). The upper cone of these bowls is always decorated with faceting, and some specimens have applied horizontally placed handles below the rim. They have the same technological characteristics as the previous type. The diameters of these bowls are from 35 to 40 cm (Nikolić, Raičković Savić and Mitić 2023: 129, **type I/26**).

An interesting find is a bowl (**Table I.6**) with an arched rim and a calotte receptacle on a low foot. There is often a pseudo-spout on the rim. This bowl is made of well-sifted clay, fired to red (5YR 6/6), and a red-painted outer surface. This specimen is particularly interesting because the fingerprints of the master who painted the vessel are evident on the outer side, which is the first case in Viminacium. Whether due to a lack of knowledge or time, the vessel was moved before the paint completely dried; thus, the artist unintentionally left his personal mark on the vessel (**Table III.2**). The diameter of the vessel rim is 26 cm, and of the base is 9.7 cm, the height is around 7.7 cm, and the volume is about 1.4 litres (Nikolić, Raičković Savić and Mitić 2023: 134–135, **type I/42**).

There is also a bowl that is morphologically similar to the *mortarium* form, although not as large, with a broad, lowered rim (**Table I.7**), whose inner edge forms a spout; the receptacle is conical or calotte-shaped, and the bottom is flat. It is made from well-sifted clay (2.5 YR 6/8). The interior of the vessel is roughened with crushed pebbles. Usually, a stamp is found on the spout, but it is not preserved on this specimen. The rim dimension of this sample is 34 cm (Nikolić, Raičković Savić and Mitić 2023: 146–147, **type I/74**). Although *mortaria* are generally recognised as kitchenware, this specimen can be considered tableware, according to Viminacium typology, since it was executed very carefully with fine and sifted clay. Although, only one specimen of this type is found here, we exclude the possibility that its origin is outside of this production centre, since its technological characteristics comply with those of the other vessels found at the Provalije site.

In the layers of the 2nd and 3rd century, four bowls of a biconical receptacle, with a short and grooved rim at a low foot, which are often represented in Viminacium, were found in the waste pit as well (**Table I.8; Table III.1**). The upper cone is usually decorated with stamped ornaments or facets. They are made from well-sifted clay, fired in red (2.5YR

[1] Drag. – Dragendorff 1895.

5/6, 7/8, 8/4), and the outer surface is red painted. The rim diameter is 32 cm (Nikolić, Raičković Savić and Mitić 2023: 176, **type I/186**).

(II) Pots

Fifteen pots classified into one new and four types already found in Viminacium have been documented in this waste pit.

Fragments of a pot with an oval opening, slightly tilted rim, and slightly rounded belly walls were found; the bottom is oval, concave, with pronounced edges (**T. I.12**). Below the rim, horizontal handles are applied, often with thumb impressions. It was made from well-sifted clay, fired to red (5YR 6/6, 7/4). The exterior surface is uncoated. Parallel grooves appear below the rim and on the belly (Raičković Savić and Bogdanović 2017: 197–202; Nikolić, Raičković Savić and Mitić 2023: 176, **type II/8**:196).

Usually represented pot forms in Viminacium are those with two handles, a grooved rim with a strap-profiled edge, a pronounced neck, and a spherical receptacle on a low foot (**Table I.11**). Four pots of this type were found in the waste pit. They are made from well-sifted clay, fired to red (2.5YR 6/8) and with a red painted outer surface. The outer edge is decorated with deep grooves, and the upper segment of the receptacle has facets The rim diameter is 20 cm (Nikolić, Raičković Savić and Mitić 2023: 217, **type II/66**).

A particularly interesting find from the waste pit, found in two specimens, is a specific type of pot where the handle goes over the opening, with a short, horizontal rim, a sloping neck, and a high receptacle, called a "basket". Only the handle and belly parts were preserved in this excavation, but this was sufficient for a typological identification. The belly of these pots is decorated with applied horseshoe--shaped ornaments (**Table II.1; Table III.7**). They are made from well-sifted clay, fired to red (2.5YR 6/8) and an untreated exterior surface. The rims of these pots typically range between 13 and 17 cm (Nikolić, Raičković Savić and Mitić 2023: 238–239, **type II/163**).

Another type of pot present in the waste pit has a short, horizontally spread rim, pronounced neck, and spherical receptacle. It is entirely decorated with incisions made using a wheel – the roulette, in multiple directions (**Table II.2; Table III.5**). It is made from sifted clay fired to brown; the exterior surface is similarly coloured. This pot shape resembles a smaller pithos version (Nikolić, Raičković Savić and Mitić 2023: 211, **type II/48**). Only one such pot was found in the waste pit and it represents a new type for Viminacium typology.

Another pot discovered in the waste pit is one of the most popular pot shapes found in all investigated Viminacium sites from the 1st to the 4th century. This shape is represented by seven specimens and features a short horizontally executed rim, a cylindrical neck, and variously placed bellies on a ring foot. The outer surface is painted in shades of red and brown (Nikolić, Raičković Savić and Mitić 2023: 211, **type II/48**).

(III) Plates

Twelve plates have been documented in this waste pit, classified into five types already found in Viminacium.

They are numerically represented by the form with a calotte receptacle on a low ring foot, with three plates (**Table I.16**). They are modelled on the form Drag. 32[2], (Consp. 4.2.[3]), from well--sifted clay, fired to red and have red-painted outer surface. The rim dimensions reach up to 32 cm, although a smaller diameter is typical for this type (Nikolić, Raičković Savić and Mitić 2023: 249, **type III/12**).

Two plates with a horizontally drawn rim with a strap-profiled outer edge also appeared in this context. The recipient is calotte-shaped, with a bottom in the form of a ring foot (**Table I.17**). They are made from well-sifted clay, fired to red (2.5YR 6/8), and red painted outer surface. The diameters of the specimens here range around 28 cm (Nikolić, Raičković Savić and Mitić 2023: 252, **type III/22**).

Even larger in diameter is a plate found with a horizontally spread rim, pronounced edges and a calotte-shaped receptacle (**Table I.14**). The rim is decorated with a combination of grooves. It is made of well-sifted clay, fired to red (2.5YR 6/8), and red painted outer surface. Its diameter reaches

[2] Drag. – Dragendorff 1895.
[3] Consp. – Ettlinger *et al.* 1990.

up to 36 cm (Nikolić, Raičković Savić and Mitić 2023: 250, **type III/15**).

In this pottery type, three plates of various dimensions with a shallow, conical receptacle on a wide, flat bottom were singled out from the finds. They are made from clay with admixtures of fine-grained sand, known as *kaolin clay*, and fired to yellow-brown or yellow-red (5YR 8/4, 10YR 8/2). Their rim diameters range from 28 to 32 cm (**Table I.15**) (Nikolić, Raičković Savić and Mitić 2023: 247, **type III/7**).

Three shallow plates of different dimensions have a recessed rim towards the interior, variously profiled edges, slightly rounded belly, and a wide, flat bottom (**Table I.13**). They are made from well-sifted clay fired red to brown (2.5YR 5/8, 6/8; 5YR 6/8); the outer surface is uncoated or red-painted. On the largest plate, whose rim diameter exceeds 40 cm, the inner side is decorated with roller incisions (Nikolić, Raičković Savić and Mitić 2023: 256, **type III/36**, decorated inside).

(IV) Amphorae

Vessels typologically identified as containers for transport found in the waste pit are determined solely by the specimens belonging to so-called flat-bottomed table amphorae. **Thirty-one flat-bottomed table amphorae**, classified into one new and one type already found in Viminacium, have been documented in this waste pit. Their use does not appear to have been connected to transport, but rather they were used as tableware.

The most numerous are amphorae with cylindrical necks and short spherical or elongated ovoid receptacles with concave bases and pronounced edges. They were made from well-refined clay, fired in red (2.5YR 6/8; 5YR 7/6), with outer surfaces painted red or red brown. Over 25 amphorae of this type have been found (**Table II.5**) (Nikolić, Raičković Savić and Mitić 2023: 279, **type IV/9**). Their production was already confirmed at the Viminacium area (Bjelajac 1996: 99–101, tip XXXI). Of particular interest is that two of them underwent deformation and breakage due to high temperatures (**Table III.3**). This situation indicates errors by the craftsmen during the firing process, as higher temperatures than the clay could tolerate were reached due to negligence, which caused the essential bonds in the clay mass to rupture, resulting in the final product being discarded as scrap.

The discovery of six red-fired and painted amphorae with wide, short, horizontally flared rims is of particular interest. These amphorae have a pronounced relief rib from which the handles originate (**Table II.6; Table III.4**). So far, no closer analogies for this type of amphora have been found at the investigated sites of Viminacium.

(VI) Pithoi – pithoid pots

Pithoi, in their primary function, belong to vessels for storing and preserving foodstuffs. However, those identified in the waste pit are forms that should instead be classified as pithoid vessels, that is large pots used as tableware but modelled in the form of pithoi used for storage

Two pithoid pots were found in the waste pit, both belonging to a type already found in Viminacium, but modelled as its two variants (**Table II.3; Table II.4**).

The pithoid pots have a short rim and ovoid receptacle and a narrow flat bottom. They were made from well-refined clay, fired in red (2.5YR 6/8), with a red-painted outer surface. The diameter of their rim is 28 cm (Nikolić, Raičković Savić and Mitić 2023: 316, **type VI/25**).

(IX) Beakers-cups

Regarding vessels for consuming liquids, **two beakers** classified into two types, already found in Viminacium, have been documented in this waste pit.

One of them is a form with a single handle, a slightly curved rim, a spherical belly, and a narrow solid base (**Table II.8**). It was made from well-sifted clay, fired in red (2.5YR 6/8, 7/8), with a red-painted outer surface. It reaches a height of 8 cm, and its rim diameter is 6 cm (Nikolić, Raičković Savić and Mitić 2023: 335, **type IX/24**).

A rare type of beaker, also found in the mentioned waste pit as one specimen, can have one or two handles, a grooved rim with a trapezoidal profile edge, a slightly rounded neck, and a pronounced belly on a low ring-shaped base. It was made from fine to well-sifted clay,

fired in red to dark brown (2.5YR 6/8), and has a dark red varnished painted outer surface. This type is usually decorated with grooves and motifs of garlands and small circles made by stamping (**Table II.7; Table III.8**) (Богдановић 2017: 274–275, T. IV/4; Nikolić, Raičković Savić and Mitić 2023: 334, **type IX/22**).

(XII) Jugs

In this waste pit, the numerous fragments belonging to jugs are particularly significant. **Twenty-six jugs**, classified into five types already found in Viminacium, have been documented in the waste pit. They confirm previous assumptions about types as local products that have not yet been accurately categorised by a workshop and demonstrate typological diversity.

Six jugs with differently executed spouts have a wide opening with slanted edges and a long neck with a pronounced shoulder and each has the belly set differently. The base is mainly in the form of a low base, with one handle that is always grooved. They were made from well-sifted clay, fired in red (2.5YR 6/8; 5YR 6/6, 6/8, 7/6, 7/8), with a red-painted or dark red varnished outer surface (**Table II.13; Table II.14**) (Nikolić, Raičković Savić and Mitić 2023: 382, **type XII/16**). Horizontal grooves adorn the neck and belly. Within this type are sporadic specimens with less pronounced shoulders and uncoated surfaces alongside those with biconical receptacles and vertical, glazed lines on the neck.

Eleven jugs with deeply grooved rims, trapezoidal profile edges, short necks from which a handle extends, and rounded shoulders also appeared in this waste pit (**Table II.9**). The rim is adorned with cannelures, with rim dimensions larger than 8 cm, and the belly has faceting decoration. They were made from well-sifted clay, fired in red (2.5YR 6/6), with a red-painted outer surface (Nikolić, Raičković Savić and Mitić 2023: 385, **type XII/25**). Among the scrap in this waste pit, the largest number of fragments belong to jugs of this type.

One more usual type of jug belongs to a form with a deeply grooved rim, a long, narrow neck, and an ovoid receptacle, while the bottom is in the form of a low foot (**Table II.10**). Five jugs of this type were found. They were made from well-sifted clay, fired in red (5YR 6/6), with a red-painted outer surface. The rim dimensions of these jugs range between 5 and 6 cm (Nikolić, Raičković Savić and Mitić 2023: 378, **type XII/7**).

Two jugs with a curved rim, sharply profiled edges adorned with a cannelure, a short, narrow neck, and a biconical belly on a low foot belong to this pottery type. Below the rim is a thin, relief strip extending to an oval cross-section handle. It was made from well-sifted clay, fired in red (2.5YR 4/2), with a dark reddish-brown varnished painted outer surface. The rim dimensions of this jug are around 6 cm (**Table II.12**) (Nikolić, Raičković Savić and Mitić 2023: 376, **type XII/2**).

Additionally, two jugs with grooved external rim edges and a richly decorated high-set belly with a wide centrally grooved handle were discovered (**Table II.11; Table III.6**). They were made from well-sifted clay, fired in red (2.5YR 6/8) (Nikolić, Raičković Savić and Mitić 2023: 385, **type XII/25**).

* * *

The found pottery predominately belonged to tableware. In addition to tableware, there are storage vessels, in this case pithoid vessels, as well as those generally used for transport, but which were, here, used as tableware – flat-bottomed table amphorae. A specimen of a mortarium, in this specific case, was classified as tableware as well. This analysis provided more confirmation of the importance of the production of vessels for everyday use, both for serving and storage, and for the transport of foods.

Technological features with decoration

What is specific for the found pottery, is the absence of a kitchenware repertoire, a variation of the plate sizes and the method of decorating jugs.

The mid-2nd to mid-3rd century was a period during which Viminacium reached the peak of its prosperity, reflected in the development of other activities, so it is not surprising that there was such intense pottery production. This is the time when both Gallic and Germanic material arrived in Viminacium through imports (Nikolić, Raičković Savić and Mitić 2023: 32 64, 98). However, despite the significant imports, local

pottery production took precedence. Although the pottery from Viminacium was largely made from poorly refined clay with smaller amounts of sand[4], and the coatings sometimes lacked consistency, this was not the case with the products from the researched waste pit. Their craftsmanship can be compared to imported materials. They were made from clay of the same quality, well-sifted, fired in red, with their outer surfaces painted in various shades of red. All vessels were made on a potter's wheel, and their external surfaces were treated through colouring and incising.

Jugs in the waste pit were decorated with a special tool in the shape of a wheel – a roulette. The decoration of vessels often employs this decoration technique called rouletting. This technique allows for the creation of various patterns, with the incisions formed as thin or thick vertical lines and notches, similar to those on older Flavian vessels. Local craftsmen in Viminacium used different types of these tools, enabling them to create deeper triangular and rectangular incisions arranged in horizontal or circular rows. Vessels decorated exclusively using the roulette method are rarer than those that combine this technique with other methods, such as barbotine or stamping. Typically, rouletting was used to decorate the outer sides of the rims and receptacles, less commonly the interior of the bottom. Decoration using the roulette has been noted in the earlier period of Viminacium production. In the 2nd century, the number of vessels decorated with this tool expanded (Богдановић 2017: 271).

A sickle ornament was found on a pot from the waste pit identified as a "basket", whose handle extends over the rim. Such vessels have been found in Viminacium and were always associated with the need to draw water from wells, but no previously found examples have been of this quality of workmanship (Nikolić, Raičković Savić and Mitić 2023: 49–50). The sickle ornament executed in barbotine is linked to Gallic influence, and on Viminacium products it is often accompanied by glazing. The vessels where this motif appears most frequently are goblets (cups), each possibly accompanied by a small pot that likely served the same function (Nikolić, Raičković Savić and Mitić 2023: 17, 34–35).

Decoration achieved through stamping on bowls from the waste pit is considered one of the most popular decoration techniques. In Viminacium, two phases have been identified, and the decoration on the bowls found in the waste pit belongs to the earlier phase, which lasted throughout the 2nd century. In this phase, vessels were made based on imported forms of terra sigillata. This bowl shape is common, but it is not usual for it to be decorated with stamping. This may indicate the inventiveness of the craftsmen. The same bowl shape is decorated with facets, appearing as differently positioned wider lines that are incised with a broad tool, bone tool, or wooden stick. This method of decoration has been traced from earlier periods and was most common on bowls of this type in the 2nd century, and appears until the first half of the 3rd century (Богдановић 2017: 267).

Glazing, as a method of decoration and surface protection for vessels, has been noted on all forms of vessels from Viminacium, but only jugs with traces of glaze were discovered in the waste pit. Other glazed examples at Viminacium have been found in the settlement layers or in the necropolis areas (Nikolić, Raičković Savić and Mitić 2023: 104–105). This situation also suggests the skill of the craftsmen from this pottery production centre. On the other hand, fingerprints present on insufficiently dried surfaces indicate inexperience or haste in execution.

Cracking and waste products are very common occurrences in the pottery found in Viminacium (Raičković 2007: 17). Such material is found in the waste pit as well and is presented with the deformed amphora.

DISCUSSION AND CONCLUSION

A review of all pottery fragments found at the Provalije site reveals that they are of the same quality of craftsmanship and decoration method as the pottery excavated at multiple Viminacium sites (from the eastern necropolises to the civil settlement and suburban villas)[5]. However,

[4] See more in: Nikolić, Raičković Savić and Mitić 2023, Catalogue.

[5] Unpublished material, available to the authors of the paper.

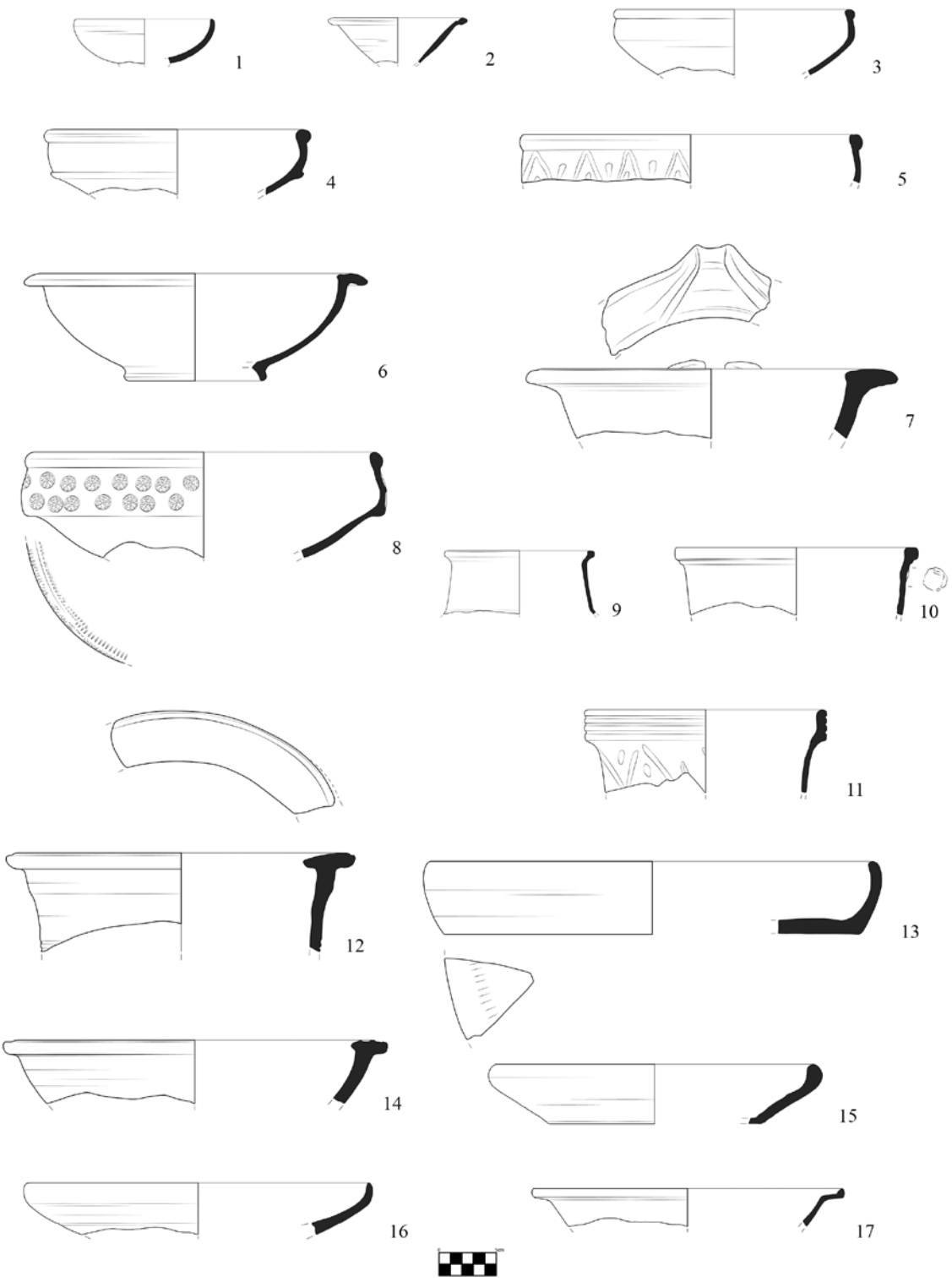

Table 1 (T. I). Bowls, pots, and plates from the waste pit (drawings by Nebojša Bobić, unpublished material).

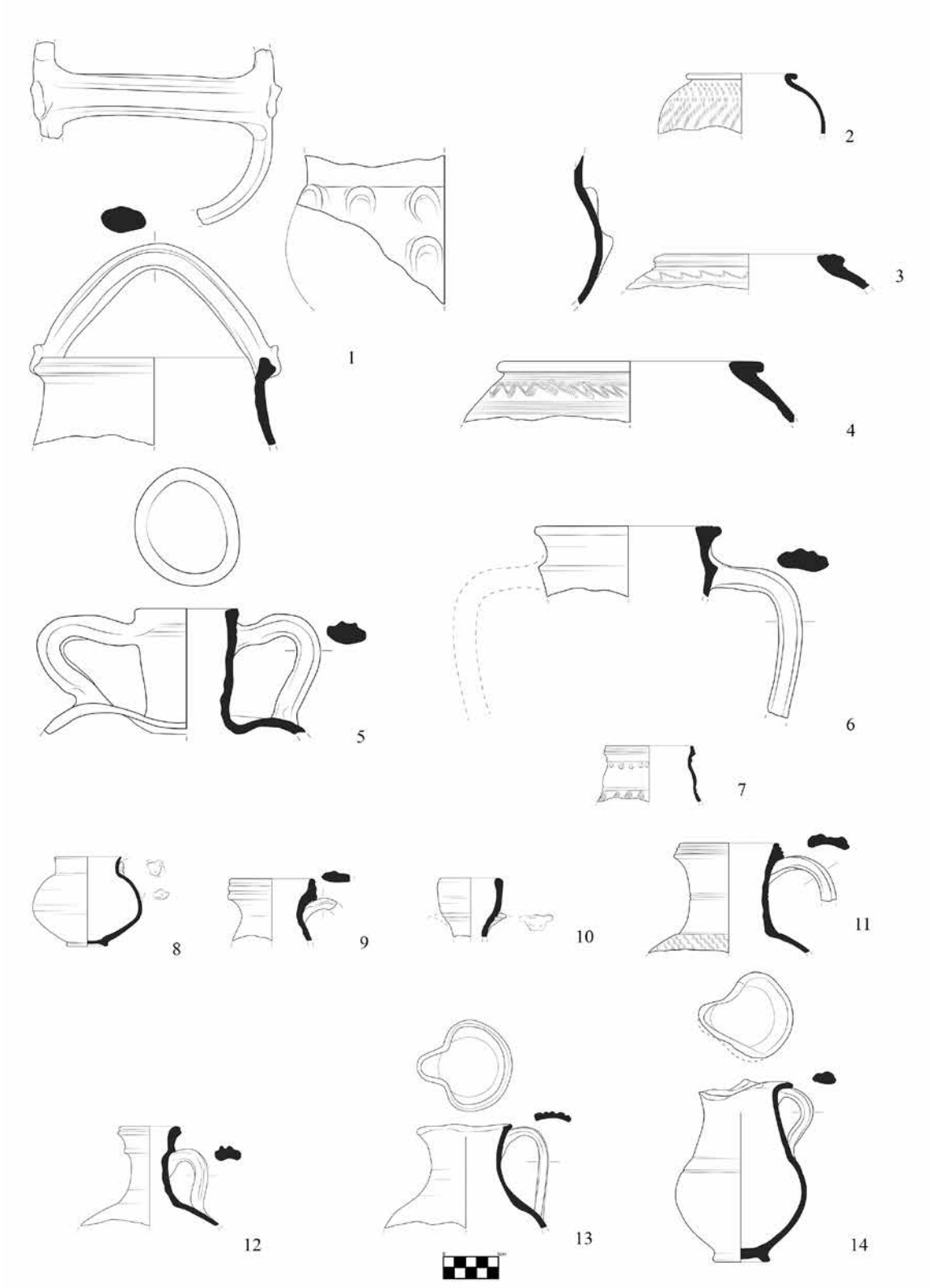

Table 2 (T. II). Pots, amphorae, pithoi, cups, and jugs from the waste pit (drawings by Nebojša Bobić, unpublished material).

Table 3 (T. III). Seals, fingerprints, vessel deformations and decoration methods present on the fragments of vessels found in the waste pit (photos by Angelina Raičković Savić).

although the specific characteristics of the vessel types found in the waste pit and already excavated at some Viminacium sites indicated that they were of local origin before the excavations at the Provalije site, the absence of a production centre on the territory of Viminacium to which the vessels could be connected and their differences compared to the products originating from the production centre at the Pećine site did not provide the possibility of reaching that conclusion and, therefore, not all of the types were assigned to the known Viminacium production and their imported origin was not excluded. Even the research into the production of pottery in the surrounding territories did not yield results that would connect the pottery found throughout Viminacium with other workshops distant from this Roman city.

The pottery belonging to the already known types, found in the waste pit at the Provalije site, but not assigned as local until its excavation there, could lead to two possible assumptions: that some of the pottery was produced at the centre at this site, but discarded; or that that the workers who operated the kiln brought the pottery produced in some other unknown centre here and used it for their own purposes (eating). However, two things could count against the second option – if it was a waste pit used by workers, it should have contained other waste materials as well, aside from those of ceramic origin, which this pit did not contain; and it was more probable that the workers used vessels fired at the same place, rather than bringing their own from afar. The other important result of the excavations is embodied in the discovery of the vessels excavated for the very first time in Viminacium, not belonging to the types already found. They share the same technological features as those recognised as existing types and found in the same waste pit.

Considering the fact that the kiln was designated as a brick kiln, the find of a discarded amphora, already assumed as belonging to the Viminacium production, is important for delivering other possible conclusions. Two of them can be made: that this kiln was additionally used for the firing of pottery of larger dimensions (which has been already attested at the production centre of the Pećine site); and that some other kiln, probably situated nearby in this production centre but still not found, was, the pottery kiln whose discarded products were thrown away with the products of the brick kiln, in the same waste pit.

The mentioned excavations offered us conclusions regarding characterising these vessels as local products, originating from the production centre at the Provalije site. Additionally, after the review of these vessels, we can strongly suggest that probably two pottery centres existed and operated simultaneously, each with a distinct production range and, thus, the mutual proximity of two centres that produced utterly different tableware forms, although both functioned in the same period,[6] could be a very interesting topic for future research.

The pottery from the waste pit is a reflection of the specialized production in this city during the Roman period, showcasing a rich and varied selection of tableware. The vessels, mainly bowls, plates, pots, and amphorae, reveal distinctive technological features, but display alignment with other pottery centres within the region in terms of decoration and form. These pieces were made from finely sifted clays, fired to a red or brown hue, and often decorated with incised lines, grooved patterns, and sometimes applied elements. The presence of handles, spouts, and faceted decorations on various forms indicates a high level of craftsmanship and attention to detail, which is characteristic of urban Roman pottery workshops. The range of sizes and shapes found suggests these ceramics were intended for a variety of practical uses, from serving and eating to storage and possibly even ritual contexts, with many vessels also appearing as grave goods. Moreover, the marked similarity with the pottery found in the urban and suburban layers of Viminacium suggests a standardised production system, with a clear distribution of certain vessel types across different contexts (domestic, funerary, and commercial).

In particular, the discovery of pots with applied decorations, such as horseshoe-shaped ornaments, and bowls with distinctively decorated rims, offers valuable insight into the aesthetic preferences and technological innovations of the period. The

[6] A study of ceramic vessels as well as brick and ceramic kilns conducted in 2007 contributed to the understanding of the production processes in the 2nd and 3rd century. For more information, see Raičković 2007.

combination of local production with potentially regional influences underscores Viminacium's position as a significant centre within the Roman province of Moesia, where both local traditions and external influences coexisted and influenced the development of material culture. Ultimately, the ceramics from this pit reflect a thriving craft industry, supporting the notion of Viminacium as an important urban hub where ceramic production was closely tied to the economic and social life of the settlement.

Before the discovery of the waste pit at the Provalije site in 2018, our knowledge of the origin of some of the vessel types found at Viminacium sites was incomplete. Newly found vessels have offered very important insights into the technological and organisational aspects of Viminacium pottery production. The above described tableware found at the Provalije site supplemented the repertoire of the pottery used and produced in Viminacium dated to the 2nd and mid-3rd century. It remains hopeful that conditions will one day be met for systematic research in the area of the Provalije site; thus, obtaining a more comprehensive picture of this production centre.

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REZIME

KERAMIČKE POSUDE IZ OTPADNE JAME PORED RIMSKE PEĆI U OKVIRU TERMOELEKTRANE KOSTOLAC A

KLJUČNE REČI: VIMINACIJUM, GRNČARIJA, PROIZVODNI CENTAR, OTPADNA JAMA, KERAMIČKE POSUDE, ZDELE, LONCI, AMFORE, KOSTOLAC, LOKALITET PROVALIJE.

Tokom decenija zaštitnih i sistematskih iskopavanja Viminacijuma i okoline, koja su započela još 1882. godine i sprovode se i danas, pronađeni su ostaci proizvodnje građevinskog keramičkog materijala i grnčarije na ukupno četiri lokaliteta. Među njima su i dva proizvodna centra, na lokalitetima Pećine i Provalije.

U krugu termoelektrane Kostolac A u gradu Kostolac na lokalitetu Provalije u neposrednoj blizini Viminacijuma, prilikom izvođenja građevinskih radova, tokom proteklih decenija u više navrata otkriveni su ostaci peći za opeku iz rimskog perioda. Osim ovih arheoloških celina, istražene su i jame u njihovoj neposrednoj blizini, koje su služile za odbacivanje otpadnog materijala. U jednoj od njih, 2018. godine pronađen je i grnčarski materijal, koji je ukazao na postojanje još jednog proizvodnog centra pored do sada poznatog na lokalitetu Pećine u krugu termoelektrane Kostolac B u selu Drmno. Ova studija predstavlja do sada neobjavljene keramičke posude pronađene u otpadnoj jami. Upravo na osnovu analize ovog materijala došlo se do saznanja o istovremenom funkcionisanju

više centara za proizvodnju keramičkih posuda u periodu od sredine 2. do sredine 3. veka na prostoru Viminacijuma.

Delimično otkopana jama bila je ispunjena brojnim ulomcima keramičkih posuda, leptirastim podnim opekama i fragmentima crepa. Veruje se da je korišćena za odlaganje proizvoda iz pomenute peći ili potencijalno iz druge obližnje, do sada neotkrivene peći. Grnčarski materijal iz otpadne jame konstatovan prilikom ovih istraživanja pripada najvećim delom trpeznoj keramici, ali su zastupljene i posude za transport i skladištenje u znatno manjoj meri. Kao tipični predstavnici pomenutog perioda, u najvećem procentu se javljaju zdele i tanjiri kalotastih i bikoničnih recipijenata, rađeni od dobro prečišćene gline, pečene u nijansama crvene boje, a zatim i fragmenti stonih amfora. Među keramičkim oblicima najzastupljeniji su krčazi čiji su recipijenti bogato dekorisani urezivanjem. Raspon pronađenih veličina i oblika sugeriše da je ova keramika bila namenjena za različite praktične namene, od posluživanja i jela do skladištenja, pa čak i ritualnih konteksta, pri čemu se mnoge posude takođe pojavljuju i kao grobni prilozi.

Određeni tipovi ovde otkrivenog grnčarskog materijala slični su posudama pronađenim u urbanim i prigradskim slojevima Viminacijuma, ali je njihovo lokalno poreklo samo pretpostavljano, usled nedostatka dokaza za mesto njihove proizvodnje. Njihove tehnološke karakteristike razlikuju se od posuda identifikovanih proizvodnom centru na lokalitetu Pećine, što dalje ukazuje da su dva centra radila svaki sa različitim asortimanom.

Značaj pronađenog grnčarskog materijala je u potvrđivanju njegove lokalne proizvodnje u Viminacijumu tokom 2. i 3. veka, što je pružilo novi uvid u proizvodni asortiman viminacijumskih grnčarskih centara iz pomenutog perioda. Keramika iz otpadne jame odražava naprednu zanatsku industriju, podržavajući sliku o Viminacijumu kao urbanom centru gde je proizvodnja keramike bila usko povezana sa ekonomskim i društvenim životom naselja. Ona je odraz specijalizovane proizvodnje u ovom gradu tokom rimskog perioda, sa bogatim i raznovrsnim izborom posuđa. Posude otkrivaju posebne tehnološke karakteristike koje su u skladu sa drugim grnčarskim centrima u regionu, posebno u pogledu ukrasa i oblika. Kombinacija karakteristika lokalne proizvodnje sa potencijalno regionalnim uticajima dalje naglašava njegovu poziciju kao centra rimske provincije Gornje Mezije, gde su lokalne tradicije i spoljni uticaji koegzistirali, formirajući zajednički njegovu materijalnu kulturu. Ostaje nada da će se jednog dana steći uslovi za sistematska istraživanja na području lokaliteta Provalije, čime će se dobiti sveobuhvatnija slika ovog proizvodnog centra rimskog Viminacijuma.

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REVIEW OF FRAGMENTS OF ROMAN WALL PAINTINGS FROM SKELANI, BOSNIA AND HERZEGOVINA

ABSTRACT

In the premises of the ancient building complex at the Zadružni Dom site in Skelani, Republika Srpska, Bosnia and Herzegovina, alongside very well-preserved mosaics, a large number of fragments of wall paintings from the Roman period were found. The building was dated to the late 3rd and early 4th century, being a part of the presumed settlement of Municipium Malvesiatium in the former province of Dalmatia.

Although the first archaeological excavations of the settlement were conducted at the end of the 19th century, it was only in the 21st century that they were resumed. The fragments of wall paintings were recorded in various rooms of the mentioned building during these excavations. Unlike the preserved large floor mosaics, the fragments do not provide much data for the reconstruction of the paintings, but reveal the existence of diverse colour schemes and artistic motifs. They offer a range of other information, related to different types of plasters and their composition, evidence of past renovation, and traces of burning and pigment alteration. In addition to the large number of fragments, in certain parts of the building, in situ wall painting has been preserved in the socle area, additionally contributing to the understanding of the decoration used in this late antique building.

KEYWORDS: ROMAN WALL PAINTING, FRAGMENTS, PLASTERS, MUNICIPIUM MALVESIATIUM, SKELANI, DALMATIA.

INTRODUCTION

During the archaeological excavations of the building at the site of Zadružni Dom, part of a former Roman settlement, presumably *Municipium Malvesiatium,* situated in today's town of Skelani, in the Srebrenica municipality, in the territory of the Republika Srpska, Bosnia and Herzegovina, conducted during 2008, 2014 and 2015, numerous fragments of wall paintings were found. These fragments were conserved, preliminarily classified in groups and joined into units in the following period. The results of this process will be further presented in this paper, with the aim of contributing to future research of the wall painting in the building, the decoration of the building, which additionally encompasses mosaics, as well as different aspects of the building.

Skelani – Presumed Municipium Malvesiatium

Municipium Malvesiatium was presumably a town in the Roman province of Dalmatia (Čović 1988: 79). Located on the left bank of the Drina river, in the central part of the Podrinje region, it is the natural centre of the Eastern Osat area and, together with Western Osat, it forms the Osat microregion with its centre in the town of Srebrenica (Babić 2009: 171). The silver, lead, and zinc ores found locally, along with its good connectivity by river and land, made the presumed *Municipium Malvesiatium* a major trade and administrative centre, which, like other Roman towns in the territory of today's Bosnia and Herzegovina, was built according to Roman models (Pašalić 1960: 73). It was established during the time of the first Flavian dynasty, probably during the reign of Emperor Vespasian, as evidenced by inscriptions found on both sides of the Drina river, containing *M(alvesiatiumT) municipium Fl(avium)* (Bojanovski 1988: 177).

The first archaeological excavations in the area began in 1896 and lasted for three years (Patsch 1907: 430). New archaeological research only resumed in 2008, during which time four sites were explored: Zadružni Dom, Baba Ankina Kuća, Brankova Njiva, and the Porta Srpske Pravoslavne Crkve (Babić 2009: 173). Archaeological research of the site of Zadružni Dom continued in 2014 (Гавриловић Витас и Поповић 2015: 197-198) and 2015, as well as in 2016 (with the additional research of the Brankova Njiva site), 2018, and 2019. In 2012, the archaeological complex found at this site was designated as a national monument of Bosnia and Herzegovina (Odluka 2012).

Zadružni Dom site

At the Zadružni Dom site, a building dating to the late 3rd and early 4th century AD, was explored (**Figure 1a**). It is possible that the building was residential in nature, belonging to a very wealthy resident or someone from the city administration. Based on its architecture, it was assumed it was the domus of a wealthy owner connected with trade, mining or the transport of various goods (Гавриловић и Витас 2015: 197–202). However, there is also the possibility that it was a place where certain official activities of the resident could have been conducted as well. Based on the other excavated remains in the area, it can be assumed that this building was likely the most significant structure in the Roman settlement and, thus, it may have served as a city hall or luxurious baths (Babić, 2009: 37–58).

The 2015 investigations confirmed the existence of an older building below the excavated building at the site of Zadružni Dom that was already assumed in 2014.[1] It was dated to the period from the 1st to the 3rd century. The dating of both the younger and older buildings was confirmed by movable archaeological finds. The older building was abandoned close to the period of its demolition, as evidenced by the archaeologically rich layer with preserved cooking pottery in light brown soil with traces of burning. The function of the older building has not been confirmed, but it can be assumed it was residential in character. The younger building was completely abandoned before its destruction occurred, and only sporadic movable archaeological material was found in the layers filling its rooms. It had a rectangular layout, with an entrance area, eleven rooms (labelled with the letters A to K), three apses, a peristyle, and a corridor around it[2]. It was destroyed in a fire, likely during a barbarian invasion (Гавриловић Витас и Поповић 2015: 214), with traces of burning visible on the fragments of the wall paintings as well. Only after future archaeological excavations at the site of Zadružni Dom, will many assumptions on the function and life of both buildings be able to be confirmed or rejected.

MATERIALS AND METHODS

Context of the wall painting remains

The wall painting of the excavated building is preserved *in situ* and in fragments. The first part of the younger building has rooms A, B, C, D, and F and likely represented the public area, while the other part of the building, with rooms G, H, I, J,

[1] The data given here on the results of the excavations conducted in 2018 and 2019 is part of the unpublished excavation reports written by I. Grujić.

[2] An assumed reconstruction of the younger building is proposed in Поповић 2018b.

Figure 1a. View of the building (after Гавриловић Витас и Поповић 2015: 207, fig. 17, Documentation of the Institute of Archaeology, Belgrade).

K, and the inner courtyard, was probably private in nature (Гавриловић Витас и Поповић 2015: 213) (**Figure 1b**).

Small sections of wall paintings were still preserved on many walls in their lower zones during the excavations (**Figure 2a**). In 2008, a few locations with in situ paintings were noted.[33] On wall 15 and wall 6 in the south-western corner of room G, two layers of plaster with paintings from two different periods were noticed in 2014. A part of a wall painting was discovered **in situ** in room C - on wall 17, as well as on wall 19 in the room A, and wall 2 in room F during the same campaign (Гавриловић Витас и Поповић 2015: 202–205).

One of the *in situ* paintings was preserved on wall 2, in room F, to a height of slightly over 15 cm (**Figure 2b**). Since it has not been cleaned, it is unclear whether the lower zone was painted brown or a reddish colour. A horizontal line about 1 cm thick with an incision at the top is visible, with an ochre field above it. On the other preserved wall painting part, two segments are displayed — one with an imitation of green marble with black veins, and the other with an ochre background, although only a small portion is visible. Between them is a vertical field with a white background. The lower horizontal field is ochre coloured (**Figure 2c**).

The eastern building sector includes the area of the apse 1 and rooms I (*praefurnium*) and J, where, in addition to mosaics, fragments of wall paintings were found in 2014 (Gavrilović Vitas and Popović 2015: 210). The excavations of room H brought to light fragments of wall paintings with a beige background and a red border, while in apse 2, fragments of red, yellow, green, beige, and white were discovered (Гавриловић Витас и Поповић 2015: 199). During the 2008 and 2015 campaigns, many fragments were found as well (**Figure 1a**). In the south-western part of room G, fragments found in 2008 included one with a depiction of a bird's head (Popović 2018a: 892, fig. 11b; Babić 2009: 46–47, 57) (**Figure 3**).

The largest concentration of wall painting fragments is visible in room K, where also fragments of probably the most beautifully executed mosaic in the building with the head of Medusa were found. The mosaic can be connected stylistically to mosaics with the same motif in Mediana and Marcianopolis, dated to the 4th century and found in the triclinium,

[3] The markings for the 2008 find spots were given in Figure 1b according to the labels in the boxes and the description in the diary of the excavation conducted by Mirko Babić. There are many fragments in the boxes with no preserved labels and, thus, their find spots are unknown and not marked on the Figure 1b.

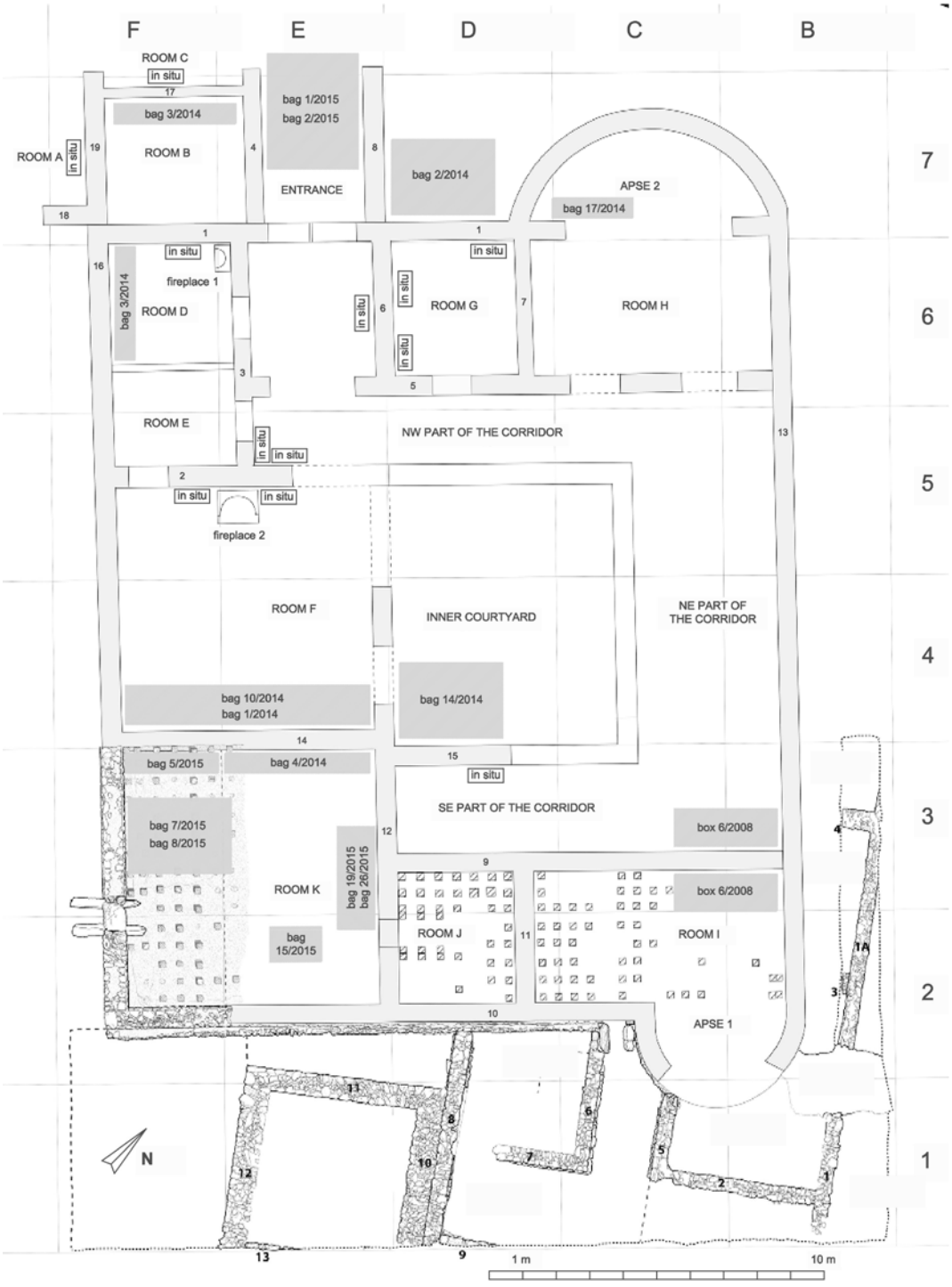

Figure 1b. Plan of the building as it was after the excavations conducted in 2015: younger building (plan of the Institute of Archaeology, Belgrade; Гавриловић Витас и Поповић 2015: 200, Fig. 1) schematically drawn over the remains of the older building (plan of JU Arheološki muzej "Rimski municipium" Skelani), with the marked areas of the found fragmented and *in situ* wall paintings (combined drawing made by Vanja Žigić; labels for wall paintings find spots made by Emilija Nikolić)

Figure 2. Remains of wall paintings *in situ* (wall 2, room F), as they were during the excavations conducted in 2014 (Documentation of the Institute of Archaeology, Belgrade).

which could offer a possible function of room K (Гавриловић Витас и Поповић 2015: 215–216). After conservation work on the mosaic, it was concluded it was executed very skilfully and has significant artistic value (Франковић, Вучетић и Раногајец 2020: 195–196).

Classification of the fragments

After the archaeological excavations, the wall painting fragments were placed in boxes and bags. For some fragments, the labels have faded, so we do not have data regarding from which sections of the building they originated (this primarily concerns 2008). A thick layer of soil covered the fragments on all sides. Over 950 fragments were

Figure 3. Fragments with a depiction of a bird (photos by Dragana Gavrilović).

Figure 4. Cleaning of the fragments (photos by Dragana Gavrilović).

processed and conserved in the period after 2019. The conservation work included several phases: cleaning (**Figure 4**), classification, consolidation and reassembly, as well as artistic reconstructions. The fragments were cleaned from mud and then classified by colour and plaster type. The painted layers and plaster were consolidated where necessary. The fragments were reassembled into coherent units as much as the available material allowed, and placed in sand for levelling. Artistic reconstructions of painting on certain fragments were made to better understand the iconography, as they can reveal much more than photographs and drawings. Not all damage present on the fragments was recorded, and the drawing was idealised in cases where the paint had flaked off.

The classification of fragments presented in this paper was done within the scope of the conservation work, which encompassed detailed documentation process connected to state of conservation and labelling of the found fragments. Thus, each archaeological campaign was analysed separately, and each of them has its own fragments collected during the excavation process from specific locations on the site. The fragments in the locations' collections were grouped according to the visual specifics of the painted layer as well as the composition of the plaster, but also joined in separate units where possible. The areas where the fragments were found during the excavations are shown on the **Figure 1a.** This was done according to available publications and field documentation.

This paper has no intention to mutually compare the fragments originating from different archaeological campaigns or rooms, or to discuss their possible detailed locations in the rooms according to a room's possible function, but rather aims to present the found fragments preserved after the excavations and artistically illustrated, and give some initial observations about them, serving as a basis for future research on these topics, which can further bring conclusions on

the wall painting and decoration in the building in general and, consequently, on the character of the building itself.

RESULTS

Fragments found in 2008

Box no. 1/2008, no finding context provided. There are four fragments without a painting layer (**Figure 5**), but pinkish in colour due to the colour of intonaco, which contains crushed brick aggregate. The arriccio made of lime and fine sand was grey in colour, and some larger lime lumps can be seen. The thickness of the plaster is about 2.5 cm, with the intonaco layer being approximately 2-3 mm thick. **The other** seven fragments have reed or wattle impressions on the back (**Figure 6**), which may indicate that the fragments fell from the ceiling, or walls that were made in the wattle-and-daub technique. Most of these seven fragments are missing the intonaco layer, and one fragment shows a roughened surface of the plaster. The next **eight** plaster fragments have traces of red colouring (**Figure 7**), with the paint partially preserved and are about 1 cm thick. They contain fine ground brick aggregate, with only a few larger brick particles measuring 2-3 mm. The plaster is a renovation layer, as its back shows protrusions from the keying by hammer (*cf.* Gavrilović and Milovanović 2021: 21, fig 7; Rogić 2014: 513) work. Among the other fragments in this box, there were three fragments for which it was not possible to determine exactly what representation they contained, but it was evident that they were part of a picturesque composition (**Figure 8**).

Box no. 4/2008, no finding context provided. There were 26 fragments with white surfaces that continue into red colouring. Thirteen fragments have red surfaces. White backgrounds with a red line are present on nineteen fragments (**Figure 9**), with their thickness ranging from 1.2 to 1.5 cm. Only white surfaces are visible on nine fragments. White surfaces transitioning into dark red colouring, highlighted by a black glazed line 6-8 mm thick appear on five fragments (**Figure 10**). Fragments with dark red colouring are represented with eight pieces. A white surface with a black line 6-8 mm thick can be seen on three fragments (**Figure 11**). Of fourteen fragments that form part of a red border on a white background, where red glazes can be seen in places, six fragments were selected for artistic processing (**Figure 12**). Apart from the mentioned part of the border seen in **Figure 12**, the red corner of the border can also be seen on one fragment (**Figure 13**) - here, on the white plaster surface, an ochre stroke in the shape of a "comma" can be observed. Among the fragments there is one on which only a thin layer of arriccio and intonaco is preserved, while the plaster layer used to level the wall has fallen off. It is evident that this fragment was part of an interesting iconographic solution; a thin incision is visible on the surface, along with traces of blue, red, and white, while the painting was done on a white background (**Figure 14**). The other three fragments that are not connected to the previously described fragments in **Figure 14** can be associated with it based on the plaster, and one of them has a characteristic cinnabar tone (**Figure 15**). The fragment with the thickest plaster in this box (4 cm) consists of three layers with the wall levelling layer about 3 cm thick, the arriccio made of lime and fine sand and grey in colour, and the intonaco about 2-3 mm thick. In some fragments of this box the arriccio easily separates from the wall levelling plaster (**Figure 16**).

Box no. 4/a2008, no finding context provided. Ten fragments have a white plaster base, ochre lines and decorations in the form of circles and "commas". Their plaster is distinctive, because of the characteristic craquelure visible across the surface. The largest of these fragments has a plaster thickness of 3 cm, although it is evident that it has not been preserved in its entirety. The intonaco layer is approximately 2 mm thick, and the arriccio is grey and brittle **(Figure 17).** An interesting decoration among other fragments can be seen in the form of short ochre strokes, of which there are five, made with a round brush. The painted depiction was framed by a red ochre border and a thin line. A transition from ochre to red is visible in the border and line, which is a result of high temperatures **(Figure 18a).** It is possible that this wall painting was located near a heat source - such as a furnace. Here, the plasters of fragments from both the earlier and later periods can be seen (**Figure 18b**). The total thickness of the plaster from the later period is about 7 mm, with the intonaco being 2 mm thick. In the plaster from the earlier period, small stones are visible in

the arriccio. On the fragments shown in **Figure 19**, meandering strokes in green, light red, and dark red can be seen, starting from a single point and widely diverging at the ends, while somewhat following the shape of each other. The strokes end in a pointed tip. It is unclear what they might represent. The plaster is of the same quality and composition as the fragments shown in **Figure 18**. A part of the only figural representation can be seen on a fragment found *in situ* that preserves the head of a green bird, with a dark red beak and a ring around its neck. Based on the colour scheme, two similar fragments found in this box and shown in **Figure 3**, on the right side of the image of the head, could possibly be associated with this representation, as they might depict part of the bird's wing and tail (?) (**Figure 3**). The plaster is of the same quality and composition as the fragments shown in **Figure 18.**

Box no. 6/2008, (17.) 09. 2008, trench no. 3. About eighty fragments are placed in the box. They did not form larger units during classification. Only the white surface of the plaster is present on twelve fragments, while the rest of the fragments have remnants of different coloured surfaces - red, black, ochre, and green. Some fragments show an alteration in the colour of the plaster, with a change to a bluish tone, which may be the result of a strong heat source. The thickness of one of those altered fragments is about 3 cm.

Box no. 6/2008, 01.10. 2008, trench no. 3, the room with an apse, layer of debris. Twenty-two fragments include those with different shades of red painted surfaces, and some borders continue on the white plaster base. The other fourteen fragments have a white plaster surface. Five fragments are with ochre colouring, while six fragments have a white mortar surface on which a reddish-pink linear solution can be observed (lines about 1 cm thick). One fragment has a blue colouration that continues onto the white plaster surface. One fragment has a light green azure colouration. Some fragments without a painted layer (white plaster surfaces) and fragments with blue colouring differ from the other plasters - their intonaco is about 2 mm thick, the arriccio is 1-2.5 cm, the aggregate is very sieved, and the plaster itself is brittle. The other fragments in this box have plaster of different thicknesses from 8 mm to 4.5 cm. On the back of the thickest fragment there are visible traces of rods.

Box no. 6/2008, trench no. 3, corner above the mosaic, bag no. 9. This box consists of twenty fragments. Several fragments have been joined together, but a larger unit has not been obtained; instead, they are logically arranged. On one of them, a blue strip can be seen, which is pressed against red-coloured surfaces on the top and bottom (**Figure 20a**). The plaster thickness ranges from 5 mm to 1.5 cm (**Figure 20b**). The intonaco thickness is between 2 mm and 5 mm, grey-beige in colour, and does not differ from the colour of the arriccio, which contains some small stones. In the intonaco area, blue discoloration of the plaster, or alteration, is visible, similar to the plaster of the fragments from the previous box. In **Figure 21**, eleven fragments with a border system are shown, consisting of a red border and a thin red line. The background on which the painting is done is partially white and partially grey-blue. There are sixteen fragments with a "blue background" and parts of floral elements, of which three fragments continue on the red border, and several fragments are without decoration, while one fragment has decoration in the form of dots - an imitation of marble cladding, all with the plaster 6 mm to 3 cm thick. Three fragments have a recognisable linear decoration, featuring a thin light red line and a thicker pink line (**Figure 22**). The plaster is bluish in some places (similar to those previously mentioned) and is 8 mm thick. On two fragments with a white background, parts of possible floral red motifs can be seen (**Figure 23**). On one of them, two black dots are also visible. The plaster is thin, which is the characteristic of the previous group as well. On only one fragment there is a thin red line with a small decorative droplet registered (**Figure 24**). This decoration was likely repeated. Among the fragments of this box, there are also twelve fragments with green colouring whose plaster is about 5 mm thick, nine fragments with a red painting layer, nine fragments of the white plaster base with red linear decoration and borders, one fragments with blue-grey colouring and six fragments with white plaster surface. On one fragment among those from this box, plaster from both the older and the younger period is present, while the other fragments only have plaster from the younger period.

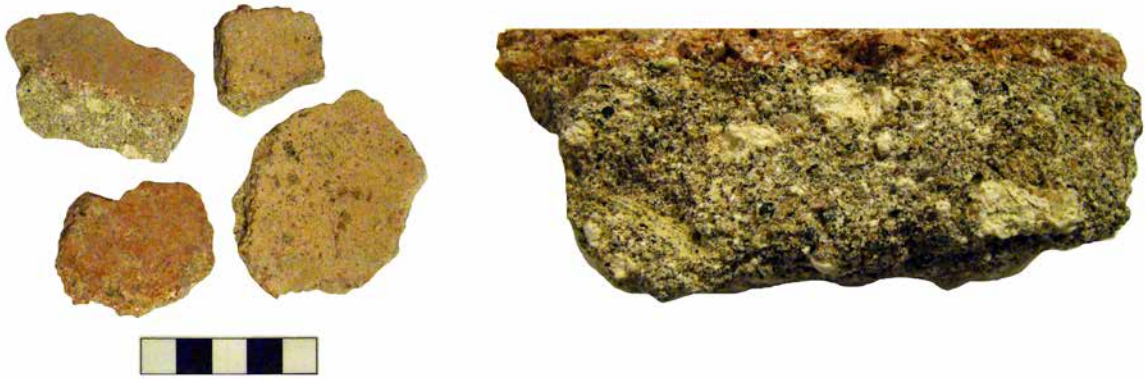

Figure 5. Appearance and cross-section of the fragments (photos by Dragana Gavrilović).

Figure 6. Appearance of the fragment - impressions from reeds on the back (photo by Dragana Gavrilović).

Figure 7. Appearance and cross-section of the fragments (photos by Dragana Gavrilović).

Figure 8. Artistic contribution based on the original fragments (painted by Dragana Gavrilović).

Figure 9. Appearance of the fragment (photo by Dragana Gavrilović).

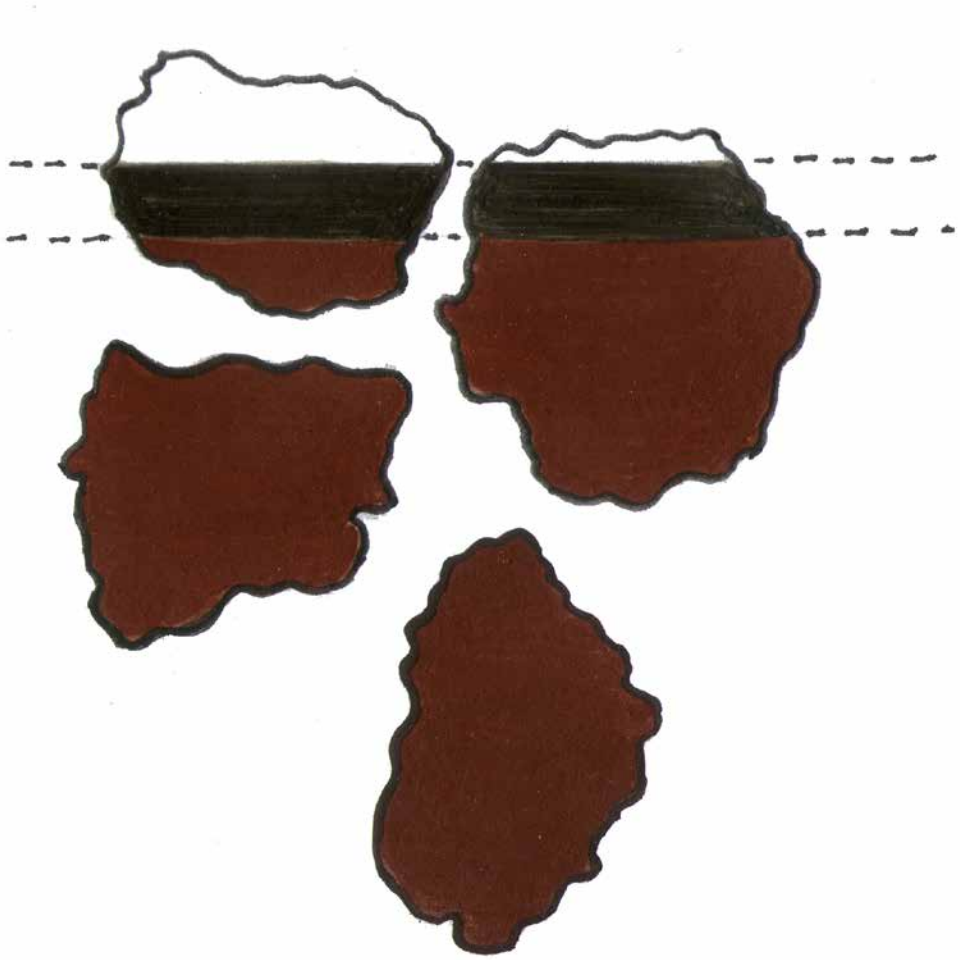

Figure 10. Artistic contribution based on the original fragments (painted by Dragana Gavrilović).

Figure 11. Appearance of the fragments (photo by Dragana Gavrilović).

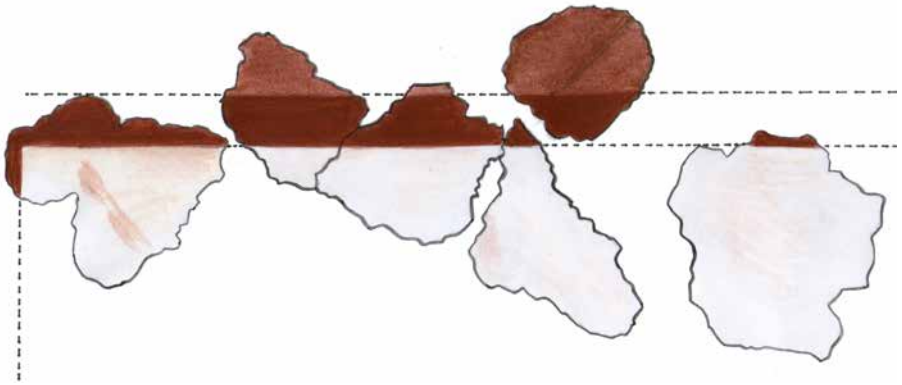

Figure 12. Artistic contribution based on the original fragments (painted by Dragana Gavrilović).

Figure 13. Appearance of the fragments (photo by Dragana Gavrilović).

Figure 14. Appearance of the fragments (photo by Dragana Gavrilović).

Figure 15. Appearance of a fragment (photo by Dragana Gavrilović).

Figure 16. Appearance and cross-section of a fragment (photos by Dragana Gavrilović).

Figure 17. Appearance and cross-section of the fragments (photos by Dragana Gavrilović).

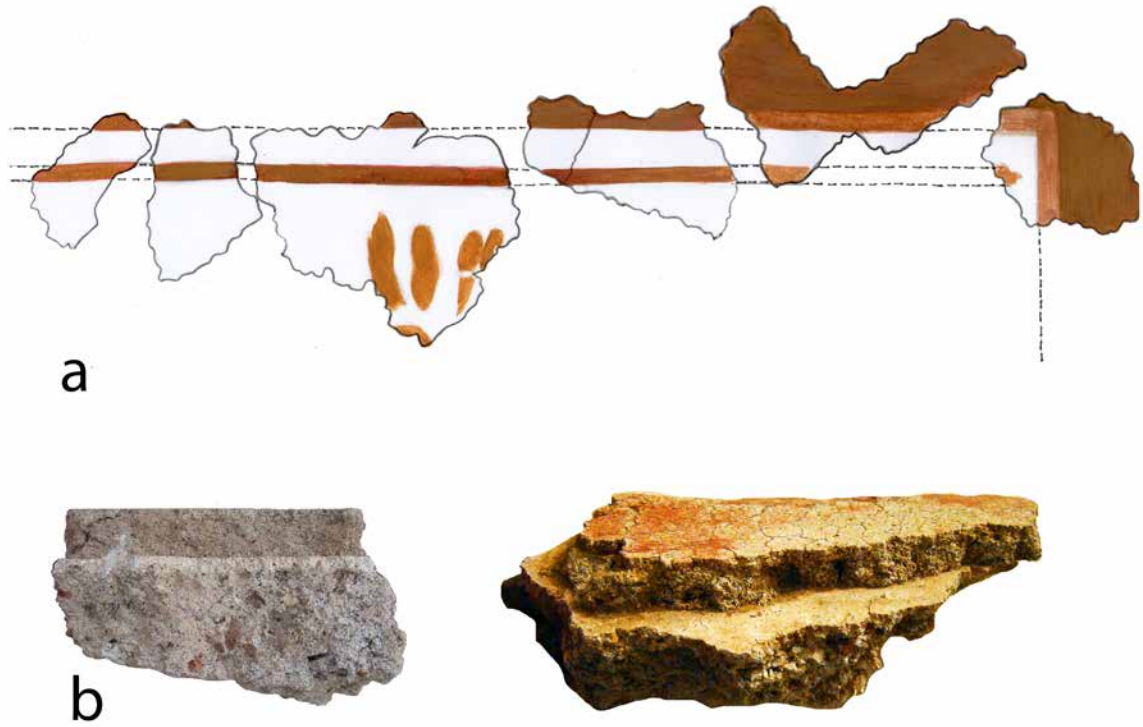

Figure 18. a. Artistic contribution based on the original fragments (painted by Dragana Gavrilović); **b.** Cross-section of a fragment - evidence of renovation from the past, two layers of plaster, each from different periods (photos by Dragana Gavrilović).

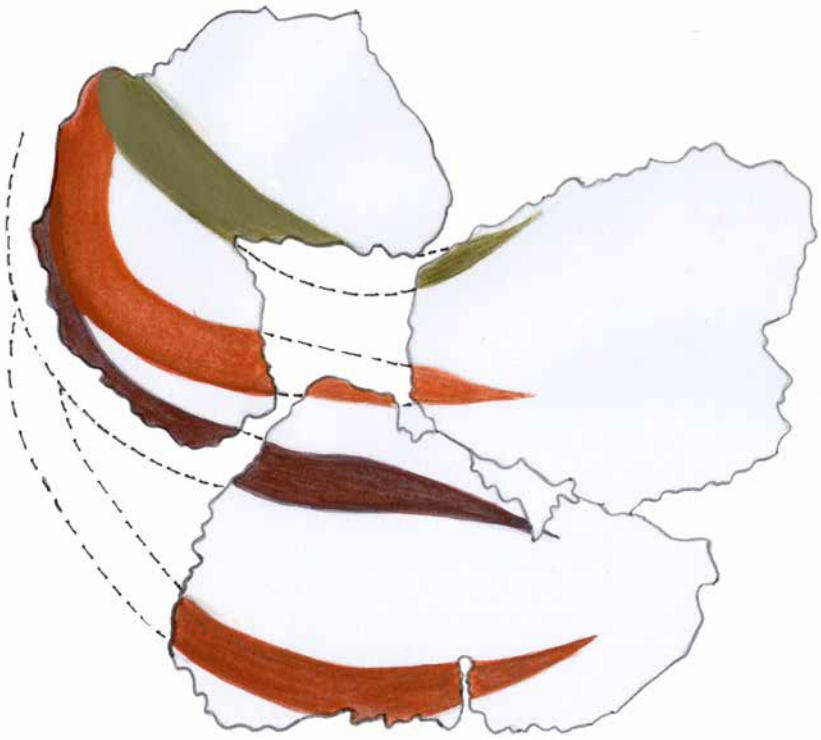

Figure 19. Artistic contribution based on the original fragments (painted by Dragana Gavrilović).

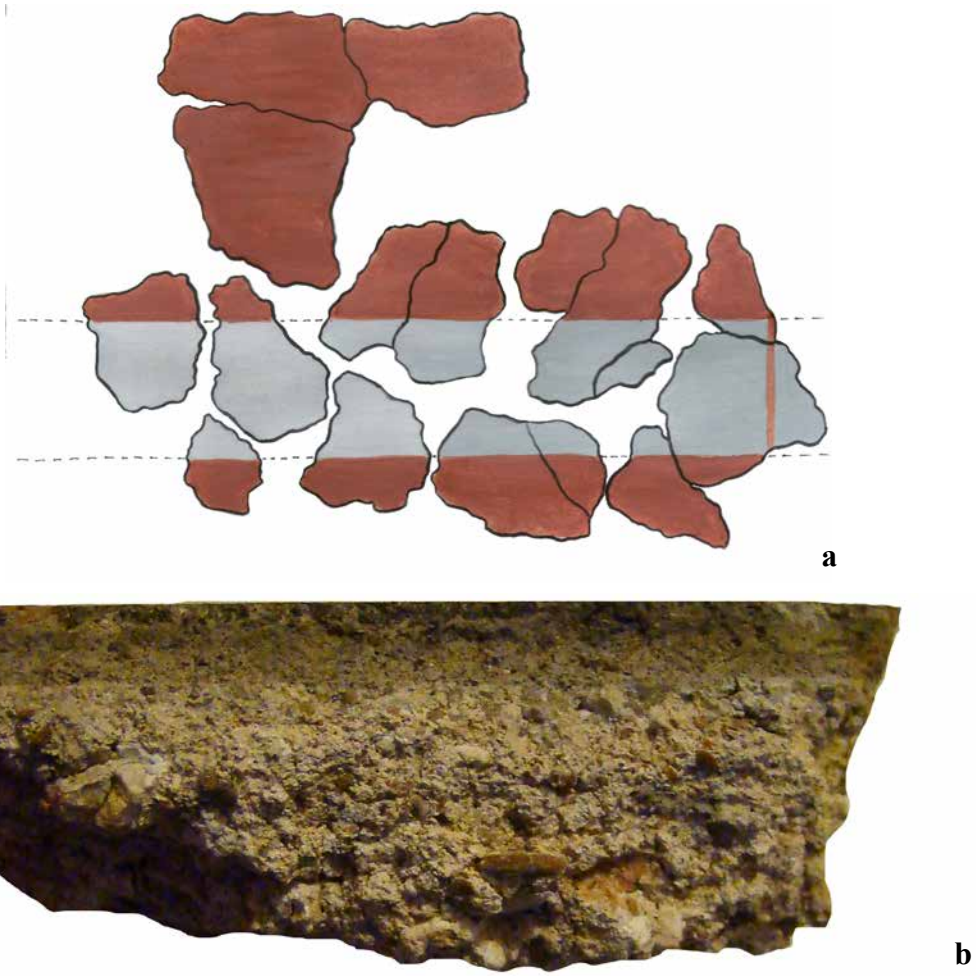

Figure 20. a. Artistic contribution based on the original fragments (painted by the author); **b.** Cross-section of a fragment - evidence of renovation from the past, two layers of plaster, each from different periods (photos by Dragana Gavrilović).

Figure 21. Appearance of the fragments (photos by Dragana Gavrilović).

Figure 22. Appearance of the fragments (photos by Dragana Gavrilović).

Figure 23. Appearance of the fragments (photos by Dragana Gavrilović).

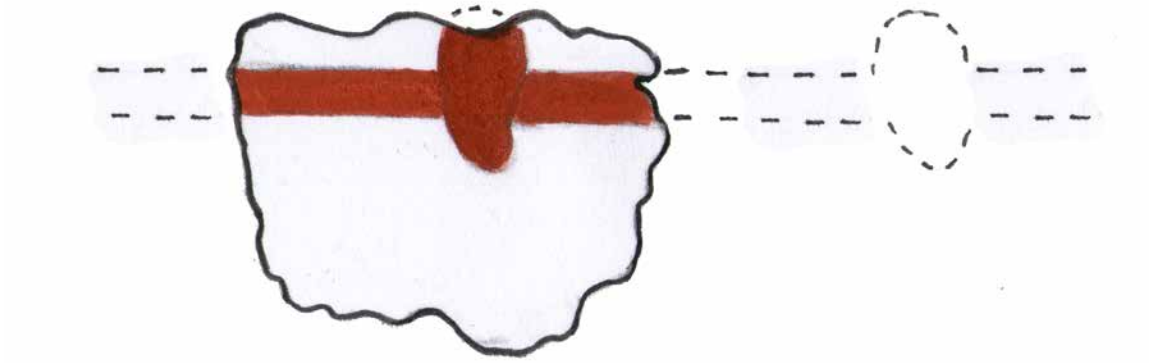

Figure 24. Artistic contribution based on the original fragments (painted by Dragana Gavrilović).

Fragments found in 2014

Bag no. 2, 17.07.2014, quadrant D7. This bag includes twenty-seven fragments that we can divide in two groups, with the most representative ones from the first group shown in **Figure 25**. Here, a brownish band dominates, which varies in shade due to it having been painted on fresh plaster. The surface of the intonaco shows brushstrokes. In the upper zone of the painting layer, ochre tones were used, while below the band, the colour is very light, almost white. On a larger fragment, in its lower zone, traces of black can be seen. On some fragments, both younger and older periods of plaster are visible. The plaster of most fragments consists of light grey arriccio and with fine gravel visible. The thickest arriccio is about 2 cm. The intonaco is white and about 2 mm thick. The plaster is not compact. In the second group of fragments, the characteristic texture of the intonaco surface from the furrows of the brush with which it was painted is not visible, but the painting layer is flat. Fifteen fragments of white plaster surfaces are in this group, and traces of red and green paint are present on some of them. Two fragments are coloured red. The plaster has light grey arriccio, with the thickest layer of about 2 cm, with small stones visible in its composition. The intonaco is white and about 2 mm thick. The plaster is not compact.

Bag no. 17, 17.07. 2014, quadrant C7, inner part of the apse. The fragments from the interior of apse 2 are characterised by a "triangular cross-section" with a flattened top, offering opportunities for further analyses of the shape and function of the wall/structure they belonged to (**Figure 26**). With some of these fragments, only the outer side is painted red (a total of eight), while their inner side is white (see **Figure 26a**; **Figure 26b**; **Figure 26c**). Some fragments are white on both the outer and inner sides (a total of four fragments - **Figure 26d**). The aggregate contained crushed brick powder (**Figure 26e**). Four of these fragments were found with accompanying mosaic tesserae.

Bag no. 3, 19.07.2014, along wall nos. 16 and 17. There is a fragment where a right-angle "frame" is visible, formed by two red borders (**Figure 27**). Additionally, on a white plaster base, part of another right angle is represented, formed by thin red lines. This linear angle continues onto the white surface, where a small part of another grey angle is visible. The plaster belongs to the group of brittle types. Six fragments with a white background were in this bag as well, showing parts of red heart-shaped motifs (**Figure 28**). The plaster of these fragments is two-layered, with the light grey intonaco being about 4 mm thick. The arriccio is darker grey, about 1.5 cm thick, and compact.

Bag no. 14, 24.07.2014, quadrant D4. Here, we have five fragments with red colouring; two fragments from the wall corner, red in colour, with the larger one having white pastose line over the red one; and one fragment with ochre colouring. These plasters are porous and up to 3 cm thick. The arriccio is light grey with fine pebbles and small grains of sand visible. The intonaco is about 2 mm thick.

Bag no. 1, 30.07.2014, inner face of wall no.14. This bag consists of many fragments, with the most characteristic ones being those with linear decoration in different colours (**Figure 29**). The fragments could not be joined into larger units. On one fragment, a part of a green semi-circular field with white strokes can be seen. The plaster of the fragments is mostly compact, with an intonaco of about 3 mm and arriccio of grey with a thickness of 1-3 cm. The other fragments in the bag are: those with light and dark red colourings (eight fragments); those with white backgrounds and non-compact mortar (twelve fragments); those with white backgrounds and remains of red strips (four fragments); one with mosaic tesserae; and one with a pinkish colouring.

Bag no. 10, 30.07.2014, along wall no.14, inner face of the wall. Here, we can distinguish fragments with marble veneer imitation, (**Figure 30a; Figure 30b**), as well as fragments with linear decoration (**Figure 30c; Figure 30d**). In **Figure 30a**, a grey marble imitation with black veining is visible, this depiction being bordered with a black strip. The arriccio of these fragments is made of finely sifted aggregate, compact, with a 2 mm thick white intonaco. On the back of the plaster, protrusions can be seen entering holes from the keying by hammer, suggesting that the plaster dates from a younger period. In **Figure 30b**, there is the other group of fragments with a black background and marble imitation done with green paint splashes,

continuing onto a white background with red circular decoration. The preserved thickness of these plasters is 3 cm. It consists of two layers of grey wall levelling plaster with visible lumps of lime, and its aggregate includes sand and brick. The arriccio is about 5 mm thick, grey, and of a fine texture. The intonaco is 2 mm thick and white. For the smaller fragments in this group, the plaster is considerably thinner, around 6 mm thick. The arriccio is made of finely sifted aggregate, compact, with a 2 mm thick white intonaco. On the back of the plaster, protrusions entering holes suggest that this plaster is from a younger period. The next seven fragments have a white surface and a green strip with a grey line approximately 1 cm thick, and some of them can be seen in **Figure 30c**. The plaster thickness ranges from 7 mm to 1.5 cm. The arriccio is made of finely sifted aggregate, compact, with a 2 mm thick intonaco. **Figure 30d** shows a fragment with linear decoration in colours including light green, white, red, and black. The white is pasty. The plaster is very thin, about 5 mm thick, with a grey arriccio and a white intonaco, about 2 mm thick.

Bag no. 4, 31.07.2014, quadrant E3, along the southern face of wall no.14? There is a fragment of a white plaster surface on which part of a red border is visible. The mortar consists of white intonaco, about 2 mm thick. The arriccio is grey in colour, compact, and about 2 cm thick.

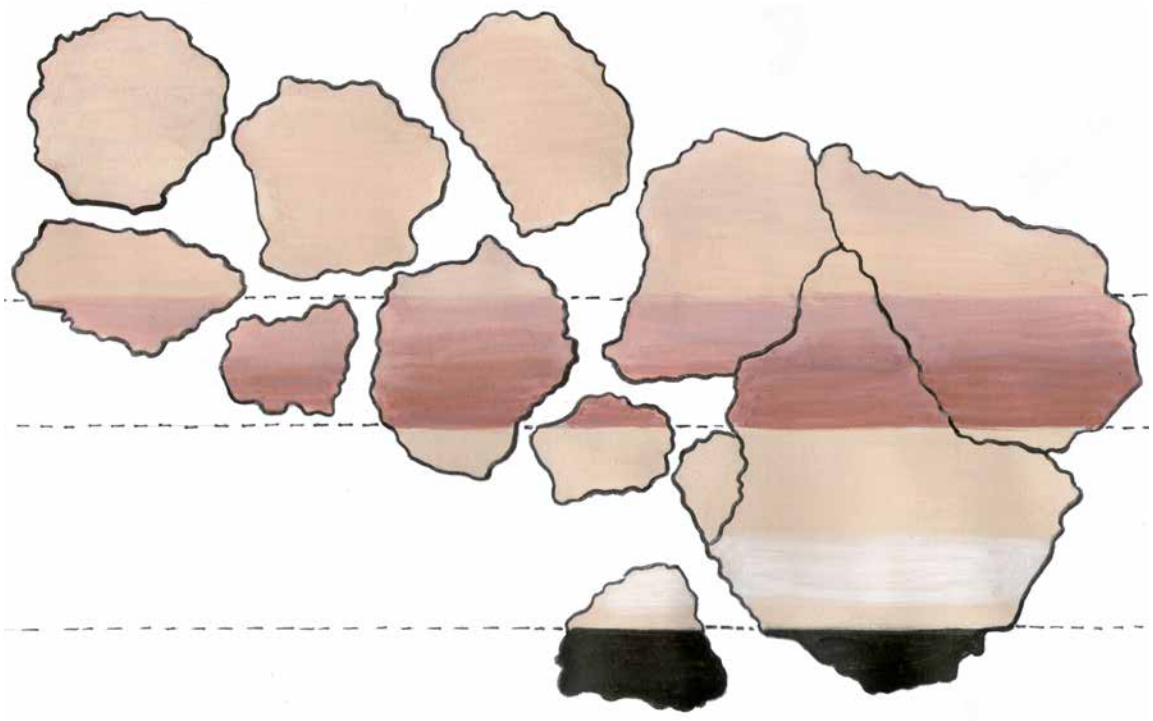

Figure 25. Artistic contribution based on the original fragments (painted by Dragana Gavrilović).

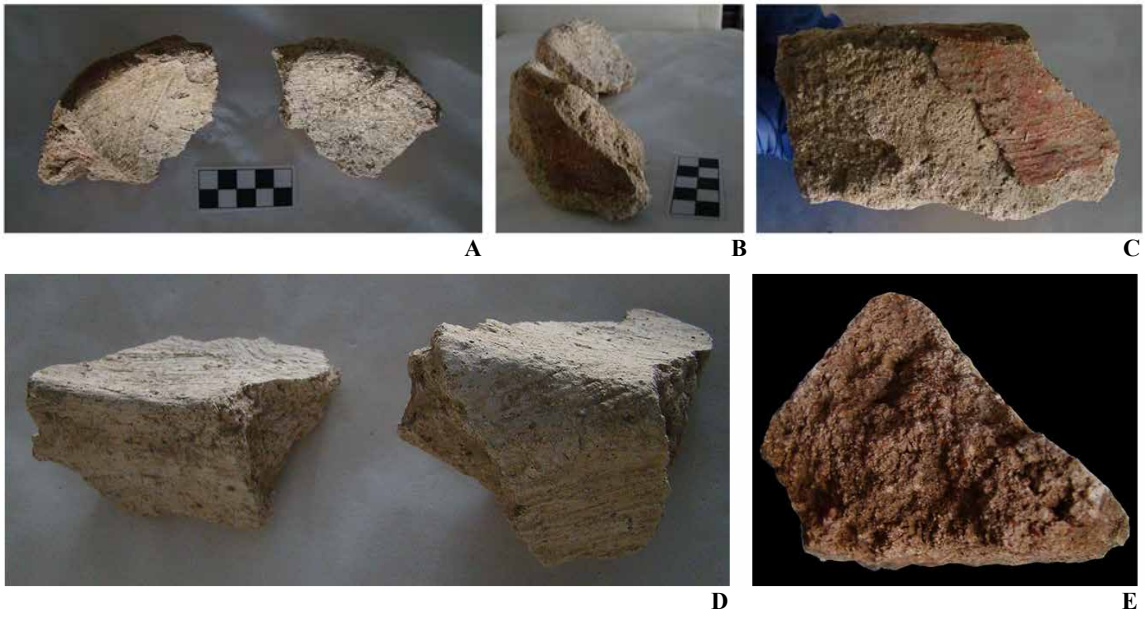

Figure 26. Appearance and cross-section of the fragments (photos by Dragana Gavrilović).

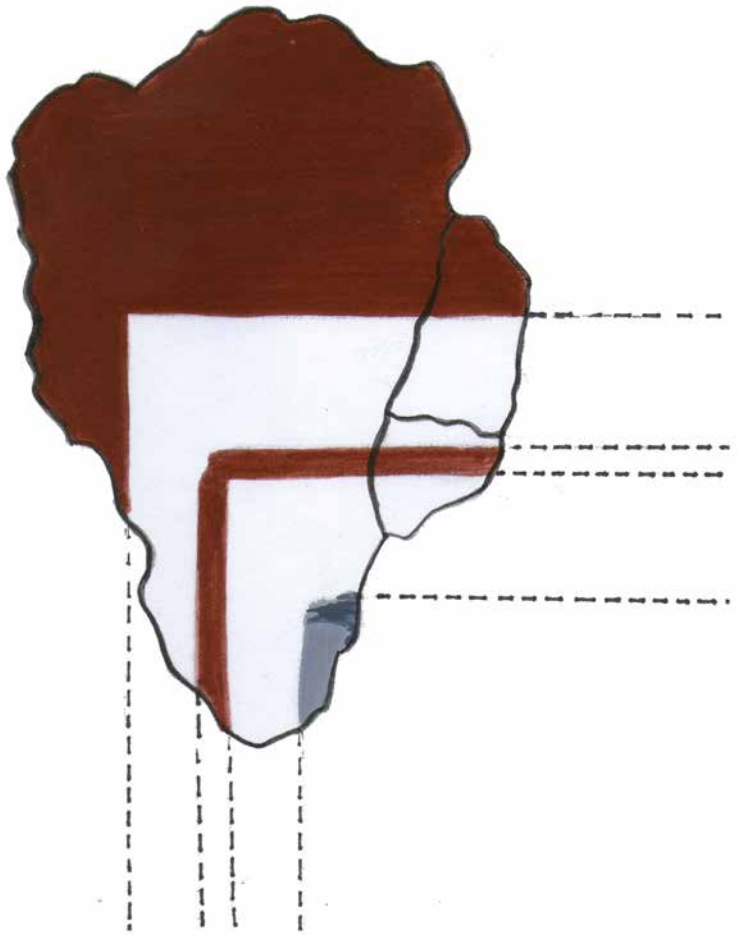

Figure 27. Artistic contribution based on the original fragments (painted by Dragana Gavrilović).

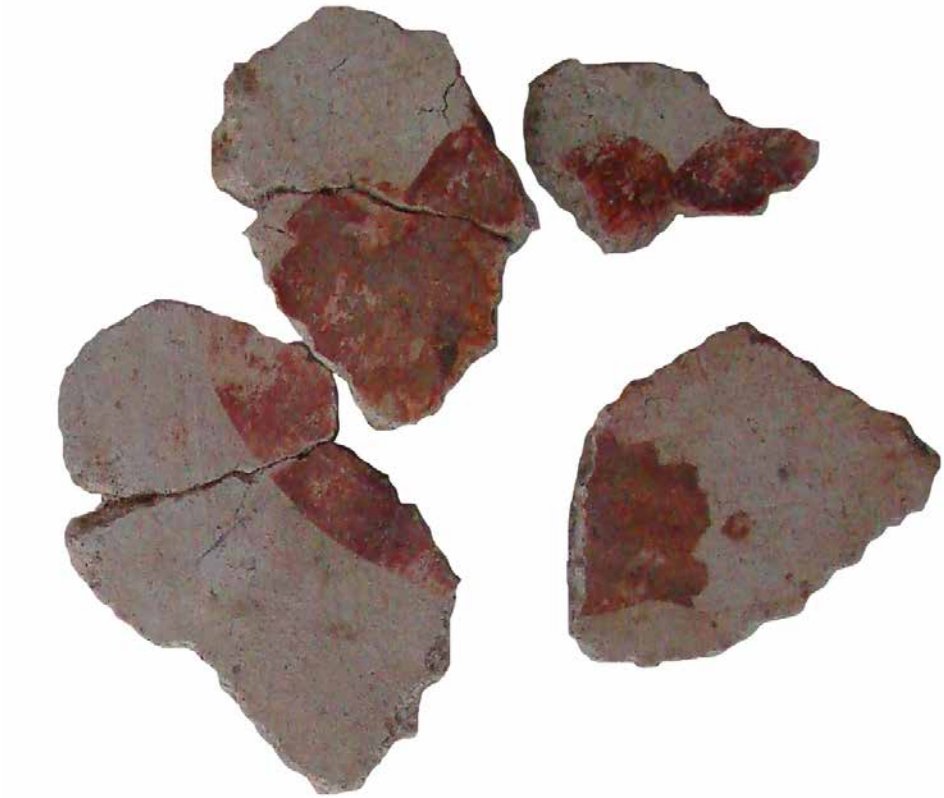

Figure 28. Appearance of the fragments (photo by Dragana Gavrilović).

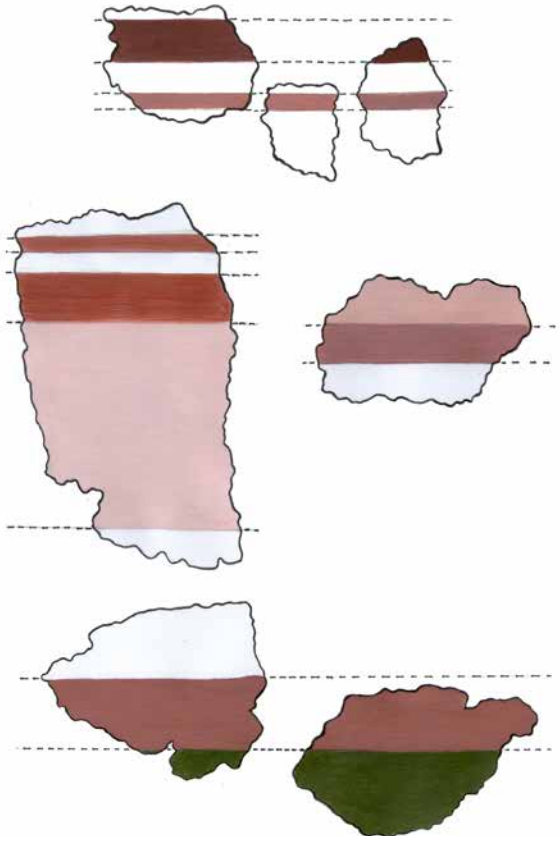

Figure 29. Artistic contribution based on the original fragments (painted by Dragana Gavrilović).

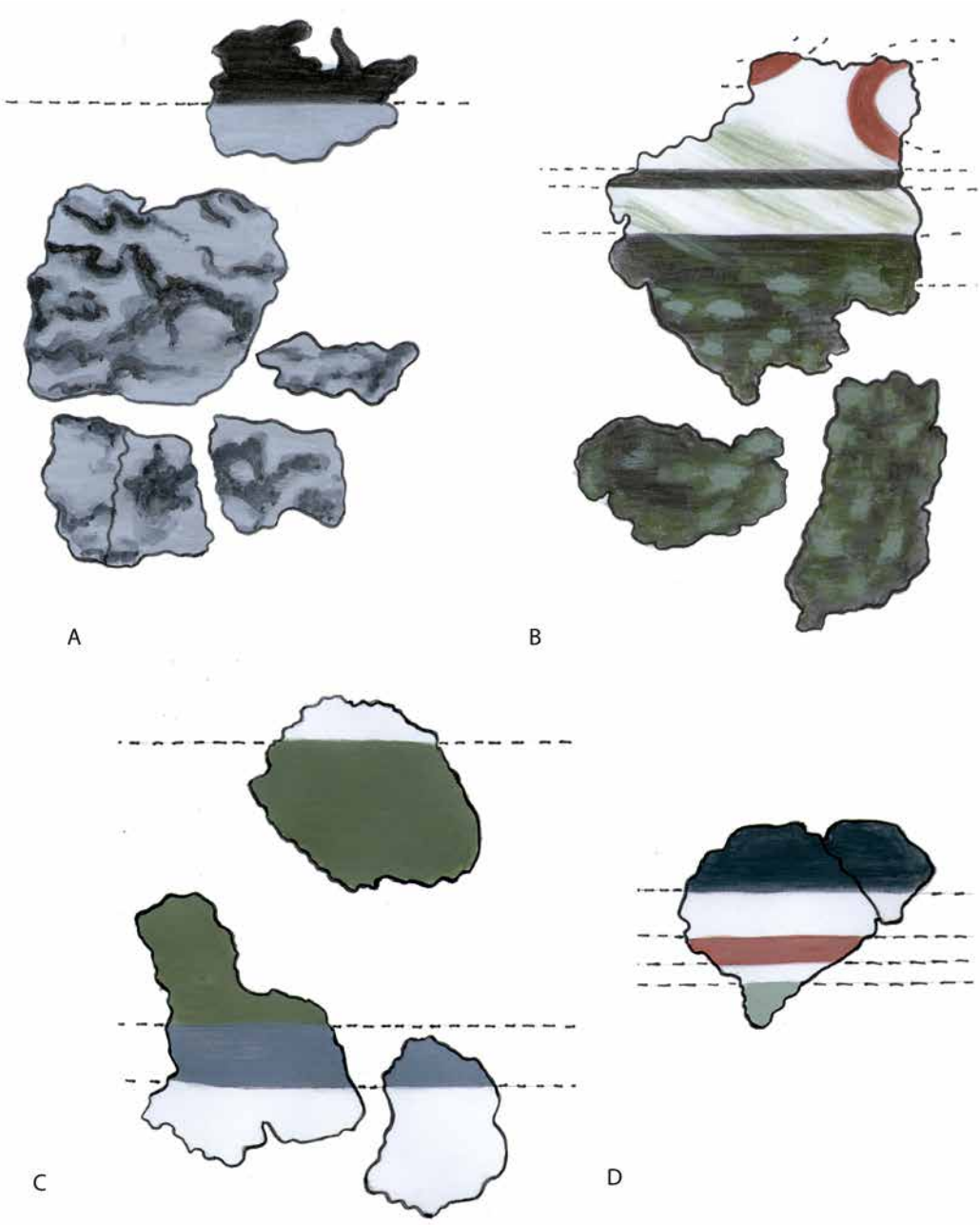

Figure 30. Artistic contribution based on the original fragments (painted by Dragana Gavrilović).

Fragments found in 2015

Bag nos. 1 and 2, 26.08.2015, quadrants E7 and E8. These bags include forty fragments of white surfaces (only a portion of the fragments is shown in **Figure 31**, and one fragment of a white surface with a small section of red colouring (**Figure 31a**). On one of these four fragments there is an unlevelled mark, likely from an uncleaned tool (**Figure 31b**). The plasters in these bags consists of two layers, with a white intonaco approximately 2 mm thick and a grey arriccio of about 2 cm thick. A few fragments were joined, but no significant units were obtained.

Bag no. 5, **05.09.2015, quadrant F3, room K, along wall no.14, layer of light brown soil with fragments of mortar, mosaic and bricks.** This group consists of six units, sorted by colour,

motif, and plaster. One of them has vegetal motifs executed in green on a white background (fourteen fragments - **Figure 32a**). The other unit has fragments from a younger period with "a frame", showing parts of a green frame extending onto a pink surface, but also a green vegetal decoration with pink linear motifs on a white background is visible (7 fragments – **Figure 32b**). Two fragments with blue colouring (**Figure 33**), beneath which a pink underlayer is recognisable can also be parts of this unit. The other unit contains two fragments. On one fragment of two with ochre painted surfaces, one can see part of a linear decoration with "leaves" executed in a brown tone. The mortar is compact, the ariccio is grey, and about 1.5 cm thick, and the intonaco is white, and 2 mm thick. The next unit has five fragments with red linear decoration on a white mortar base, also from the younger period). A further eighteen fragments from the younger period, having different shades of pink and red, were registered. Finally, the sixth unit consists of thirteen fragments from the younger period, with different shades of pink and red, which continue on a white plaster base; two fragments with a white plaster surface can be attached to this unit.

Bag no. 7, 07.09.2015, quadrant F3, room K. From a total of twenty fragments, five with specific artistic content have been distinguished here. Of two of these with an ochre background, one has a semi-circular white line, with red and white dotted motifs, while the other shows part of a wavy white decoration with a red embellishment (**Figure 34a**). The white colour on both fragments is pasty, and they belong to the younger period. One fragment from the younger period with a white plaster surface shows part of a light purple stroke and two green lines, which were probably part of a plant motif. On the next two fragments, a light purple colouring can be seen. On one from the younger period, a black wavy line, with dots above it, is visible. On the other fragment, the purple colour extends onto the white colouring, with small dots painted on the purple surface (**Figure 34b**). The plaster of both fragments is about 1 cm thick, the base is grey, and the intonaco is 3 mm thick, and lighter than the arriccio. In this bag there are also 13 fragments with white plaster surfaces and two fragments with red surfaces, mostly connected to the younger period.

Bag no. 8, 08.09.2015, quadrant F3, room K, layer of light brown soil with fragments of mortar, mosaic and brick. Six fragments of a pinkish-coloured surface are visible, separated from a black surface by a white pasty line of 1.7 cm thickness (**Figure 35a**). The plaster is from the younger period and is about 1.2 cm thick, grey in colour, with a 2 mm thick layer of white intonaco (**Figure 35b)**. Plasters with vegetal motifs are also found (**Figure 35c**). Dark green leaves painted on a white background can be seen on one fragment, while plant motifs in dark green are executed on a light green glazed base on the other. Fragments with intense red colouring are also found (**Figure 35d**). The red is painted on a white surface. The plaster from the younger period is compact, about 8 mm thick, with the intonaco being about 3 mm. The total thickness of the plaster with both periods present is around 2 cm. A part of a decoration with an elliptical shape on a purple-grey surface is found as well, on one fragment from the younger period (**Figure 35f**). Among the fragments in this bag, there are two with light yellow colouring, originating from the younger period, where the wall curvature is visible. In many fragments from this bag, both older and younger period plasters can be seen, indicating the "renovation of a wall painting", such as the case in the next groups (**Figure 36a; Figure 36b**). The younger period plaster varies in thickness from 2 mm to 8 mm and consists of a single layer of intonaco (**Figure 36b**). The thickest plaster from the older period is about 5 cm thick and consists of three layers. The intonaco thickness ranges from 3 mm to 8 mm. In the ariccio, pebbles of varying sizes, from 2 mm to 8 mm, can be seen. The first layer of plaster does not differ from the ariccio in composition. On the back of the thickest plaster, traces of reeds or twigs can be observed (on only one fragment). On the back of both the older and younger period plasters, traces of keying by hammer are visible (**Figure 36b**). Holes created by sharp tools are seen on the older period plaster, while protrusions can be seen on the back of the younger period plaster. This group includes fragments with linear decoration (**Figure 36c**). A total of twenty-three fragments have been preserved, with the white surface with thin red line depicted being 4 mm thick. Above it, there is a purple line, approximately 1.2 cm thick. This system of linear

decoration was highlighted by a wide red border, 7.2 mm thick. Among the fragments with purple linear decoration, one small fragment was observed, showing an angle formed by the purple lines. This decorative scheme likely consisted of a system of frames. The first frame consisted of a thin red line, then purple, and finally a thick red frame, as shown in the reconstruction (**Figure 36d**). On two fragments with a red border, traces of cord can be seen. On the surface of the older period plaster, only occasional ochre and pinkish glazed colouring can be observed (**Figure 36f**). The next group of seventeen fragments has an almost identical iconographic solution to the previously described example. The difference is only in the intensity of the colours – the red is darker, and the purple has a blue tint. Plaster from the older and younger periods are not observed together here. The total thickness of the plaster is 1-2.5 cm. The mortar consists of arriccio in which pebbles of different sizes are present, and the intonaco is 2-8 mm thick. A similar iconographic solution can be seen on two fragments (**Figure 36e**), where the previously mentioned purple line, about 1.2 cm thick, is recognisable on a white surface. Below it there is a red line, 8 mm thick, and at the very bottom, a green surface is present.

Bag no. 15, 14.09.2015, room K, K6, layer of the light brown soil with mortar. This group consists of fourteen fragments: seven fragments with a white plaster surface; two fragments with ochre-coloured surfaces, on which brush marks are visible (**Figure 37**); two fragments with reddish colouring; one fragment with grey colouring; one fragment with a white plaster surface that continues to red; and one fragment with a part of a red border and a light green vegetal motif painted on a white intonaco surface (**Figure 38**). The thickest plaster is approximately 2 cm thick and is very compact. The arriccio is grey, and the intonaco is very thin and white.

Bag no. 19, 14.09.2015, room K, K20, layer of the light brown soil with mortar. Here we have three fragments, two of which have a white plaster surface and one with grey colouring.

Bag no. 26, 14.09.2015, room K, K12, layer of the light brown soil with mortar. The next two fragments are from the younger period. One displays part of a linear decoration with elliptical motifs in dark red on a white background, while the other shows part of a green decoration, also on a white background (**Figure 39**).

* * *

Bag with no number or additional data obtained (presumably from 2008). Twenty-three fragments have grey and ochre colouring painted on a white plaster background.

Figure 31. a. Appearance of the fragments; **b.** One fragment with a tool mark visible on the plaster surface (photos by Dragana Gavrilović)..

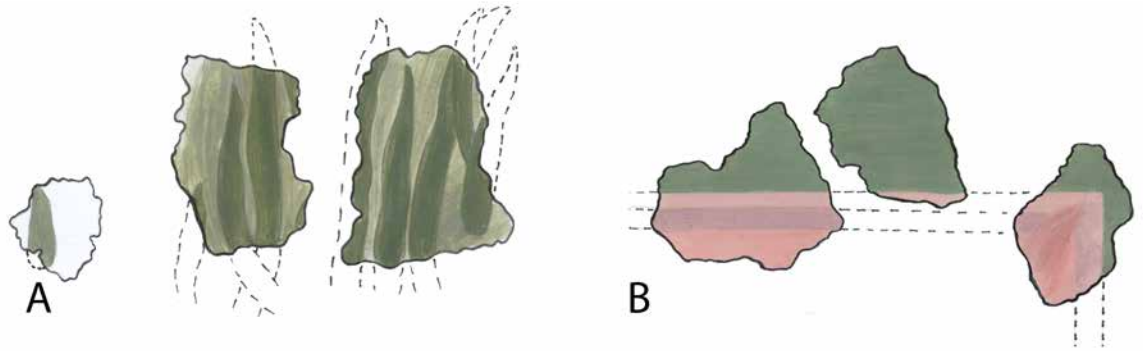

Figure 32. Artistic contribution based on the original fragments (painted by Dragana Gavrilović).

Figure 33. Appearance of the fragments (photos by Dragana Gavriović).

Figure 34. Artistic contribution based on the original fragments (painted by Dragana Gavrilović).

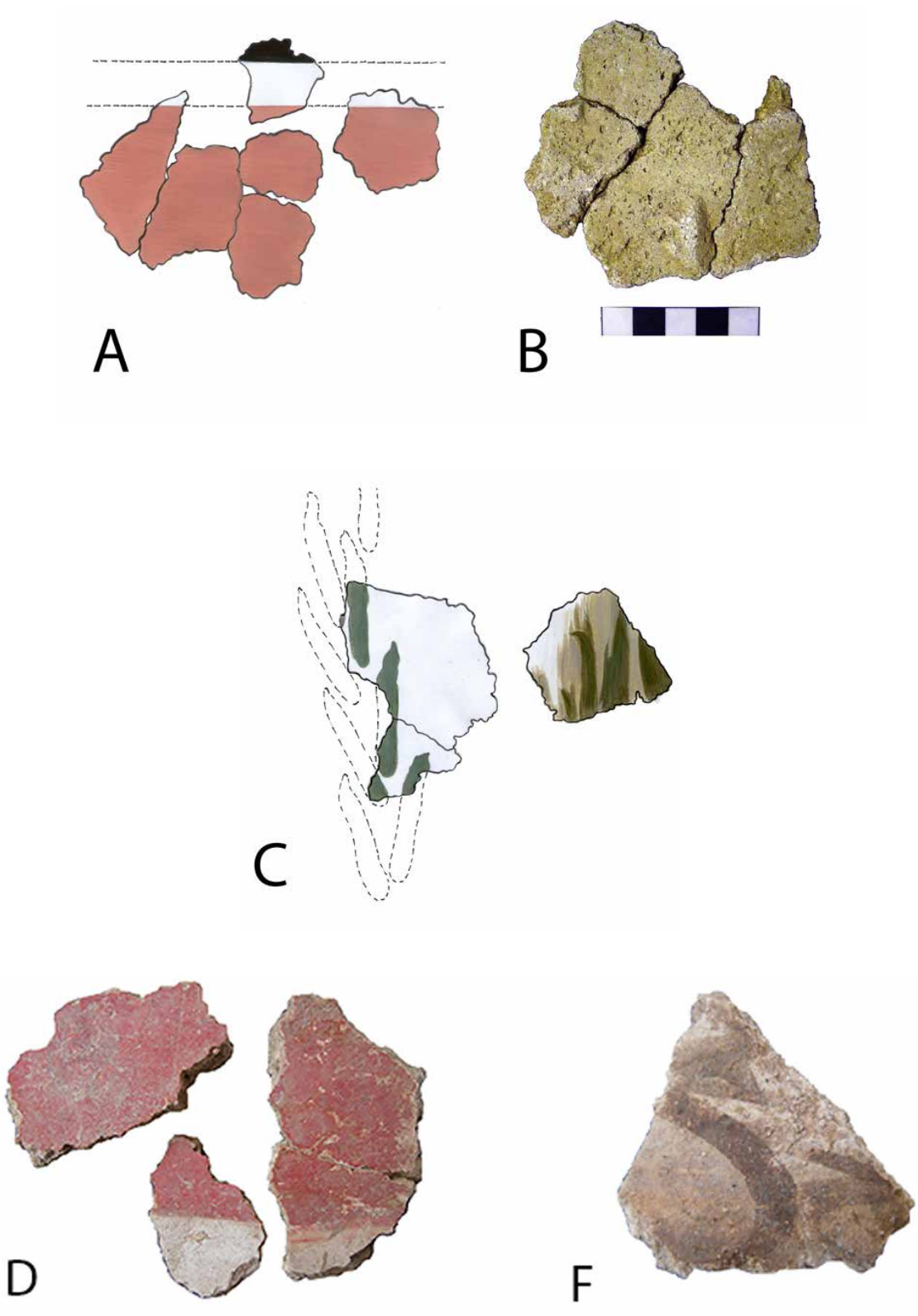

Figure 35. Artistic contribution based on the original fragments (painted by Dragana Gavrilović); appearance of the fragments (photos by Dragana Gavriović).

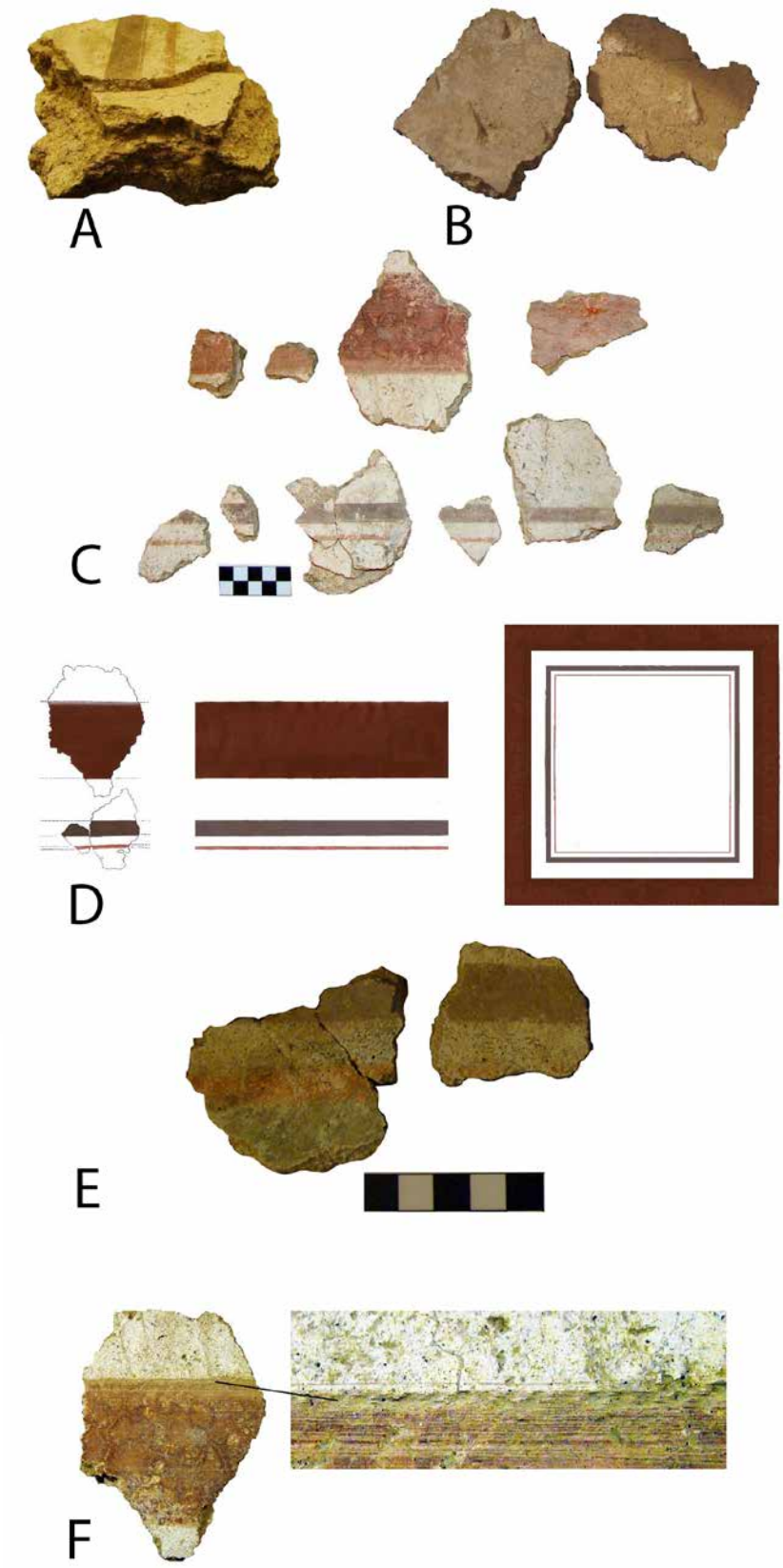

Figure 36. Artistic contribution based on the original fragments (painted by Dragana Gavrilović); appearance of the fragments (photos by Dragana Gavrilović).

Figure 37. Appearance of the fragments (photo by Dragana Gavrilović).

Figure 38. Appearance of a fragment (photo by Dragana Gavrilović).

Figure 39. Appearance of the fragments (photo by Dragana Gavrilović).

DISCUSSION

The late antique building at the site of Zadružni Dom in the former Roman town of *Municipium Malvesiatium* was likely a mixed residential-public structure. The floors were covered with luxurious mosaics, and the walls were painted, as indicated by numerous fragments found during the archaeological excavations, but also proved by the remains of the decoration preserved *in situ*. According to the disposition of the found fragments and those still preserved on the walls, it can be concluded that almost all the rooms, as well as the corridor in the building, were wall painted, which can be further used as important data for research on the function of the rooms themselves.

Conservation work on the wall painting fragments found at the site of Zadružni Dom in 2008, 2014 and 2015 has led to various conclusions. Multiple types of plaster were identified. Most fragments feature paintings on a white background, though some have vividly coloured surfaces, also evidenced by the *in situ* preserved painting. It is not common to find all the successive plaster layers existing together in the analysed wall painting fragments, and most of them are preserved with either the arriccio or intonaco layers.

A very uncommon find is a plaster layer used for levelling the wall irregularities. Some fragments show reed impressions on the back, which usually suggests a ceiling structure, or walls made using the wattle-and-daub technique. Although not artistically significant, the fragments from the interior of apse 2 are characterised by a "triangular cross-section", which can lead us further to the analyses of the architectural elements of the room. A thin incision was recorded on the surface of the intonaco on only one fragment, and in the group containing this fragment there is also one with a part of a painting that cannot be defined, featuring a characteristic cinnabar tone.

A large number of fragments show evidence of past renovation work. On the backs of the plaster from both the older and younger periods, traces of keying by hammer can be observed, a method used for ensuring a strong bond between the plasters, i.e., the plaster from the older period shows holes made by a sharp tool, while the younger plaster has protrusions on the back.

The plaster of most fragments found in 2008 is interesting because of the specific fine cracks visible on its surface, suggesting either poor plaster quality or that the wall painting was exposed to some heat source. In the intonaco area of some fragments, the bluish-grey colour of the plaster is occasionally visible, indicating alteration due to exposure to significant heat, which corresponds to the results of the archaeological excavations, which confirmed the building was burned down. As for the painted layer, the transition from ochre to red (alteration) is mainly visible on fragments from 2008, particularly from the younger period, also likely due to high temperatures, but suggesting that this wall painting was near a heat source, possibly a furnace.

The fragments found in 2008 are mostly dominated by a white background and very simple decoration, primarily linear in the form of strips and borders, but also circles and strokes in the shape of a "comma". The exception is a fragment where only the head of a green bird with a dark red beak and a ring around its neck is preserved. Based on the colouration, this fragment might be related to another fragment showing strokes that could represent part of the bird's body and tail (?).

Among the fragments studied in 2014, those displaying various types of marble imitation stand out: fragments with a black base and a marbling effect created by splattering green paint, which continues onto a white background with a red circular decoration. In addition to this marbling, there is also an imitation of grey-black marble. The black base is adorned with winding grey strokes that depict marble veins. The *in situ* preserved compositions also suggest that the wall painting decoration featured an imitation of marble panelling.

During 2015, fragments with evidence of renovation and varied colouring were also found. Some fragments feature a very pastose white paint layer. In addition to linear decoration and framing schemes conceptually reconstructed during the conservation work, there are also interesting artistic elements such as dots, ellipses, and vegetal motifs. The colour palette is diverse. Among the fragments are two with light red colouring (belonging to the younger period), which show an arched curvature of the plaster, indicating that not all walls were perfectly flat. The fragments with

frames could not be combined into larger wholes but, based on logical arrangement and an analysis of the artistic content, it was concluded that a framing scheme was likely painted. Both older and younger plaster layers are visible in these fragments.

CONCLUSION

Most of the wall painting in the building at the site of Zadružni Dom has not been preserved, and even the found fragments are mostly very small. Thus, any significant conclusions about the iconography present on the walls of the building cannot be drawn at this moment. Since the labels of the find spots were not preserved for all fragments, future work on the interpretation of the found fragments should include a detailed inspection of the excavation diaries and photos and, thus, an attempt to mark their completely correct disposition in the building's rooms. Additional research on the wall painting fragments found in the building should be focused on simultaneous analyses of those found along the same wall or in the same room, which could possibly enable their interpretation and reconstruction as a whole. An in-depth comparative research of the fragments from Skelani and other Roman sites situated in Bosnia and Herzegovina (Busuladžić 2011; Busuladžić 2012; Cogo 2018; Čremošnik 1955; Čremošnik 1965; Čremošnik 1976; Čremošnik 1984) would make a significant scientific contribution to the knowledge on provincial Roman wall painting. Additionally, research on the wall decoration present in analogous examples of buildings found in the Roman provinces would also be very valuable. Although the artistic content of the wall painting in the building does not seem very rich, based on to the preserved fragments, it indeed shows the remains of the various motifs and colours and, along with the existence of the very fine and artistically valuable mosaics at the site, we can suggest that the wall paintings could have various iconographical repertoires as well.

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REZIME:

PREGLED FRAGMENATA RIMSKOG ZIDNOG SLIKARSTVA IZ SKELANA, BOSNA I HERCEGOVINA

KLJUČNE REČI: RIMSKO ZIDNO SLIKARSTVO, FRAGMENTI, MALTERI, MUNICIPIUM MALVESIATIUM, SKELANI, DALMATIA.

Municipium Malvesiatium bio je rimski grad, značajan trgovački i administrativni centar u provinciji Dalmaciji, za čije ostatke se pretpostavlja da leže ispod teritorije današnjeg mesta Skelani (opština Srebrenica), Republika Srpska, u Bosni i Hercegovini. Prva arheološka iskopavanja ovog mesta započeta su 1986. godine. Nova arheološka istraživanja započeta su tek 2008. godine, a nastavljena su do 2019. godine.

Na lokalitetu Zadružni dom 2008. i 2014. godine istražen je objekat koji se datuje u period kasne antike, odnosno u kraj 3. i u prvu polovinu 4. veka n. e. Ovaj kasnoantički objekat verovatno je bio stambeno-javnog karaktera i imao je jedanaest prostorija, dve apside, peristil i koridor oko njega. Podove su prekrivali raskošni mozaici, a zidovi su bili oslikani, što osim *in situ* očuvanih oslikanih delova zidnih površina potvrđuju i brojni fragmenti zidnog slikarstva pronađeni 2008, 2014. i 2015. godine. Objekat je stradao u požaru, verovatno prilikom napada varvarskih plemena, a tragovi gorenja vidljivi su i na ulomcima zidnih slika. Na osnovu istraživanja iz 2018. i 2019. godine potvrđeno je postojanje starije stambene građevine ispod one već istražene. Datovana je u period od 1. do 3. veka. Obe građevine su imale najmanje po dve građevinske faze.

Tokom 2016. godine obrađeno je preko 950 fragmenata zidnog slikarstva, a svi su pronađeni tokom iskopavanja mlađe građevine. Kod velikog broja fragmenata zidnih slika može se uočiti dokaz obnove pa se na poleđinama malternih slojeva iz starijeg i novijeg perioda vide tragovi pikovanja. Mali broj fragmenata na poleđini sadrži otiske od trske, što najčešće sugeriše na plafonsku konstrukciju ili zidove od pletera. Većina fragmenata sadrži slike na beloj pozadini, o čemu svedoči i očuvani deo jedne kompozicije *in situ*. Što se tiče dekoracije, prisutne su jednostavne linearne šeme, ali i imitacija mermera, geometrijske figure, vegetabilni i zoomorfni motivi, među kojima se izdavaja motiv ptice.

Najveći deo zidnog slikarstva u objektu nije sačuvan, a pronađeni fragmenti su uglavnom veoma mali, pa se značajni zaključci o ikonografiji prisutnoj na zidovima zgrade u ovom trenutku ne mogu izvući. Buduća istraživanja pronađenih fragmenata zidnog slikarstva u objektu trebalo bi da budu usmerena na istovremene analize fragmenata pronađenih u istom prostornom kontekstu – blizina istog zida ili okvir jedne prostorije, što bi otvorilo mogućnosti njihove interpretacije i rekonstrukcije u celini. Detaljno komparativno istraživanje fragmenata iz Skelana i drugih rimskih lokaliteta koji se nalaze u Bosni i Hercegovini donelo bi značajan doprinos saznanjima o rimskom provincijskom slikarstvu. Takođe, istraživanja zidne dekoracije prisutne u analognim primerima objekata pronađenih u rimskim provincijama takođe će biti veoma dragocena. Na kraju, postojanje umetnički vrednih mozaika na lokalitetu, posebno onog sa Meduzinom glavom, može sugerisati da su i ove zidne slike mogle imati različit ikonografski repertoar.

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Use of tools based on large language models and generative AI: ChatGPT (translation).

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USE OF MODERN TECHNOLOGIES IN DIGITIZING MILEŠEVA MONASTERY: A REPORT ON THE WORKFLOW

ABSTRACT

Modern methods for the presentation and protection of cultural heritage are inseparable from the use of digital technologies. The digitization process has made it possible to examine movable and immovable heritage objects in detail and document their condition and, as such, has found a purposeful use in research, education and presentation processes. This paper focuses on the application of modern technologies in digitising a cultural property and presents its workflow. Through 3D laser scanning, drone recording, standard and spherical (360°) photography, scanning of old and rare books and, finally, the creation of a web presentation and application for mobile devices, we explore the methods of the digital documentation of cultural heritage using the example of the medieval Mileševa Monastery, one of the most important spiritual and cultural centres of the Serbian people. The advantages of the project are presented, together with ideas for further development. Digitization of heritage is not only a technical but also a cultural undertaking and, therefore, is of utmost importance for humanity. Thus, the goal of this project was to enable better access and preservation of the multi-layered cultural heritage of the Mileševa Monastery for future generations.

KEYWORDS: DIGITIZATION OF CULTURAL HERITAGE, MODERN TECHNOLOGIES, MILEŠEVA MONASTERY, CULTURAL HERITAGE PRESERVATION, 3D LASER SCANNING, WEB-BASED VISUALISATION, DIGITAL DOCUMENTATION.

INTRODUCTION

Digitization of cultural heritage has long been imperative in modern society, and has been greatly advanced by the development of cutting-edge technologies that enable detailed documentation and presentation, thereby facilitating the digital preservation of movable and immovable heritage objects, whose physical changes are inevitable over time (Stylianidis and Remondino 2016). The most commonly used techniques for these purposes are: 3D laser scanning, aerial recording with unmanned vehicles, professional photography, 360° photography, and the digitization of documents, websites and mobile applications.

3D laser scanning is an imaging technique that uses lasers to measure and map the surface of objects precisely. Due to the possibility of collecting detailed data, it has long been useful in industry, geodesy, medical diagnostics, and digitizing cultural monuments (Yastikli 2007).

Unmanned aerial vehicles (UAV) - drones have become an indispensable tool in the process of digitizing immovable cultural heritage, thanks to the possibility of filming from different angles and

heights. They have proven to be very useful for collecting data on large objects and geographical areas from different perspectives, allowing access to locations that are difficult to access or carry a certain security risk for researchers (Westoby *et al.* 2012).

Photographing with professional cameras is an inseparable part of the digitization process that serves for detailed documentation and preservation of visual data (Cultural Heritage Digitisation 2023; Rieger, T. *et al*. 2023). In this way, quality visual archives of various purposes are created, primarily for education, research and presentation. Photographs of buildings, architectural elements, paintings, works of art, and treasure objects have long been additionally used for generating 3D models (Remondino and El-Hakim 2006) allowing the detailed study and preservation of monuments.

360° photography is used to obtain spherical images that offer a comprehensive view of space, which is particularly useful for digitizing the interior of buildings such as religious monuments or archaeological sites, and more specifically those that are in very remote areas, hard to visit or forbidden for extensive visits to ensure their long-term preservation. The importance of this technology became especially evident during the COVID-19 pandemic when travel to monuments and sites was limited and visitors from all around the world relied on websites offering virtual tours using 360° photography. Subsequently, this method of presentation and interpretation of heritage has become a permanent part of the tourism offers (Ren and Chen 2021: 1192–1194).

Original documents, old books and manuscripts are often fragile and prone to damage during handling, so generating digital versions reduces the need for physical contact with the originals, thus extending their lifespan. Redundant and backup copies further ensure the longevity of these digital resources (Aly and Chernevych 2024: 3). Thus, their digitization is crucial for their preservation and ease of access (Anderson 2018).

Creating a website is essential for the presentation of digitized cultural heritage materials to a wider audience. The development of a mobile application enables simple, quick and more flexible access to digitized materials and their interactive content on smart devices. Users can, thus, easily explore cultural heritage through their phones and tablets, regardless of where they are (Silva *et al.* 2020; Attractions.io 2023; ARCHES 2023). Websites and applications, in addition to textual information, mostly include rich multimedia content, such as photo galleries, videos, audio guides and interactive graphs, while multilingual support is more than welcome to bring the wealth of cultural heritage closer to the widest possible circle of interested parties from different speaking areas.

In 2022–2023, on the initiative of the Mathematical Institute SASA (MISASA), and with the financial support of the Ministry of Culture of the Republic of Serbia, the medieval Mileševa Monastery was chosen to be digitized. Due to its multi-layered heritage, it was an ideal candidate for the application of modern techniques and technologies for digitization, with the intention of presenting it to experts, researchers and the wider public in an innovative way.

MATERIALS AND METHODS: TECHNIQUES AND TOOLS USED

This paper provides a report on the digitization of different elements of the Mileševa Monastery using the techniques mentioned above. Using 3D laser scanning, a precise mapping of buildings was completed, and aerial photography with unmanned aerial vehicles (drones) was used to create photogrammetric models, while photographs of buildings, paintings and treasure objects were taken to obtain high-quality visual records. The 360° photography enabled immersive views of space, while the digitization of documents contained recordings of books and other archival materials to preserve their content and ensure easier accessibility. Finally, for the presentation of the monastery and its digitized content, a website and a mobile application were created, using the obtained inputs, as dissemination platforms and the final outputs and results of the whole process.

Review of the spatial context

The Mileševa Monastery is a famous endowment and the burial church of King Stefan Vladislav, the second son of King Stefan the First-Crowned, the first Serbian king of the

Nemanjić dynasty. It is situated near today's town of Prijepolje in south-western Serbia. In 1947, it was protected as an immovable cultural property (Решење 1947), while in 1979 it was declared a property of exceptional importance for the then Socialist Republic of Serbia (Одлука 1979), which is the status it maintains to this day.

Although the monastery was founded around 1219, the precise year of the construction of its Church of the Ascension of Christ remains unknown. Since the foundation charter has not been preserved, the precious portraits of the Nemanjić rulers and later written records remain the primary sources of information about the temple. The monastery was founded near an important medieval trade route between the Adriatic Sea and the inland. Starting from 1237–1238, when King Vladislav transferred the remains of his uncle, Saint Sava, from Trnovo (Bulgaria) to Mileševa, this prestigious place of worship became the centre of Saint Sava's cult, which would reflect its status in the church hierarchy. Thus, Mileševa's hegumen was accorded second place, right after the hegumen of Studenica. The monastery was probably ruined at the end of the 13th century by the Cumans, while during the fall of the Serbian medieval state in 1459, large-scale destruction occurred at the hands of the Ottomans. After the renewal, it reached its peak in the 16th century, developing important economic ties with Dubrovnik, and cultural and craft activities associated with copying, binding and printing books. During the 17th and 18th centuries, the cycle of destruction repeated, due to floods and Ottoman attacks, leaving the monastery abandoned in 1782. Mileševa was fully restored in 1863 and it played a prominent role in the awakening of national consciousness and identity. In this period, it also became the centre of interest of an increasing number of foreign scholars, travellers and diplomats who, amazed by the beauty of the preserved frescoes, widely affirmed its importance. Saint Sava relics were kept in the monastery until 1594–1595, when the Ottomans took them and burned them in Belgrade. Today, only his left hand and his archbishop's sceptre remain. His cult has been nurtured in the monastery for centuries (Кандић и Поповић 1995: 5–12).

The monastery complex today consists of the church, bell tower, and chapel, as well as other buildings, such as the treasury, guest residences, library and episcopal building. The whole complex was the subject of digitalization, but the focus was on the church, its frescoes and its material treasures.

3D laser scanning

For the digitization of the heritage of the Mileševa Monastery, we used a Faro Focus S150 laser scanner. This device enables the collection of extremely precise data with an error margin of only ±1 mm (at 10 m). The data obtained by scanning was processed in Scene software, which is specialised for working with Faro scanners. For further processing and visualisation, the Blender programme was used, which enables detailed processing and the creation of 3D models.

Aerial recording with unmanned vehicles

During the digitization of the Mileševa Monastery, we used several models of drones: *DJI Mavic Mini 3 Pro*[1] for recording the interior of the monastery church, and, among others, *DJI Inspire 2*[2], *DJI Mavic 2 Pro*[3] and *DJI Mavic 2 Zoom*[4] for external recording. These drones enable high-quality video recordings and photos, which were used to create photogrammetric models or a short presentation film. Sufficiently precise data can be extracted from the obtained material for analysis, presentations and the generation of textures for the 3D model. Using software such as *Polycam*[5] and *Blender,* photos taken by the drones were processed and combined into three-dimensional models.

Photographing of a representative set of movable and immovable heritage objects

Canon EOS 5D mk4, *Canon Eos 6D mk2* and *Nikon Z6 II* digital cameras were used to document the multi-layered heritage of the Mileševa Monastery. The processing of the obtained visual

[1] See more on: https://www.dji.com/global/mini-3-pro.
[2] See more on: https://www.dji.com/global/inspire-2
[3] See more on: https://www.dji.com/mavic-2/info.
[4] See more on: https://www.dji.com/mavic-2/info.
[5] See more on: https://poly.cam.

material using *Adobe Photoshop*[6] and *Affinity photo*[7].

360° photography

For obtaining material to enable interactive space exploration 360° cameras are used, such as *GoPro Max*[8] or *Insta 360 X3*[9]. In the case of the Mileševa Monastery, a *GoPro Max* camera was used, which has dual lenses and allows the recording of high-resolution spherical photos with different configurations. When used as a regular camera (*Single-Lens Hero Mode*), photos have a resolution of up to 16.6 megapixels. In recording mode with both lenses (*360° Mode*), photos can have a total resolution of up to 18 megapixels. Processing of 360° photos was done using specialized software and other work tools, such as *Affinity Photo*[10] or *Adobe Photoshop*[11]. After processing, the interactive panoramas were created using the specialised *Kolor Panotour Pro*[12] software.

Digitization of old and rare books

Given that the process of digitizing cultural heritage is mostly field-based, the *Travelers Conservation Copy Stand (TCCS 4232)*, which has a camera mount, book/document holder, and shadow avoidance lights, proved to be the optimal solution. The photographic equipment installed in our case was a *Canon Eos 5D mk4*[13]**.** The *TCCS 4232* stand, also known as the "Traveller", was developed by Manfred Mayer at the University of Graz Library (Austria) and is designed for the digitization of books and manuscript heritage in a way that minimizes damage. Another advantage is its mobility: the stand fits into a convenient and easily portable protective case that also includes additional digitizing equipment, such as lamps, mirrors and acrylic plates (Kapeller and Schön 2017: 5–6).

RESULTS AND DISCUSSION

During the working process for obtaining digitized data on the monastery, a general methodology was followed, developed similarly to those used by other authors in the process of object recording and modelling of cultural heritage, which comprises *data acquisition*, *data processing, data administration*, *data analysis* and *data representation* (Gruen 2013: 114–115). It consisted of *process preparation*, *data recording* and *data processing*, while the final step was *delivering the results*, no matter what technique was used. These results further served as inputs for delivering the final results of the whole digitization process – the presentation and dissemination tools – the website and the mobile application.

3D laser scanning

Except in the field of protection and preservation of cultural heritage, data collected by laser scanning can find applications in other disciplines as well, including archaeology, history, history of art, architecture and engineering. Through the interdisciplinary use of 3D models, the corpus of knowledge about cultural heritage is further affirmed and enriched, and contributes to its more comprehensive preservation. As a valuable cognitive-educational resource, 3D models can be used in professional work, educational programmes, virtual museums and digital platforms, allowing students and researchers to better understand and explore cultural heritage (Ferdani *et al.* 2020). This technology requires specialised equipment and training, as well as detailed post-production of the data to create the final model.

The 3D laser scanning process of the Mileševa Monastery included the following activities:

Process preparation. The first step involved defining the physical building and scan area,

[6] See more on: https://www.adobe.com/products/photoshop.html

[7] See more on: https://affinity.serif.com/en-gb/photo/

[8] See more on: https://gopro.com/en/rs/shop/cameras/max/CHDHZ-202-master.html

[9] See more on: https://www.insta360.com/product/insta360-x3

[10] See more on: https://affinity.serif.com/en-gb/photo/

[11] See more on: https://www.adobe.com/products/photoshop.html

[12] See more on: https://krpano.com/panotourproupdate/

[13] See more on: https://www.usa.canon.com/shop/p/eos-5d-mark-iv?color=Black&type=New&srsltid=AfmBOooy2ZrGh6JvzRKeS28q73-G0BZpsMsrBVTJJWAXZg9leQGmWhH2

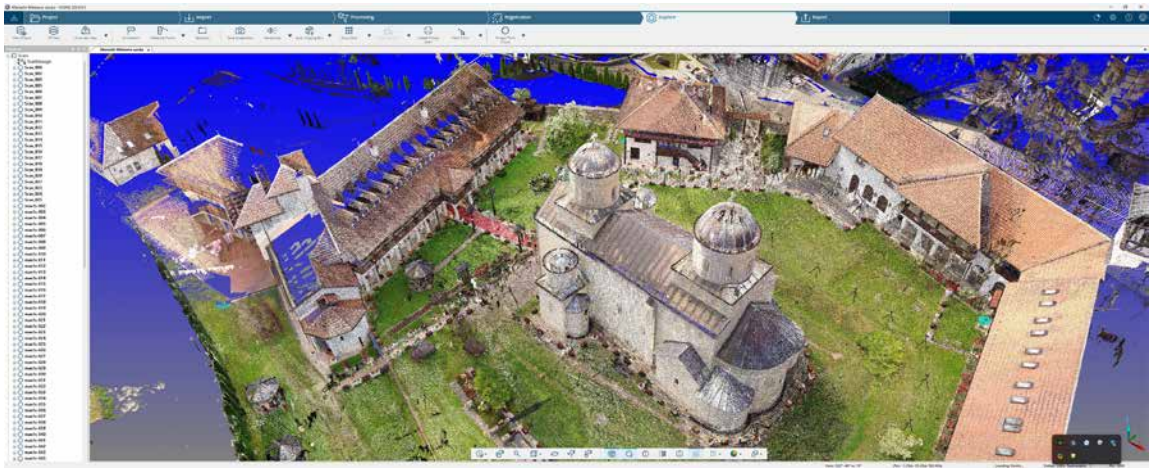

Figure 1. Point cloud obtained with the *Faro Focus S150* laser scanner (author Dragan Aćimović).

identifying key points and planning the scan to capture all relevant details.

Data recording. Scanning was performed using stationary laser scanners that emit laser beams towards the surface of the building. The reflected rays were then collected by sensors that measure the time it takes for the rays to return. Based on these measurements, the so-called *cloud of points (Point Cloud)* (**Figure 1**) was then translated into a representation of the building in the form of a *mesh*.

Data processing. Textures were added to the obtained representation of the building in the processing stage using photographs of the objects themselves. The data collected by laser scanning was processed to obtain a complete 3D model of the building.

Delivering the results: A total of 127 scans were performed for the exterior of Mileševa (Mean Point Error: 2.4 mm), while 92 scans were conducted for the interior (Mean Point Error: 0.8 mm). Point spacing**:** 3.1 mm at 10 m, number of points**:** 20,480 over 360 degrees, total points in a single scan**:** 174.8 million. This number of scans ensures adequate coverage of the complex architectural structure and details, with each part of the structure captured from multiple perspectives to minimize "blind spots" in the point cloud. The Faro Focus S 150, used for this purpose achieves this level of precision thanks to its high resolution and system stability. With this point cloud density, a precise documentation of cultural heritage can be achieved.

Aerial recording with unmanned vehicles

The advantage of the photogrammetry method is that it enables fast and relatively affordable digitization of large surfaces and objects, with a high level of detail due to high-quality textures (Wang *et al.* 2020: 576). In addition, using drones for photogrammetry is often more cost-effective compared to traditional surveying and documentation methods. Drones reduce the need for scaffolding, cranes and other, often bulky and expensive equipment, and also reduce time spent in the field. All of these make photogrammetry an affordable and accessible option for many heritage institutions (Shad *et al*. 2024; Themistocleous 2020: 241, 247). Drones are valuable for the documentation of tall buildings, the interior of difficult-to-access parts of monasteries and other cultural monuments, especially those located on steep and inaccessible terrain.

To obtain accurate models, it is necessary to carefully plan the flight path and process large amounts of data. Unmanned aerial vehicles have software technology that enables the creation of panoramic and spherical images that provide a comprehensive view of the entire space. These recordings can later be used for virtual tours, presentations and other promotional and educational purposes, allowing users to explore the space from different angles and perspectives. This advanced technology justifies its didactic role. Data collected by drones can be integrated with geographic information systems (GIS), allowing detailed analysis of spaces and structures.

GIS technologies are used for mapping, analysing and visualising data intuitively, thereby increasing the efficiency of cultural resource management (Liu *et al.* 2024).

Regular drone imaging helps experts identify and monitor the effects of climate conditions and other factors that may affect the condition of cultural monuments.

The drone recording process of the Mileševa Monastery included the following activities:

Process preparation. The preparatory phase involved planning the flight of an unmanned aerial vehicle, choosing the appropriate equipment depending on the type of recording (whether the exterior or interior of the building is being filmed, whether the priority is video material, photography or creating photogrammetric material) and defining the recording area.

Data recording. The recording process itself was carried out by flying an unmanned aircraft around or inside the building while collecting photographic/video material from different angles. To obtain a 3D model based on photographs, the method of photogrammetry was used, which involved photographing the building with a certain degree of photo overlap and additional settings. In this way, a series of photographs from different angles was generated (Kraus 2007; Mikhail *et al.* 2001; Watts *et al.* 2012) During the determination of the camera angle on the drone, a camera placed at an angle of 45° was found to give the best results because it allows a better insight into the details of facades and other vertical structures. This angle helped in reducing shadows and provides better coverage.

Data processing. Using the software, photos were processed and combined into precise three-dimensional models (**Figure 2**) that faithfully depicted the details of architectural elements or frescoes, which is of great importance for scientific research and the implementation of protection measures on the monument.

Delivering the results: The drone recording results were used in several ways. The first was the generation of photographic and video material. A total of 392 images with a resolution of 6016x3376 (approximately 20.3 MP) were produced (**Figure 3**), along with 378 MP4 files with a resolution of 3840x2160 (commonly referred to as 4K). The second involved the photogrammetric generation of a 3D model from the photographs (50,000 polygons; 12,712 triangles; 6,544 vertices; 19,068 edges; 12.526 faces) for display on a website. The third was the creation of a short film based on the recorded video material.

Figure 2. Photogrammetric 3D model of the Mileševa Monastery, 2022 (author Snežana Mijić).

Photographing of a representative set of movable and immovable heritage objects

As a valuable educational resource, photo archives are gaining an increasingly prominent place in school and academic curricula, often replacing direct contact with cultural heritage. From the middle of the 19th century when it was "an empirical, objective means of recording the world" (Hood 2023: 253) until today's digital era, photography has not lost its relevance, making it easier for researchers to further analyse artistic styles, techniques and materials used in different periods (Holm 2020: 384). This medium has also proven its reliability when "deciphering" layers of information that are not visible to researchers with the naked eye, which further enriches the understanding of the historical context and other specifics of the inspected cultural heritage. Finally, the Internet and information technologies have made photography more accessible than ever; influencing cause-and--effect relationships, and the greater visibility and accessibility of cultural monuments.

Figure 3. Shots of the monastery complex by a Mavic 2 pro drone (photo by the authors, 2022).

The photography process in the Mileševa Monastery included the following activities:

Process preparation. Visual identification and selection of immovable and movable heritage objects for photography (the monastery church, wall paintings , archaeological finds, icons, church vestments and utensils, and old liturgical books).

Data recording. Using professional cameras, high-quality images with a high level of detail were collected. Special attention was paid to lighting, framing, shooting angles, focus and exposure to ensure the greatest possible accuracy of the display, that is, to minimize the possibility of distortion or loss of information.

Data processing. Finally, the processing of the obtained visual material was completed, and the sorting of photos needed for the creation of a digital archive, website and web application was started.

Delivering the results: Photographs (**Figure 4; Figure 5; Figure 6**) were generated for the creation of a digital archive, website, and web application. A total of 562 images with a resolution of 6048x4024 (approximately 24.3 MP) and 369 images with a resolution of 6720x4480 (approximately 30.1 MP) were produced.

Figure 4. a. View of the church from the north by day; **b.** View of the church from the south by night (photos by the authors, 2022).

Figure 5.*White Angel (Archangel Gabriel)*, detail of the fresco composition of the *Myrrhbearers at Christ's Tomb*, third decade of the 13th century, south wall of the nave (photo by the authors, 2022).

a

b

Figure 6. a. Relic box of the proto-hegumen Longinus Mileševac from 1684; **b.** The archbishop's sceptre of Saint Sava handed to him by Patriarch Manojlo I on the occasion of the proclamation of the autocephalous Serbian Orthodox Church in 1219, detail, treasury of the Mileševa monastery (photos by the authors, 2022).

360° photography

Like 2D photos, 360° photos are an important tool for documenting and preserving cultural assets. The main advantage of the 360° virtual tour is reflected in the experience of heritage in a way that was unimaginable until recently, which provides a sense of physical presence and a detailed understanding of the space, the so-called immersive experience (Škola *et al.* 2020: 1). It is possible to explore the digitized space with this technology from any device, including smartphones, tablets and computers. Virtual tours can be easily shared through social networks and websites, further increasing the visibility of the monument and participating in education through user engagement and experience (Argyriou, Economous and Bouki 2020: 846). It is desirable to enrich the user experience with concise text descriptions, annotations, audio guides, links within 360° tours and other multimedia content**.**

The process of photographing with 360° technology in the Mileševa Monastery implied the following activities:

Process preparation. First, the locations where the equipment for 360° photography would be installed were visually identified, in our case at key points in and around the Mileševa Monastery.

Data recording. By using 360° cameras, spherical photos were taken that enable interactive space exploration.

Figure 7. Mileševa Monastery, 360° photo in Flat view mode (photo by the authors, 2022).

Data processing. The photos were then processed and stitched together. Processing of 360° photos was done using specialized software, with which it is possible to easily remove the "print" from the tripod. After processing the 360° photos, interactive panoramas were created using specialised software (**Figure 7**).

Delivering the results. The result of the recording is the generation of 102 images with a resolution of 5760x2880 (approximately 16.6 MP) in a 360° format. Based on these images, a virtual tour was created, optimized for web display and mobile application use.

Digitization of old and rare books

The benefit of scanning books and archives is that it enables the permanent preservation and easier access to information, with the possibility of searching digital documents, especially if the generation of quality metadata is carried out (RDM 2023). At the same time, readability and consistency must be ensured through well-adjusted photographic parameters, as well as adequate storage and organization of digital files. The digitization of books and archival materials brings numerous advantages that significantly contribute to the preservation and accessibility of these important historical sources. Taking into account the fact that digital copies are resistant to physical wear and damage caused both by the human factor and by the effect of natural disasters, the use of modern technologies for digitization achieves the permanent preservation of content that would otherwise be subject to decay and loss (Rieger *et al.* 2023).

The process of recording books and other archival material involved the following activities:

Process preparation. The preparatory phase involved the selection of books and the planning of the recording procedure to ensure the maximum protection of the original documents. The installation of the equipment was done in an adequate location with the setting of photographic parameters adapted to the environment.

Data recording. The process involved careful handling and protection of original documents during scanning/photographing (**Figure 8a**).

Data processing. Digital images (**Figure 8b**) were processed to ensure readability and consistency. This included colour correction, page alignment and removal of other irregularities.

Delivering the results. The Mileševa treasury and library preserve a significant number of valuable books, of which the most valuable copies were included in the digitization, such as the Đurđe Crnojević *Octoechos of the First Voice (Oktoih Prvoglasnik)* from 1494, the *Psalter* (1519) and *Prayer Book* (1540) printed by Božidar Vuković, *the Four Gospels* (1538) and the *Belgrade Four Gospels* (1552).

Figure 8. Book digitization: **a.** Travellers Conservation Copy Stand (TCCS 4232) in operation; **b.** Layout of a recorded book page (photos by the authors, 2022).

Website creation

The main advantage of the website is that it enables global access to digitized material, and increases the transparency of data and the visibility of cultural monuments. What should be paid special attention to is the constant updating and maintenance of the site, as well as optimization for different devices and browsers (UNESCO UK 2023; Europeana 2023; Center for Digital Heritage and Geospatial Information 2023).

It is recommended that the design of the site is interactive and has a user-friendly interface, which facilitates navigation and access to content. A responsive design allows the website to automatically adapt to different screen sizes, whether users are accessing the site from desktop computers, tablets or mobile phones. This is important to ensure a consistent and quality user experience regardless of the device being used. Mobile optimization is useful, considering the growing number of users who access the internet through mobile devices. Implementation of accessibility standards such as WCAG (Web Content Accessibility Guidelines) (WCAG 2023) is also recommended as it ensures that content is accessible to people with different types of disabilities. This includes the use of alt text for images (describing the content of the image), the ability to navigate via keyboard, support for screen readers and adaptive font sizes.

When it comes to increasing a site's visibility on the internet, search engine optimization (SEO) is an indispensable component. Relevant keywords, meta tag optimization, site loading speed and quality backlinks all contribute to a better site ranking on search engines like Google. This intensifies site traffic and allows more users to find and explore digitized materials, and quality content is essential for user retention. All information should be accurate, relevant and well-structured. In addition to textual content, it is important to include multimedia elements such as high-resolution images, video and audio, and interactive graphs.

The creation of website content[14] (**Figure 9**) for the Mileševa Monastery involved following procedural actions:

Process planning. It was necessary to redefine the objectives and structure of the site, as well as to identify the target group.

Design and development. Web design tools such as HTML, CSS, JavaScript and CMS

[14] The website content is available via: http://www.serbia-forum.org/sf/GlavnaSpomenici11.

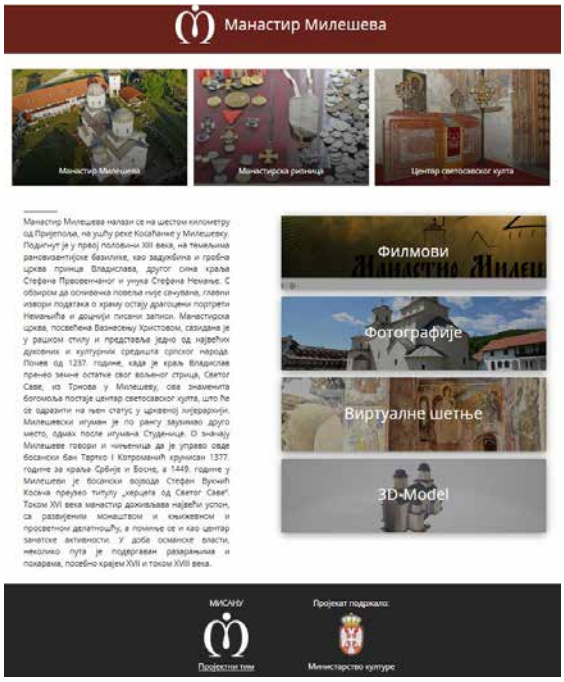

Figure 9. Digital presentation of the Mileševa Monastery on the Serbia-Forum platform (website), Mathematical Institute SASA.

platforms are mostly used to create an interactive and user-friendly site. If flexibility and support for various plugins and modules are preferred, it is recommended to use CMS platforms such as WordPress or Joomla, but in this case, special attention was paid to website security. When security is preferred over simplicity, flexibility and support for various plugins, one can use JSPWiki[15] as the backend and eXist-db as the database (used for Mileševa`s website creation). JSPWiki provides high security and data integrity, while eXist-db provides efficient management of XML-based data, which is ideal for projects that require strict security protocols and complex data structures.

Implementation. This involves placing digitized materials on a site optimized for search using SEO techniques. The site should also feature a responsive design to be accessible on different devices. Depending on the activities carried out, the site can include 3D models, photographs, a short film, virtual tours, descriptions of objects of cultural and historical heritage and other relevant information, which are the elements all included in the website of the Mileševa monastery.

Safety and maintenance. Implementing security measures, regularly updating software and making backup copies of data is the condition sine qua non of any serious web presence. Mileševa`s website maintenance includes regular functionality testing, correcting possible errors and performance optimisation, which contributes to the long-term quality and reliability of the site.

Delivering the results: The website was created in both Serbian and English, offering photos, 3d models, videos and virtual tours, as well as educational texts for its visitors. The website includes the following topics: *Mileševa Monastery* (with subtopics on *History***,** *Architecture* and *Wall Painting*); *The Monastery Treasury* (with subtopics *About the Treasury***,** *Collection of Icons, Church Vestments and Utensils***,** *Archaeological Heritage* and *Liturgical Books*); *The Centre of the Saint Sava Cult*; *Movies* (a 10-minute film created from aerial and terrestrial videos of the Monastery and its surroundings with music); *Photographs; Virtual Tours* (**Figure 10**); and *3D-Model*. All data can be downloaded by website visitors.

Mobile application creation

The user experience of the mobile application can be enriched by the integration of augmented reality (AR) and virtual reality (VR) technologies, further impacting the "cognition, experience, interaction, learning, and overall satisfaction of tourists" (Roodposhti and Esmaeelbeigi 2024: 2). It is also desirable to provide personalisation of the experience through options such as creating a list of favourites, adding notes or searching by keywords and dates, thus facilitating navigation through the digital collection. Enabling offline access to digitized content, even without an internet connection, especially for visitors who are in locations where there is no stable internet connection. The application should be updated regularly so that users have access to the latest information and functionality. Finally, the application must respect the highest standards of security and privacy. The protection of user data is ensured by the application of security protocols, such as data encryption and secure authentication, and compliance with regulations such as the GDPR (Brunswick 2019).

[15] See more on: https://jspwiki.apache.org/.

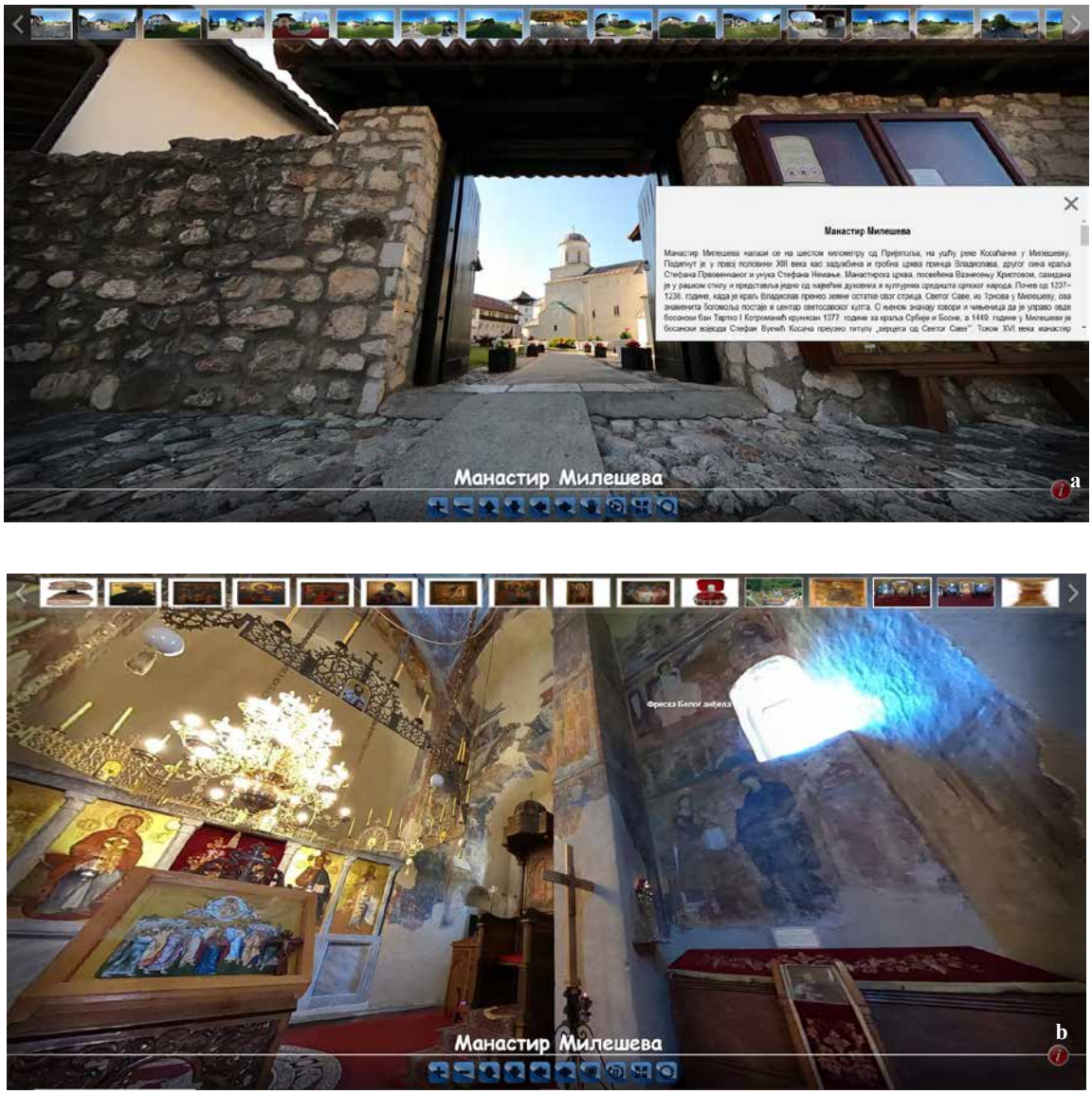

Figure 10. Screenshots of the visual tour available through the platform: **a.** Entrance to the Monastery; **b.** Church interior.

The process steps for creating the mobile application for the Mileševa Monastery (**Figure 11**)[16] were as follows:

Process planning and design. The first step referred to defining the functionality of the application and designing the user interface. The application was made to support iOS and Android platforms. The interface design was created to be simple and intuitive for users, with optimal use of the screen for various device sizes and with an emphasis on ease of navigation and quick access to information.

Development. The development of the application for Mileševa was carried out using Unity, enabling the simultaneous creation of applications for Android and iOS platforms. This cross-platform technology significantly accelerated the development process, while the use of the C# programming language facilitated a modular approach to implementing key functionalities. The application is divided into several modules, including a module for intuitive navigation, a multimedia module for displaying

[16] The application was developed by a team from the Mathematical Institute and the Archimedia Group from Niš.

images, 360° content (virtual tours), text-based content, maps, and virtual tours, as well as an offline module for operating without an internet connection for certain displays.

Testing and implementation. Apps should be tested on different devices to ensure compatibility and optimal performance. Testing of the mobile application for Mileševa was conducted on a wide range of devices to ensure compatibility and stability, while performance was further optimized for fast loading times and efficient use of device resources. Distribution was carried out through the Google Play Store and Apple App Store, adhering to the guidelines of each platform. Unity and C# have proven to be a reliable combination for developing a scalable and functional application tailored to user needs.[17]

Optimization and updating. When the application was developed, it was optimized

[17] Android store: https://play.google.com/store/apps/details?id=org.arhimedia.emg.mileseva&hl=sr&gl=US&pli=1; Apple store: https://apps.apple.com/rs/app/manastir-mileseva/id1661560829.

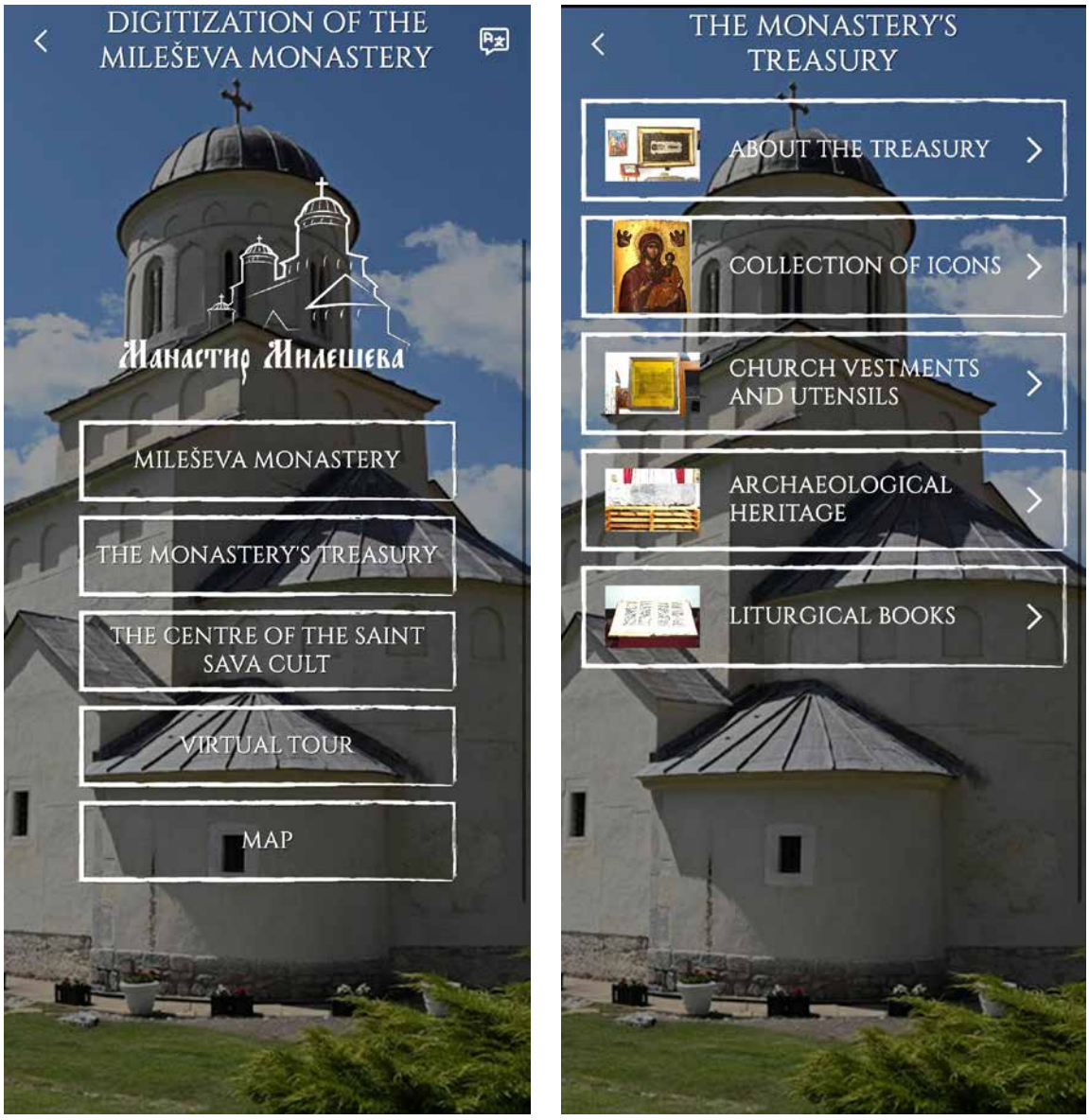

Figure 11. Digital presentation of the Mileševa Monastery on the application for mobile devices, Mathematical Institute SASA and Archimedia Group, 2022.

for performance on mobile devices and is to be regularly updated to add new functionalities and correct errors and possible security omissions.

Delivering the results: The mobile application was created in both Serbian and English (**Figure 11**), offering many photos and educational texts for its visitors. They include the following topics: *Mileševa Monastery* (with subtopics on *History, Architecture* and *Wall Painting*) with the 3d model and the Film; *The Monastery Treasury* (with subtopics *About the Treasury, Collection of Icons, Church Vestments and Utensils, Archaeological Heritage* and *Liturgical Books*); *The Centre of the Saint Sava Cult*; and *Virtual 360 Tour.*

* * *

One of the most important advantages of laser scanning is the possibility of obtaining extremely precise data on the shape and dimensions of an object, which is crucial for documenting and analysing the state of cultural monuments. Laser beams record all irregularities and textures on the surface of objects, providing a comprehensive representation of their physical characteristics. In the case of the Mileševa Monastery, this technique proved to be very useful in documenting complex architectural elements (such as parts of stone sculptural decoration), as well as wall paintings and items from the monastery's treasury. Digital documentation using a 3D laser scanner has brought extremely precise data on architectural features and paintings that represent some of the highest achievements of Serbian and European art of the 13th century. As such, this data will find applications in future scientific research and conservation-restoration interventions. An additional advantage was reflected in the speed and efficiency of collecting large amounts of data (one scanner can record thousands of points per second), which reduces the time required for fieldwork.

The processing and visualisation process enables the creation of a reliable 3D model that provides a precise representation of objects from all angles, and with regular scanning, it is possible to identify and monitor changes and damage caused by the passage of time and/or due to atmospheric influences. Thanks to this, the obtained 3D model of the Mileševa Monastery can serve as a basis for the protection of this monument, allowing experts to react promptly and plan potential conservation and restoration interventions. In addition, restorers can use a digital monument replica to simulate different restoration methods and evaluate their impact before applying them to real objects.

The collection of data, especially from hard-to-access parts of the monument, was enabled by using drones for photogrammetry, while professional and 360° photography further enriched the fund of high-quality visual archives. The interactivity features of 360° photos that allow users to "immerse" themselves in the space, move around at will and choose what they want to explore, in our specific case, generated a virtual tour as an insight, not only into the architectural features and decoration of the Church of the Holy Ascension of Christ, but also into the museological setting of the monastery's treasury. The accessibility reduced barriers and made this heritage more accessible, especially to socially sensitive groups and people with disabilities.

The digitization of old and rare books contributed to the permanent preservation and more efficient access to valuable manuscript heritage of the Mileševa Monastery. Wider access to all digitized materials was achieved through the creation of a website and a mobile application, which will certainly contribute to greater visibility and accessibility of this cultural monument.

The effectiveness and user-orientation of the website were achieved using functionalities that allow interaction with the content, such as zoom options for a detailed view of the frescoes and objects from the treasury, 3D models that can be rotated and viewed from different angles, a short film about the monastery complex itself shot by an unmanned aerial vehicle (**Figure 12**), as well as interactive maps that enable virtual tours with a better experience of the space.

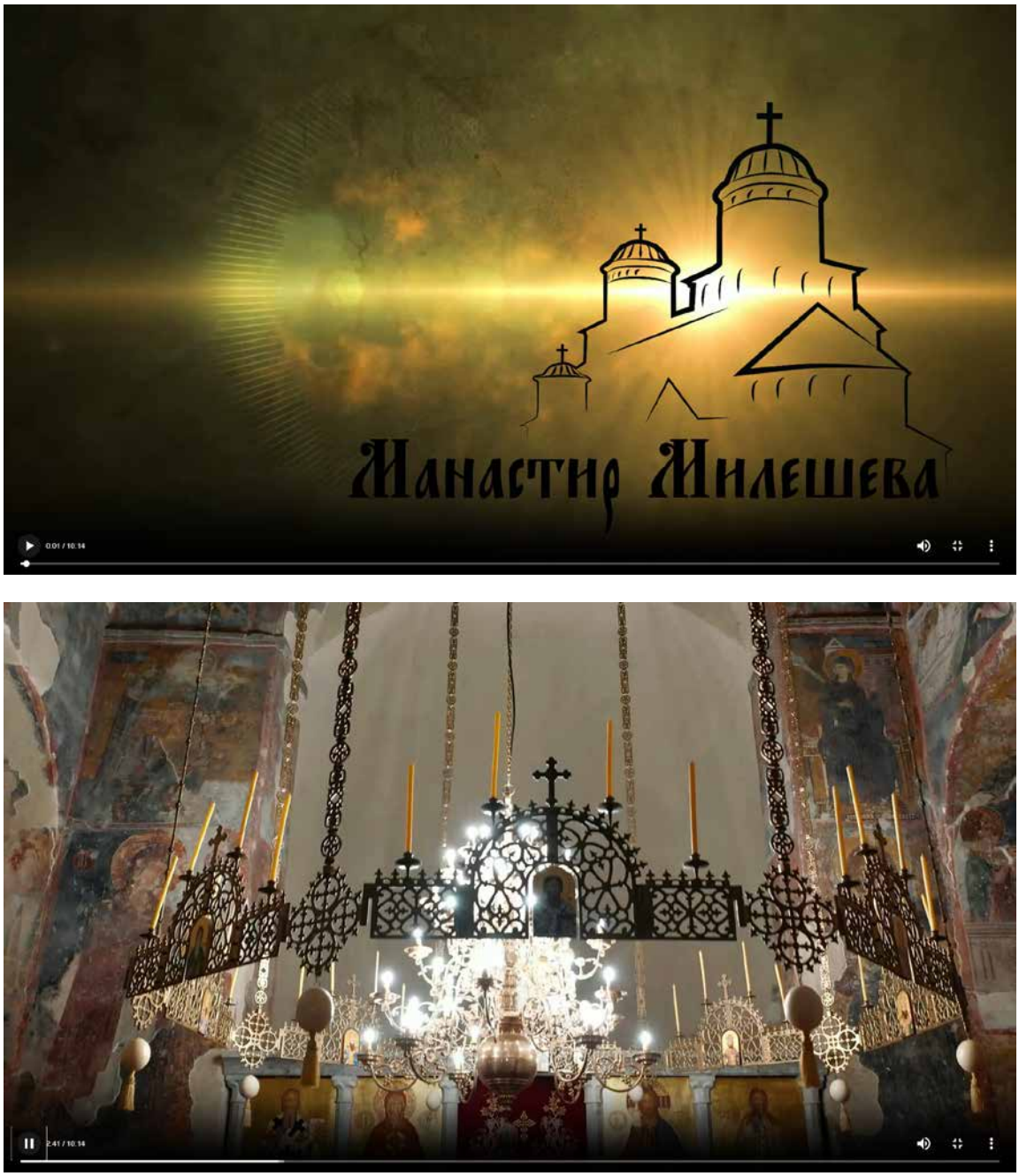

Figure 12. Film about the Mileševa monastery available on the website and mobile application (intro with a still of the film).

CONCLUSION

Digitization through the application of modern technologies represents a significant step towards the preservation and improvement of access to cultural heritage, especially monuments of exceptional importance such as the Mileševa Monastery in Serbia. These technologies are increasingly being used in education as well, which can be confirmed by the fact that the created application for mobile devices was declared by the Ministry of Education of the Republic of Serbia as an additional teaching tool for elementary and secondary schools in September 2023. In addition, this application can stimulate the interest of students and researchers in all scientific fields,

and a no less significant contribution is reflected in the improvement of tourism based on cultural heritage.

Future digitization projects connected to the Mileševa Monastery could include other advanced technologies, such as artificial intelligence, which is increasingly becoming a part of our everyday life and, in the context of cultural heritage, has the potential to be purposefully used for automatic content analysis and classification. Investing in the education and training of qualified staff to work with sophisticated digitization methods was and remains imperative because only in this way can the high quality of collected and processed data be ensured.

Following the great importance of the Mileševa Monastery as a historical, archaeological, architectural and artistic monument, its digital presentation can involve storytelling forms as well as virtual reality and augmented reality in the process of virtual reconstruction (Wang *et al.* 2020: 582). Digital storytelling has already been proven as an effective method for education about the cultural monuments for visitors and the creation of specific user experiences is constantly being advanced (Rizvić, Bošković and Mijatović 2024; Škola *et al.* 2024). Historic stories of the Monastery can be brought to life in this way, involving visitors in the life of the Monastery, with the potential to attract the young generation whose members have been born into a completely digital world.

Digitization of heritage is not only a technical but also a cultural undertaking and, therefore, the digital dissemination of cultural monuments and artefacts will gain more and more importance over time. In this process, an important role will be played by the involvement of the wider community through interactive platforms that allow users to add comments, tags and other indicative information, potentially improving it and increasing their own interest in cultural heritage.

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REZIME

UPOTREBA SAVREMENIH TEHNOLOGIJA U DIGITALIZACIJI MANASTIRA MILEŠEVE: IZVEŠTAJ O RADNOM TOKU

KLJUČNE REČI: DIGITALIZACIJA KULTURNE BAŠTINE, SAVREMENE TEHNOLOGIJE, MANASTIR MILEŠEVA, OČUVANJE KULTURNE BAŠTINE, 3D LASERSKO SKENIRANJE, VIZUALIZACIJA, DIGITALNA DOKUMENTACIJA ZASNOVANA NA VEBU

Primena digitalnih tehnologija u očuvanju i prezentaciji kulturne baštine predstavlja ključni aspekt savremenih praksi u oblasti zaštite i promocije kulturnih dobara. Digitalizacija omogućava detaljno ispitivanje, dokumentovanje i očuvanje kulturnih spomenika, čineći ih dostupnim široj publici i budućim generacijama. Ovaj rad istražuje inovativne tehnike i pristupe u digitalizaciji kulturnih dobara, sa posebnim fokusom na manastir Mileševu, značajan spomenik srpske kulturne i verske baštine.

U ovom projektu korišćene su raznovrsne digitalne tehnologije kako bi se obezbedila visoka preciznost i kvalitet dokumentacije: 1. 3D lasersko skeniranje: Pomoću uređaja kao što je *Faro Focus 150* omogućeno je stvaranje preciznih trodimenzionalnih modela. Ovi modeli nude detaljan uvid u arhitektonske karakteristike manastira, uključujući složene geometrijske strukture i ukrase, čime se omogućava analiza i rekonstrukcija objekata; 2. Snimanje dronovima: Različiti dronovi, uključujući *DJI Inspire 2*, *DJI Mavic Mini 3 Pro* i *DJI Mavic 2 Pro/Zoom*, korišćeni su za kreiranje fotogrametrijskih modela, visokokvalitetnih fotografija i video-snimaka. Ove tehnologije omogućavaju snimanje teško dostupnih područja i pružaju celovit pregled objekata iz različitih perspektiva; 3. Profesionalna fotografija: *Canon* i *Nikon* oprema korišćena je za stvaranje detaljnih i visokorezolutnih fotografija unutrašnjosti i eksterijera manastira. Ove slike služe kao trajni zapis umetničkih i arhitektonskih detalja; 4. 360° fotografija: *GoPro Max* kamera omogućila je stvaranje interaktivnih panoramskih prikaza, pružajući korisnicima mogućnost da istražuju manastir kroz virtuelnu realnost; 5. Digitalizacija knjiga: *Travellers Conservation Copy Stand 4232* u kombinaciji sa opremom *Canon* korišćen je za digitalizaciju starih knjiga i rukopisa. Ova tehnologija osigurava očuvanje fragilnih materijala i njihovu dostupnost u digitalnom formatu; 6. Razvoj veb-sajta i mobilne aplikacije: Omogućava se globalna dostupnost digitalizovanih materijala koji služe kao interaktivni kanali za edukaciju i istraživanje. Veb-sajt je optimizovan za intuitivnu navigaciju i pristup multimedijalnim sadržajima, dok su mobilne aplikacije prilagođene iOS i android uređajima, čineći ih dostupnim širokom spektru korisnika. Digitalne platforme dodatno podstiču angažovanje publike, omogućavajući korisnicima da istražuju sadržaj preko virtuelnih tura, interaktivnih modela i multimedijalnih prikaza.

Digitalizacija manastira Mileševe pruža neprocenjiv doprinos očuvanju ovog kulturnog spomenika. Precizna dokumentacija omogućava istraživačima i studentima detaljan uvid u

arhitekturu, umetnost i istoriju manastira, dok digitalni formati olakšavaju pristup informacijama i njihovu dalju analizu. Javnost, takođe, ima priliku da kroz digitalne kanale istraži manastir, čak i ako nije u mogućnosti da ga fizički poseti.

Ove tehnologije igraju ključnu ulogu u zaštiti podataka o kulturnoj baštini u slučaju potencijalnih rizika, uključujući propadanje usled vremenskih nepogoda, ljudskog faktora ili drugih prirodnih i antropogenih uticaja. Digitalizacija ne samo da osigurava trajnu arhivu već omogućava i kreiranje replika za potrebe edukacije i promocije. Digitalni pristup kulturnoj baštini pruža vredne resurse za obrazovne institucije, istraživačke centre i pojedince zainteresovane za istoriju i umetnost. Virtuelne ture, interaktivni modeli i digitalizovane knjige omogućavaju studentima i istraživačima pristup bogatim sadržajima na način koji je ranije bio nezamisliv. Korišćenje ovih resursa podstiče interdisciplinarna istraživanja i inovativne pristupe u očuvanju i interpretaciji kulturne baštine.

* * *

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INVERTED EDUCATION OR HOW TO EFFECTIVELY COMMUNICATE CULTURAL HERITAGE TO YOUNG GENERATIONS: CASE STUDY OF THE COOLTOUR PROJECT IN SERBIA

ABSTRACT

The present state of approach towards cultural heritage requires innovative preservation strategies that engage younger generations. The COOLTOUR project – Millennials for Cultural Heritage – addresses this by involving millennials in cultural heritage discussions and using digital platforms for broader visibility. Through its platform, COOLTOUR provided a space for young people to create, share, and promote cultural values, highlighting heritage sites within their networks. Partnering with over 90 millennials in Serbia, the project achieved notable results, including an international mobility event at Viminacium Archaeological Park with 60 students from six European countries. This hands-on experience highlighted archaeology as a tool for intergenerational knowledge transfer.

Knowledge gathered throughout the COOLTOUR project contributed to the development of guidelines and a toolkit to help heritage managers engage millennials with the use of technology and online communication. The resource offers tools for creating workshops, managing social media, and utilising AI. It also explores how to navigate the collaborative process between Digital Natives and Digital Immigrants to achieve the best outcomes for cultural heritage communication and valorisation. This paper outlines the project's objectives, methodology, and outcomes, emphasising millennials' engagement in preserving and reinterpreting cultural heritage and the importance of intergenerational knowledge transfer.

KEYWORDS: CULTURAL HERITAGE, EDUCATION, HERITAGE COMMUNICATION, SCIENCE COOMUNICATION, MILLENNIALS, KNOWLEDGE TRANSFER, YOUNGSTERS, DIGITALIZATION.

INTRODUCTION

The importance of education on cultural and, specifically, archaeological heritage as the best way of achieving its present and future valorisation among the young generations is already understood and has been elaborated by the authors on several occasions (Plemić and Anđelković Grašar 2022; Anđelković Grašar and Jevtović 2022). In the last 20 years, the Institute of Archaeology, with its researchers, has been empowering internal capacities in order to improve its role in knowledge transfer and establish an educational methodology oriented

towards a young target group and proper local community engagement (Tapavički-Ilić, Nikolić and Anđelković-Grašar 2022; Anđelković-Grašar *et al*. 2021a; Anđelković Grašar, Nikolić and Tapavički-Ilić 2020). Progress within technology and digitalization has opened up a whole new setting for the improvement and development of this educative dialogue between cultural/ archaeological heritage and the public, especially younger generations (Rizvić 2022; Rizvić i dr. 2023).

The general idea of the *COOLTOUR project - Millennials for Cultural Heritage* [1] was to promote heritage sites amongst young generations, but also to encourage dialogue and interaction between millennials and the professionals managing the heritage sites, as well as to provide a common debate ground between public or private institutions in charge of cultural heritage, and young minds interested in new and more participative methods of heritage communication. However, its primary target group is millennials – the generation born between the early 80s and the early 2000s[2]. A whole new group of youngsters with a completely specific social and psychological profile - older millennials – Gen Y, embraced the shift from the analogue to the digital era, while Gen Z, known as young millennials, can be considered digital natives, and millennials' cohort (Thakur, Kansas and Khan 2024; Corbisiero, Monaco and Ruspini 2022; Gabrielova and Buchko 2021; Thompson 2020; Prensky 2001a; Taylor and Keeter 2010; Palfrey and Gasser 2008). Besides just being digitized, for millennials it is crucial to be connected. The question for the project was to consider the position that cultural heritage has in the virtual world of the millennial generation. The Covid-19 pandemic brought more cultural online content than ever before, with different initiatives using social media channels becoming an inevitable method of communication with its audience on a daily basis, especially with the younger population and, furthermore, a tool for spreading values derived from cultural heritage (Agostino, Arnaboldi and Lampis 2020). Cultural heritage as socio-cultural construct in digital space, based on co-creation and participation of external stakeholders contributes to the democratization of heritage values that go beyond scolarly defined typologies of heritage values that include, but are not limited to, aesthetic, social, historic, age, economic, political, scientific, and ecological values, while the public is primarily concerned with social values including safety, inclusion, participation, and resilience — positive emotional language, and diverse cultural expressions as the most shared during the COVID-19 pandemic.[3]

Not only should cultural heritage be used to promote cultural values, but the ever increasing endagerment and destruction of heritage monuments compells that its value needs to be constantly imprinted in the minds of the present and future generations. Thus, the project *COOLTOUR* had several aims: to facilitate a space that would foster the creation of content by millennials and youth, to promote heritage sites among young people and let them communicate their visions, to encourage dialogue and interaction between millennials and the professionals responsible for managing cultural heritage, and to establish a common ground for discussion between public and private institutions responsible for cultural heritage and young minds interested in new ways of preserving heritage.

MATERIALS AND METHODS

Launched in March 2022 (and completed in March 2024), the project brought together cultural heritage experts, universities and research centers, cultural management organizations, communication experts, student organizations and the millennials of six European countries. Institution partners in the project were: Associazione Enti Locali per le Attività Culturali e Di Spettacolo/Association of Local Authorities for Cultural and Entertainment Activities (IT), Institute of Archaeology (SRB), The Archaeology Students' Club/Klub studenata arheologije (SRB), Student organisation ŠOU – University of Ljubljana/Študentska organizacija

[1] The project was part of the ERASMUS+ programme, co-financed by the European Union, ID: 2021-1-IT03-KA220-YOU-000029203 (Cooltour 2021a).

[2] The term first mentioned and described in: Strauss and Howe 1991: 335-345; For definition, see in Britannica 2024.

[3] See in: Ginzarly and Srour 2022, with cited literature in paragraphs 2.1 and 2.2

Univerze v Ljubljani (SLO), Technologiko panepistimio kyprou/Cyprus University of Technology (CY), Brodoto (CRO), and Kulturális Örökség Menedzserek Egyesülete/Association of Cultural Heritage Managers (HU). The project's preliminary desk research was carried out by the Heraclitus research center, Cyprus University of Technology and it provided significant data in order to better understand the target group of millennials and particularly their relationship with cultural heritage.[4]

All information collected during the preliminary desk research,[5] together with 19 best practices from Italy, Serbia, Hungary, Cyprus, Croatia and Slovenia, helped determine the *COOLTOUR* project's methodology, upon which two main project outputs were designed: *COOLTOUR* digital platform and guidelines, tested, upgraded and promoted during the mobility workshops and national pilot pogrammes.

RESULTS AND DISCUSSION

Being the largest generation ever, from an economic perspective, millennials are the most active market segment and have notable purchasing power.[6] Thus, it is extremely important to ensure that this generation is now and will be in the future the users and consumers of cultural heritage. Through cultural tourism, heritage can achieve its full potential and receive the main benefit, the proper valorization and protection by the most powerful generation ever.[7] Given their share in the economy, their needs must be considered by marketers, and cultural tourism products should be adapted accordingly (Tudorache *et al.* 2019). Millennials travel frequently and rely on the internet more than any other demographic group. By using technology, they make travel decisions, largely based on the perceived authenticity of the experience, self fulfillment and sustainability, which are things that need to be clear to those who are providing touristic content or services (Sofronov 2018). Another important factor is the millennials' pre-trip phase, i.e. the search for information regarding trip selection and planning of a visit. Millennials collect other tourist experiences, opinions and comments found on websites and social media, reading first-hand experiences of a destination and finding out how a destination impressed other tourists, all of which shapes their opinion and decision making process (Lončarić, Dlačić and Pisnik 2019). As other destination management organizations, the cultural heritage sector as the host of cultural tourism must be aware that pre-trip planning is an important aspect of the millennials' destination decision process, which, together with an authentic experience, has been highlighted as a key driver for millennials (Lončarić, Dlačić and Pisnik 2019).

From the millennials' point of view, as concluded from the preliminary research questionnaire analyses conducted during the *COOLTOUR* project[8], cultural heritage and tradition have a significant influence on the travel decision-making process (**Figure 1**). Regarding the adoption and use of technology in relation to cultural heritage, millennials are highly familiar with new technologies and utilize digital services to obtain information prior to visiting, during and after the visiting a cultural heritage site: digital

[4] The results of the research were presented in the project report: *Research on best practices on the use of digital tools in heritage management*, produced in November 2022 by the Cyprus University of Technology.

[5] The quantitative research was based on a non-probability sampling methodology, not representative of the wider population. The questionnaires were distributed online from 09/08/2022 to 25/10/2022. 263 people - of which 182 were millennials - participated in the research. The data was gathered using Qualtrics software and processed with the Statistical Package for Social Science (SPSS v.20). The statistical results consist of descriptive statistics. The results and methodology of the research were presented in the project report *Research on best practices on the use of digital tools in heritage management*, produced in November 2022 by the Cyprus University of Technology).

[6] Millennials represent 27 per cent of the global population, or about 2 billion people (Sofronov 2018).

[7] Belonging to the millennials' self-transcendence values (reflecting a concern with collective interests, such as Universalism – protecting the environment; a world of beauty; unity with nature, respecting the Earth; etc., and Tradition – devout; respect for tradition; etc.) (Cavagnaro, Staffieri and Postma 2018).

[8] The results of the research were presented in the project report: *Research on best practices on the use of digital tools in heritage management*, produced in November 2022 by the Cyprus University of Technology.

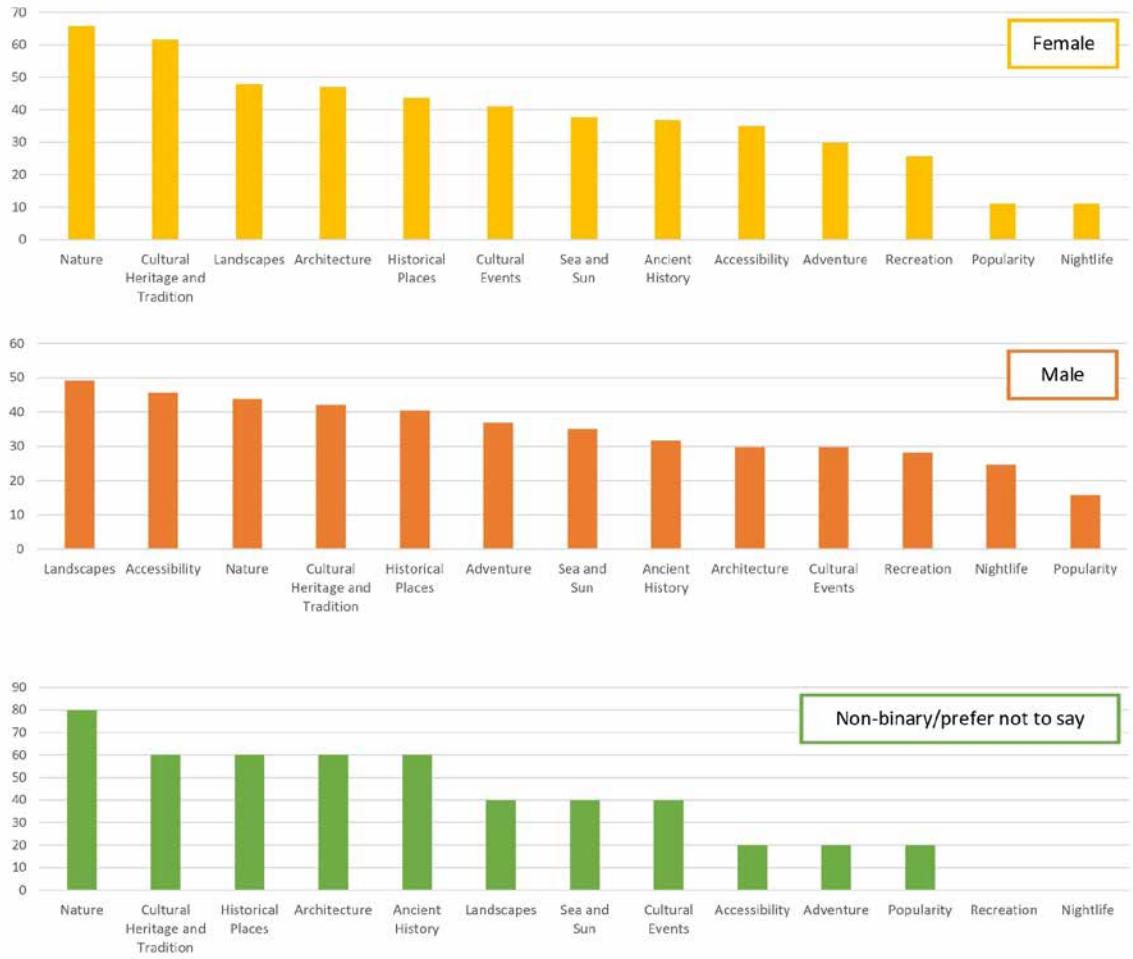

Figure 1. Percentages of respondents rating various criteria—such as historical sites, nature, cultural heritage, nightlife, and other factors—when selecting a travel destination, categorised by gender.

Figure 2. Percentage of participants using various information sources—such as smartphones, social media, search engines, and digital platforms—while visiting cultural heritage sites.

platforms (namely Google Maps, Trip Advisor, and Booking) and social media (primarily Facebook and Instagram) (**Figure 2**), and are also interested in digital applications (such as digital storytelling and augmented reality) within cultural heritage sites.

The COOLTOUR digital platform

The first project output, the *COOLTOUR* digital platform, was designed according to the research results, as mentioned above, suggesting the phase of pre-trip planning, first-hand online shared experience and authenticity to be the most important in the millennials' destination decision making. Several key terms and statements were identified from the research:

- place - a fluid term;
- community and connection;
- co-creation and personalization; manipulating space the millennial way;
- millennials value freedom;
- make it emotional - mementoes, meaning and magic moments; simplicity, authenticity, provenance; joining the dots and connecting the layers.

The platform is divided into two sections: *Heritage,* created for registered cultural heritage professionals, in charge of the creation of the initial content (heritage sites/parks, museums, galleries, monuments, etc.) providing basic information for further interaction, and the other, *Community,* which gathers the end-users and the target group – millennials, gathered in the community section of the platform (**Figure 3**). This innovative digital platform aims to promote the active involvement of millennials and collect their inputs for the creation of content and storytelling related to cultural heritage. The *COOLTOUR* platform is a hybrid social media web application allowing users to create and share content related to the archaeological sites involved in the project, such as reflections on heritage given in vlogs, and blogs, inventing new heritage brands, creating heritage-inspired emoticons, creating the themed tourist route called "Young Heritage", as well as heritage presentations from young people's perspectives, so as to strengthen the link between cultural heritage and young generations (millennials, but alpha as well).[9]

Considering the millennials' demands and answers regarding cultural heritage, the *COOLTOUR* platform was created to combine social network and digital platform features, with an interactive map and information and multimedia content regarding cultural heritage sites (photographs, videos, descriptions, addresses, etc.) prepared and provided by the heritage sites' managers (all of which were highlighted in the millennials' responses).

The COOLTOUR guidelines with toolkit

The second result of the project were the *COOLTOUR* guidelines (with toolkit) for heritage managers to foster participation and to better engage with millennials, aiming to help heritage site managers understand the importance of using technology and online communication to create a productive and fruitful dialogue with younger generations (Dankovics 2023). These guidelines should be considered as a set of tools with instructions on all important aspects of heritage communication, from how to create highly engaging workshops, manage and use social media, and to navigate AI, to how to use free, available digital features and to understand the advantages they offer. However, the main value of the guidelines is that it enhances a new methodology specifically based on the education values and possibilities that were provided by the two participant parties: cultural heritage managers and millennials, specifically covering different areas of expertise by involving partners with experience in the research, management, communication and youth sectors.

The methodology implemented was highly impacted by the study of Marc Prensky (2001b) on the relationship between Digital Natives – students as "native speakers" of the digital language of computers, video games, and the Internet and Digital Immigrants – (usually educators) those who were not born into the digital world, but have, at some later point, become fascinated by and adopted many or most of the aspects of the

[9] The *COOLTOUR* platform is available at Cooltour 2021b.

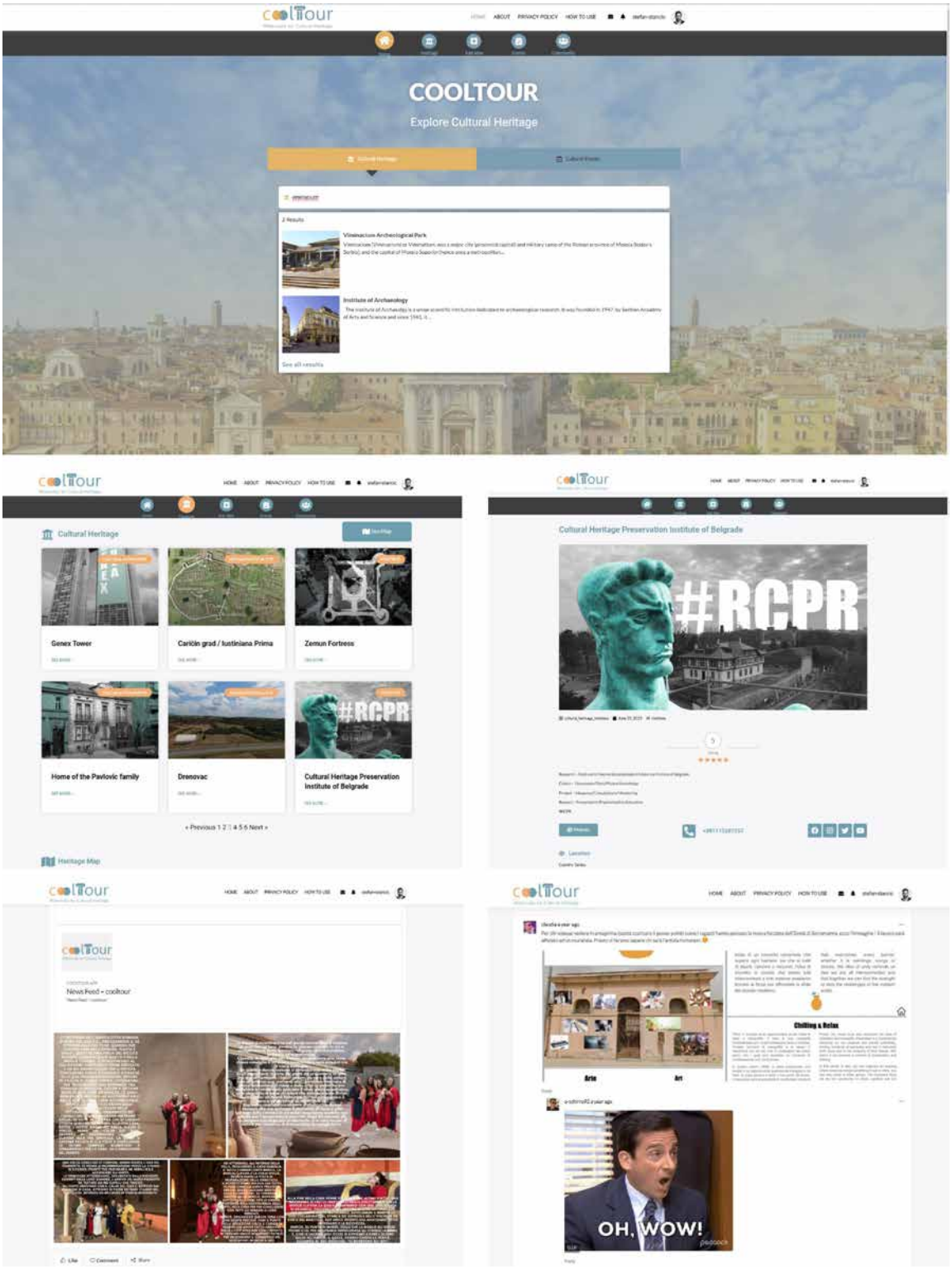

Figure 3. The *COOLTOUR* platform showcasing its final design completed after the pilot programmes: Home Section for a particular search for Cultural Heritage (top); Heritage Section devoted to the cultural heritage institutions and sites (middle); Community Section (down – available only for logged users) (available at: https://cooltour.app/ and https://cooltour.app/heritage-sites/, accessed on November 7th, 2024).

new technology (Prensky 2001b: 1–2). The Study provided several very valuable notions, such as:

- today's students are no longer compatible with the educational system and teaching methods;
- the Digital Immigrant instructors, who speak an outdated language (that of the pre-digital age), are struggling to teach a population that speaks an entirely new language;
- the Digital Natives receive information really fast, and they prefer graphics, games and internet sources over text, and work best when networked;
- The Digital Immigrant teachers assume that the same teaching methods can still work (Prensky 2001b: 1-3).

The most important conclusion of the discussion could be summed up in one paragraph: "Should the Digital Native students learn the old ways, or should their Digital Immigrant educators learn the new? Unfortunately, no matter how much the Immigrants may wish it, it is highly unlikely the Digital Natives will go backwards… Smart adult Digital Immigrants accept that they don't know about their new world and take advantage of their kids to help them learn and integrate" (Prensky 2001b: 3).

The COOLTOUR mobility workshops

By deciding to be smart adult Digital Immigrants' educators, all partners had an opportunity to test and become familiar with the proposed methodology during several internal training sessions and the international students Mobility exchange programme. It involved 60 students – millennials from Italy, Serbia, Cyprus, Hungary, Croatia and Slovenia, at Viminacium Archaeological Park in the period from March 27th to April 1st 2023, hosted by the Institute of Archaeology (**Figure 4**). Since the approach of this project revolved around including millennials in the decision-making process and questions related to heritage, the Institute of Archaeology has fully supported the participation of the Archaeology Students Club in every step of the co-designing workshops. During the six days of their stay, the newly established digital cultural heritage platform of the *COOLTOUR* project was tested, and the young people developed daily interactive and creative digital content related to

Figure 4. Young participants of the international mobility programme in Viminacium during the sightseeing study tour (photo documentation of the *COOLTOUR* project).

Viminacium and its cultural landscape, connecting geographically close, but often chronologically distant, heritages such as Ram fortress, the village of Kostolac with its mining heritage, the Milena Pavlović Barilli Gallery or the National Museum in Požarevac (with the collection of artifacts from Viminacium).[10] They also learned about archaeological heritage from scientists and professionals of the Institute of Archaeology, who provided them with scientific data for specific topics, allowing a personal connection to be made with the heritage by the students, inspiring storytelling around such topics as: love, beauty, death, ritual and magic. The power of an emotional and hands-on experience highlighted by participation and interaction was shown via a workshop of Roman cuisine, in which students prepared food according to Roman recipes. At the end, dressed in Roman clothes, they enjoyed the products of their work as part of a Roman feast, which left a great impression on them (**Figure 5**).

Mobility workshops were aimed at inspiring participants with science-based information so they could co-create and test both the methodology while being on-site and test their creative results on the platform and for communication purposes on social networks (visual and audio content such as reels, stickers, memes, snap chat filters, etc.) (**Figure 6**). In addition, they created more detailed guidelines for cultural heritage managers that are based on millennials' needs and preferences. Targeting different aspects of cultural heritage that are highly connected to everyday life was designed to support the imagination of the participants, making heritage relatable, so it would be possible to fully incorporate and stimulate critical and associative thinking about the past. An important step in that was to connect it with the present through common human struggles and happiness or sadness in life that are the same, whether they were experienced by young people in the Roman period or by young workshop participants today. Viminacium, in that sense, was the perfect place to test the app because it provided fertile ground for exploring both the tangible/intangible and natural aspects that the local cultural heritage can offer. These workshops specifically needed to detect and elaborate the role of millennials as trainers during national pilot programmes. Millennials who attended the Mobility programme at Viminacium gained useful knowledge and experience of the proper use of methodology and digital tools, as well as how to use the *COOLTOUR* platform. Subsequently, as *COOLTOUR* trainers, they were able to transfer this information to cultural heritage managers during the national pilot programmes.

This process of learning, training and transfer of knowledge, together with the developed digital tools and skills, communication through social networks and with a newly developed methodology, was the basis of the *COOLTOUR* guidelines described above (Dankovics 2023).

The COOLTOUR pilot programmes

National pilot programmes were conducted in all patners' countries with following results: Italy - five heritage sites from Sardinia and one in Piedmont region on the platform, Slovenia and Croatia – each uploading one entity on the platform, Hungary and Cyprus – each five heritage sites on the platform. National pilot programmes from Serbia included work in four regions, with eight institutions, 30 youngsters and 14 heritage managers. The Serbian pilot workshops took place throughout June 2023, in several major cities and sites managed by archaeological parks, museums, institutes for the protection of cultural heritage, galleries, and tourist organizations (**Figure 7**). These institutions included: the Museum of Srem, the archaeological site of *Sirmium* (Sremska Mitrovica); the National Museum of Niš and the Institute for Cultural Heritage Protection Niš, the sites of *Naissus* and *Mediana*; Viminacium Archaeological Park; the Gallery of Milena Pavlović Barilli; the Cultural Heritage Preservation Institute of Belgrade; the National Museum of Požarevac; the Tourist Organization of the municipality of Veliko Gradište - Ram Fortress; and the National Museum of Serbia.

During the pilots, teams were focused on testing both the platform and guidelines toolkit, with particular attention paid to each site and

[10] Selected literature was proposed for the building of the storytelling: Anđelković Grašar, Rogić and Nikolić 2013; Tapavički-Ilić, Nikolić and Anđelković Grašar 2022; Anđelković Grašar, Nikolić and Tapavički-Ilić 2020; Nikolić, Rogić and Anđelković Grašar 2013; Nikolić 2018; Nikolić and Anđelković Grašar 2020; Anđelković Grašar and Nikolić 2019.

Figure 5. Young participants of the international mobility programme in Viminacium during the Roman feast workshop (photo documentation of the *COOLTOUR* project).

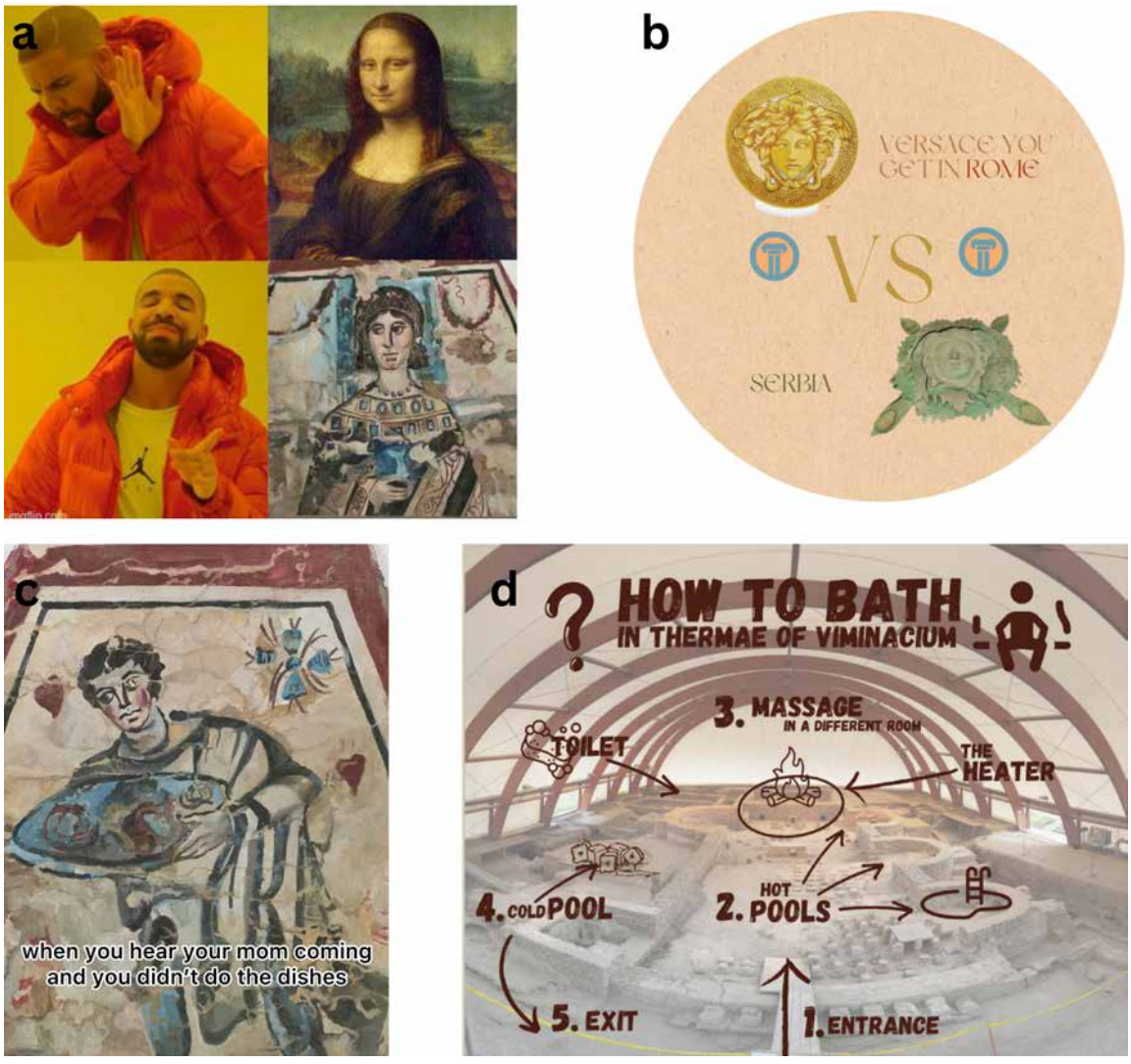

Figure 6. Creative results of the mobility programme in Viminacium: **a.** The Viminacium "Mona Lisa"; **b.** "Versace" stone sculpture; **c.** Meme featuring a detail from the fresco in the tomb; **d.** How to use the Roman baths.

Figure 7. Implementation of the pilot programme in Belgrade, 15th and 16th of June, 2023 (photo documentation of the *COOLTOUR* project).

the obstacles heritage managers meet while communicating and implementing workshops for millennials. Thanks to active and engaged participants, the national *COOLTOUR* team had a remarkable opportunity to create content, social media strategies, platform accounts for social media managers of local heritage institutions, Instagram challenges, Tik-Toks, and catchy hashtags, but also to re-visualise heritage sites, enriching the existing heritage interpretation and storytelling. Partners from Serbia continued to work with different stakeholders after the project, and are proud to share the general results, which are available on the *COOLTOUR* platform, where 14 heritage site entries from Serbia are uploaded, this being the highest number among all the partner countries.[11] Additionally two heritage sites from Montenegro are listed on the platform following the result of the Cooltour network created with the aim to provide sustainability of the project and implementation of the two results – platform and guidelines. This network is based upon more than twenty Memorandums of understanding signed with various heritage institutions throughout Europe. Finally consortium and many associated partners agreed to submitt the Cooltour2 project for new EU funding calls in order to provide additional sustainability of the Cooltour project results.

[11] Cooltour 2021c

CONCLUSION

The two-year-long *COOLTOUR* project journey allowed a productive environment for several important factors in developing and improving relationships between young generations of millennials and cultural heritage, which allowed a suitable solution for reconciling the shift, change and future of the mellenials with the tradition, permanence and the past of the heritage to be found. The resources for building such a connection from the cultural heritage management point of view are numerous, with educational potential to be utilised from objects, practices, activities, memories, etc., to the proper creation of science-based storytelling (Praetzellis 2014: 5135). Thus, in order to transfer clear scientific data, in this case archaeological data, into the more widely acceptable and understandable stories, while also possibly adopting some emotional or experiential approach, the role of the archaeological/cultural heritage expert is crucial, as the one who develops an interpretative narrative with a talent for transmission from scientists to the general public, all the while avoiding a subjective approach in the interpretation process (Tapavički-Ilić and Anđelković Grašar 2020: 132; Moshenska 2017; Thomas 2017; Anđelković Grašar *et al.* 2021b).

Heritage communication is placed at the highest level as one of the best modes of educating the younger generation, but this is not just a one-way street. That is why the *COOLTOUR* platform allows innovative methods of communicating heritage effectively with millennial audiences, including the leverage of user generated content and reviews that can provide valuable feedback to cultural heritage managers regarding a variety of positive and negative aspects of heritage sites and assets. All of the presented steps have confirmed that education moves in both directions and creates quality communication about human heritage between professionals and the public. Additionally, however, reflections and responses from the audience could inspire heritage experts to ask new questions, important not only for the research itself, but also for the "consumers of cultural heritage" (Praetzellis 2014; Given 2009: 33). By allowing education to move in both directions: from heritage to youngsters and vice versa, the *COOLTOUR* project embraced the idea of the smart adult Digital Immigrants – in this case cultural heritage professionals, to be trained and educated by millennials – the Digital Natives, putting into focus the up-to-date communication methodologies of cultural heritage online and with the use of digital tools, which, in the end, resulted in a kind of inverted education, placing the student in the role of the teacher, as a valuable addition to the traditional teaching method.

To conclude, we could say that both the outcomes of the *COOLTOUR* project – the platform and the guidelines with the new methodology and toolkit, deal with the two most powerful shifts of the new century that also affected millennials the most: new technologies and scientific communication, both recognised by the Serbian Ministry of Science, Technological Development and Innovation as crucial for the Serbian science strategy "Power of Knowledge" 2021-2025. As stated in the strategy document: "Such (new) technologies divide the world into two categories – those who develop it, use it and successfully adapt to changes, and those who fail to bridge the emerging technological and social gap…The efficiency and coherence of the use of resources also rests on the social communities' wider opinion, so it is necessary to strengthen communication between society and scientific research and innovation system." (Стратегија 2021: 51, 60.)

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REZIME:

INVERZIVNO OBRAZOVANJE ILI KAKO EFIKASNO PRENETI VREDNOSTI KULTURNOG NASLEĐA MLADIM GENERACIJAMA: STUDIJA SLUČAJA COOLTOUR PROJEKTA U SRBIJI

KLJUČNE REČI: KULTURNO NASLEĐE, EDUKACIJA, KOMUNIKACIJA U NASLEĐU, KOMUNIKACIJA U NAUCI, MILENIJALCI, TRANSFER ZNANJA, MLADI, DIGITALIZACIJA.

U periodu od 2022. do 2024. godine, saradnici Arheološkog instituta radili su na projektu *COOLTOUR – Milenijalci za kulturno nasleđe*, iz Erazmus plus programa Evropske unije. Tokom realizacije projekta ciljevi istraživanja i aktivnosti bili su usmereni na iznalaženje najboljih rešenja u dijalogu mladih ljudi i stručnjaka iz oblasti kulturnog nasleđa, odnosno adekvatnih načina predstavljanja kulturnog nasleđa mladima, ukazujući na izuzetan obrazovni potencijal koji imaju obe strane u ovom procesu. Polazno istraživanje, koje je sproveo Tehnološki univerzitet na Kipru, pokazalo je da su milenijalci veoma zainteresovani za kulturno nasleđe, ali da je potpuno prihvatanje vrednosti i značenja kulturnog nasleđa kod mladih moguće ostvariti najpre kroz prilagođavanje njihovim interesovanjima i potrebama. Nove tehnologije i digitalna komunikacija su izuzetno važni u pozicioniranju kulturnog nasleđa u svesti milenijalaca kao interesne grupe koja je trenutno demografski najveća. Iz ovoga je proistekla metodologija projekta na kojoj počivaju dva osnovna rezultata: *COOLTOUR* digitalna platforma i smernice za menadžere kulturnog nasleđa.

COOLTOUR digitalna platforma je spoj društvene mreže i veb-aplikacije, koja omogućava korisnicama da stvaraju i dele sadržaje o kulturnoj baštini. Platforma se sastoji iz dva dela. U jednom delu su ljudi koji se profesionalno bave kulturnim nasleđem – oni stvaraju osnovni sadržaj i pružaju istorijske podatke. U drugom delu, korisnici – milenijalci, pruženo nadograđuju, stvarajući dodatni, interaktivan i digitalan sadržaj, razmenjujući mišljenja i utiske unutar svoje virtuelne zajednice. *COOLTOUR* smernice kreirane su na osnovu istraživanja, dobrih praksi i iskustva nastalog tokom primene metodologije projekta kako bi menadžerima kulturnog nasleđa omogućile adekvatan dijalog sa mladima i pomoću novih tehnologija i onlajn-komunikacije obezbedile veće učešće milenijalaca. Smernice pružaju alate i uputstva za sve važne aspekte komunikacije nasleđa, poput organizovanja radionica, upravljanja društvenim mrežama, korišćenja veštačke inteligencije i dr., pružajući instrukcije kako da ovaj kolaborativni proces bude što uspešniji. Tokom međunarodne razmene u Arheološkom Parku Viminacijum, 60 milenijalaca iz šest evropskih država radilo je na testiranju *COOLTOUR* platforme, za koju su kreirali digitalne sadržaje, zasnovane na interpretaciji naučno-istorijskih podataka do kojih su došli kroz samostalno istraživanje, studijske obilaske lokaliteta i kulturnih mesta u okolini Viminacijuma, kao i kroz priče koje su sa njima podelili saradnici Arheološkog instituta. Mladi su takođe učestvovali u unapređenju metodologije i samih smernica za menadžere kulturnog nasleđa, ukazujući na najefikasnije elemente digitalnih

alata i komunikacija. U narednoj fazi projekta, ovi mladi *COOLTOUR* ambasadori prenosili su stečeno znanje drugim menadžerima u kulturi tokom nacionalnih pilot-programa u svakoj od zemalja, učesnica projekta, istovremeno dopunjujući sadržaj platforme za njih najvažnijim mestima kulturnog nasleđa.

* * *

Use of tools based on large language models and generative AI: None.

PRIKAZI - REVIEWS

Milica Stojanović, Ivan Popović, Nenad Šošić, MUZEJSKI DOSIJE: PRIČA O DVE POTKOVICE, izdavač Narodni muzej u Smederevskoj Palanci, Smederevska Palanka 2024.

Izložba i katalog *Muzejski dosije: Priča o dve potkovice* predstavljaju jedan od rezultata realizacije trogodišnjeg projekta ostvarenog primenom interdisciplinarnog pristupa u naučnim istraživanjima. Saradnici na projektu bili su Narodni muzej u Smederevskoj Palanci i Opšta bolnica „Stefan Visoki" iz istog mesta. Saradnja je ostvarena u okviru odeljenja radiologije pomenute bolnice, gde je izvršena arheoradiološka analiza skeletnog materijala otkrivenog na lokalitetu Medvednjak.

Arheološki materijal sa Medvednjaka, stručnoj i široj javnosti predstavljen po prvi put, predstavlja srž ove priče. Lokalitet Medvednjak poznat je od 1968. godine i njemu su bile posvećene brojne izložbe i predavanja. Naglasak u predstavljanju lokaliteta uvek je stavljan na vinčanske slojeve, tako da je u drugi plan padalo postojanje nekropole iz mnogo poznijeg perioda. Sa navedene nekropole, smeštene na delu sa najvećom koncentracijom neolitskog materijala, potiče i skelet ženske individue oko koje se formirala tema istraživanja i izložbe. Posetilac, prateći tok izložbe, ima priliku da se upozna sa nalazima koji čine delove grobnog inventara, među kojima se nalaze i dve potkovice – baza od koje je počelo sveobuhvatno istraživanje.

Otkrivajući deo po deo kompleksne slagalice, posetilac izložbe upoznaje se sa više aspekata koji oslikavaju osobine ličnosti, svakodnevni život i tradiciju, i time kreće u otkrivanje identiteta žene čiji se život odvijao u ne baš tako drevnom vremenu.

Autorski tim projekta činila je sledeća stručna ekipa: autor Milica Stojanović; koautori Nenad Šošić i Ivan Popović; stručni saradnici Marina Milenković, Stefan Stojadinović i Marija Krečković Gavrilović; fotografija Darko Trajanović i Nenad Šošić; dizajn i ilustracija Valentina Talijan; crtež Aleksandra Gedeon; režija Milica Stojanović; kamera i montaža Darko Trajanović; tehnička podrška: Nenad Pajić, Časlav Pantelić, Dejan Cvetković i Jasmina Stevanović; redakcija Petar Dekić i Dragana Đurđević i lektura Milana Dodig.

Arheolozi su rekli... Put kojim potkovica ređe ide... Pronalazak nekropole na lokalitetu Medvednjak. Segmentom sa ovim naslovom autori opisuju kako se tokom „iskopavanja u arheološkom depou" često pronalaze predmeti čije poreklo, mesto nalaza i funkcija nisu u potpunosti rasvetljeni. Tako su ponovo otkrivene i dve gvozdene potkovice, nosioci celokupne priče izložbe, koje su delovale kao „nekompletan" nalaz, ali su zapravo predstavljale potencijal za multidisciplinarno istraživanje i pronalaženje brojnih podataka i analogija.

Autori naglašavaju da se odmah nametnulo nekoliko pitanja u vezi sa potkovicama – *vlasnik*, *period*, *izuzetno male dimenzije*, *otkud gvozdeni nalazi u neolitskom sloju*... Iz terenske dokumentacije izvučena je prenebregnuta činjenica da je, u okviru potesa Čairče na Medvednjaku, konstatovana nekropola iz poznijeg perioda od okolnih vinčanskih slojeva, sa 32 registrovana skeleta. Sačuvan je karton sa crtežom i foto-dokumentacijom groba 2 iz bloka 3. U okviru ukopa pronađen je skelet ženske osobe sa specifičnim grobnim prilozima. Oko glave bile su radijalno raspoređene igle sa ravnim glavicama, a na nogama – u predelu pete – potkovice malih dimenzija. Arheolozi su se našli pred velikim izazovom. Ukrasi za glavu ukazivali su na novije periode koji najčešće ne predstavljaju područje arheoloških istraživanja i tumačenja, dok su dimenzije potkovica sugerisale na njihovu funkciju izvan uobičajene namene. Autori su odlučili da pomoć u istraživanju potraže od stručnjaka različitih profila, što je rezultiralo dobijanjem velikog broja odgovora i realizacijom izložbe. Svoje lične impresije, utiske i izazove u vezi sa ovim istraživanjem arheolozi su opisali

i u segmentu naslovljenom *Arheolozi su rekli... Traganje za otiskom emocija. Spoznaja ličnosti kroz arheologiju srca.*

Deo izložbe sa naslovom pozajmljenim iz narodne poezije, *Čizme nosim a bos odim,* govori o rezultatima istraživanje nekropole i budućim planovima vezanim za ovaj projekat. Autori naglašavaju da je otkriće nekropole ukopane u vinčanske slojeve otvorilo mnoga pitanja za koja još nisu pronađeni kompletni odgovori. U okviru nekropole pronađeni su ostaci inhumiranih pokojnika, među kojima su veliki broj činili dečiji skeleti, što je na samom početku ukazalo na mogućnosti istraživanja rodbinske povezanosti među sahranjenim pojedincima.

Sa samih arheoloških iskopavanja nekropole sačuvani su samo najosnovniji podaci. Pažnju na ove nalaze skrenula su reviziona istraživanja eksponata pohranjenih u depou muzeja. Zatečeni nalazi mogli su se uglavnom okvirno datovati od 16. do 19. veka. Inicijalnu kapislu za ceo projekat predstavljalo je registrovanje nalaza gvozdenih potkovica kao grobnog priloga. Potkovice su mogle biti preciznije datovane u vreme austrijske dominacije nad ovim prostorima tokom 18. veka.

Autori otkrivaju da su pitanja podstaknuta profesionalnom radoznalošću mogla biti razrešena jedino na osnovu interdisciplinarnih istraživanja. Tako su u istraživanje uključeni fizički antropolozi (analiza skeletnih ostataka), etnolozi (saznanje da potkovice nisu bile deo obreda, nego da su nošene na čizmama, kao i simbolika nakita koji potiče iz iste celine), istoričari (podaci o turbulentnom periodu 18. i 19. veka na našim prostorima) i doktori medicine sa Odeljenja za radiologiju Opšte bolnice „Stefan Visoki" (rendgensko snimanje skeletnih ostataka). Na izložbi su predočeni do sada pronađeni odgovori, čije dobijanje je omogućila primena metoda svih navedenih metoda naučnih istraživanja.

Fizički antropolozi su rekli... Konac, beli luk i četkica za zube. Bioarheologija. Fizičko-antropološki rezultati, saglasni sa radiološkim analizama, upućuju na činjenicu da je junakinja priče ženska osoba, starosti 40–50 godina (*maturus*). Kičmeni stub je u dobrom stanju, nema tragova osteofita i osteoartritisa. Pretpostavljena telesna visina iznosila je između 156 i 160 cm. Jedina uočena paleopatološka promena je linearna hipoplazija (smanjenje formiranja gleđi zbog poremećaja u proizvodnji ameloblasta), zabeležena i u dentalnom zapisniku zajedno sa drugim zubnim oboljenjima. Navedeno ukazuje na činjenicu da su zubi mnogo istrošeniji od očekivanog kod osobe tog životnog doba, lošu higijenu, a moguće i da predstavlja indikator određenih bolesti. Naglašena je potreba za budućim hemijsko-laboratorijskim analizama koje mogu upotpuniti saznanja o svakodnevnici zajednice.

Etnolozi su rekli... „Ja imam tajka trgovca, meni je svilu kupio...". Pokrivanje i kićenje glave u obredima prelaza. S obzirom na pretpostavku da nalazi potiču iz perioda iz koga ne postoje brojna arheološka svedočanstva o načinu života i kulturi, radi sagledavanja celokupne slike bila je neophodna saradnja sa etnolozima-antropolozima radi analize grobnih priloga, odnosno tumačenja pretpostavki o njihovoj upotrebi i značenju, kako za život, tako i za smrt pojedinca. U srpskoj tradiciji žensko oglavlje sastoji se od više elemenata koji čine deo nošnje koji žena nosi na glavi u skladu sa tradicijama svoje zajednice. Pored praktične uloge, odeća predstavlja i deo sveukupnog identiteta ličnosti.

Oglavlje je bilo osnovni nosilac značenja u okviru ženske odeće kao obeležje biosocijalnog statusa i ekonomske moći. U kontekstu patrijarhalnog kulturnog modela, svako poglavlje života ženske osobe bilo je obeleženo specifičnim načinima pokrivanja glave. Neretko su žene i sahranjivane sa oglavljem, kao što je slučaj i u našem primeru. Pored osteološkog materijala, u grobu označenom brojem 2, od ukrasa za glavu, pronađeni su delovi počelice, ostaci tkanine, tri veće i deset manjih metalnih konhi, dve turske aspre, dve igle sa jagodičastom glavom, dve igle sa loptastom glavom i četrnaest jednostavnih ukrasnih igli. Na grudima su se nalazili ostaci tkanine, dva puceta sa ušicom za prišivanje i još jedna aspra. Ostaci metalne dugmadi nađeni su kod korena šake, a dve gvozdene potkovice u predelu stopala. Činjenica da je jedan deo oglavlja izrađen od skupocenih materijala govori da je naša junakinja mogla pripadati srednjem društvenom staležu. Analiza otkrivenih priloga ukazuje na analogije iz 17. i 18. veka. Ostaje otvoreno pitanje da li su potkovice na đonovima predstavljale praktični deo obuće ili su služile magijskoj zaštiti

nosioca kao predmet koji oduvek predstavlja simbol srećnog ishoda.

Istoričari su rekli... Medvednjak između istoka i zapada. Društveno političke prilike na prelazu iz 18. u 19. vek. Jedno od prvih pitanja sa kojima su se suočili arheolozi odnosilo se na duh vremena iz koga potiču nalazi, odnosno novi vek, čije je istraživanje i proučavanje u arheologiji tek u povoju. U kakvom svetu je živela junakinja priče sa Medvednjaka? Kakve su bile socijalno-ekonomske prilike za vreme ratova Habzburške monarhije i Osmanskog carstva? Kakav je bio kvalitet života ljudi u tadašnjim selima? Odgovor na ovo pitanja mogao je biti dobijen jedinom istorijskom metodom, odnosno na osnovu proučavanja pisanih izvora kao svedočanstava toga vremena.

Prostor lokaliteta Medvednjak nalazio se u okviru Smederevskog sandžaka, najveće teritorijalne jedinice naseljene srpskim stanovništvom u Osmanskom carstvu. Na ove teritorije presudno su uticali brojni ratovi koji su, tokom 18. veka, vodili Osmansko carstvo i Habzburška monarhija. U periodu od 1718. do 1739. godine kraj se nalazio pod austrijskom vlašću. Vreme pred završetak austrijske dominacije, od 1737. do 1739. godine, obeležili su brojni vojni sukobi rezultirani Drugom velikom seobom Srba, predvođenom Arsenijem IV Jovanovićem. Opustele teritorije postepeno su naseljavane novim stanovništvom, uglavnom poreklom iz južnih delova Osmanskog carstva, što je promenilo demografsku strukturu ove oblasti. Značajan gradski i strateški centar tada postaje Hasan-pašina Palanka (današnja Smederevska Palanka), smeštena na carigradskom drumu, sa značajnim vojnim prisustvom. Palanka je posebno stradala tokom osmansko-habzburškog rata između 1788. i 1791. godine, poznatom kao Kočina krajina. Ovaj rat, u kome su značajno učešće uzeli srpski frajkori u službi Austrije pod vođstvom kapetana Koče Anđelkovića, predstavljao je značajan korak u procesu koji je doveo do formiranja nezavisne srpske države u 19. veku.

Radiolozi su rekli... monohromna slika sveta u boji. Primena radiološke metode u arheologiji. Savremena radiologija nije više oslonjena samo na crno-bele slike, nego snimci dobijaju i treću dimenziju: slika sa folije prikazuje se na ekranu i otkriva sve uglove posmatranog, kao trajno svedočanstvo o anatomiji i fiziologiji tela koje se može analizirati iznova poput materijalnih ostataka čuvanih u muzejima i njihovih fotografija. Iz saradnje arheologije i radiologije nastala je nova poddisciplina: arheoradiologija. Dok ova poddisciplina u svetu predstavlja uobičajenu praksu, istraživanja materijala sa Medvednjaka predstavljaju pionirski poduhvat kod nas. U potrazi za tragovima koji otkrivaju podatke o skeletnim ostacima radiolozi su tragali za muskoskeletnim promenama – traumama, tumorima, posledicama patoloških uticaja na kosti, kao i degenerativnim promenama tokom života.

Na izloženim radiološkim slikama prikazani su ljudski ostaci – skelet star nekoliko stotina godina. Njihova analiza obavljena je na isti način kao što se radi sa snimcima medicinskih pacijenata. Na početku su utvrđene „target" lezije – koštani defekti i kanali, morfološki i strukturni izgled kosti i varijeteti. Na taj način ustanovljena je potencijalna starost individue i eventualno postojanje traume kosti. Na osnovu rendgenskih snimaka (RTG) i skener (CT) podataka, starost glavne junakinje priče procenjena je na oko 40 godina (35–45 godina), dok su defekti pronađeni u lobanji definisani kao otvori perforantnih krvnih sudova, ne kao trauma. Stanje nekoliko pršljenova u kičmi i prelomi pojedinih kostiju predstavljaju mehanička oštećenja nastala kao posledica arheoloških iskopavanja. Pored toga nisu konstatovani znaci za života stečenih preloma. Kao što smo već videli, rezultati analiza iz domena fizičke antropologije su u pozitivnoj korelaciji, čime su radiološki nalazi potvrđeni.

Predstavljeni projekat, kroz istraživanje i izložbu, pokazuje kakve sve neotkrivene priče kriju arheološki depoi kroz nedovoljno interpretirane, nekada i zanemarene nalaze i rezultate ostvarene kroz multidisciplinarnu saradnju i primenu različitih naučnih metoda. Na realizovanom projektu možemo čestitati kolegama iz Muzeja u Smederevskoj Palanci i njihovim saradnicima.

Ljubiša VASILJEVIĆ
Narodni muzej Kruševac

Slobodan Bogojević, Ivan Đurović, U DUBINAMA PROVINCIJE – IZLOŽBA KOJA MENJA PERSPEKTIVU ANTIČKOG I SAVREMENOG, izdavač Narodni muzej Čačak, Čačak 2024. Katalog sadrži sadrži 20 stranica (tri tematske celine). ISBN 978-86-84067-81-6.

Izložba i katalog *U dubinama provincije – Izložba koja menja perspektivu antičkog i savremenog* započeli su svoj izlagački put polovinom 2023. godine u Galeriji Narodnog muzeja Čačak. Projekat je realizovan u organizaciji navedenog muzeja. Izlagački put nastavljen je iste godine u Kući kralja Petra I u Beogradu i Muzeju rudničko-takovskog kraja u Gornjem Milanovcu.

Koordinator izložbe je Slobodan Bogojević, konzervator, koji je zajedno sa Ivanom Đurovićem, likovnim umetnikom, radio na konceptu izložbe, pripremi kataloga, pratećih tekstova i zastupljenih lirskih formi. Autori fotografija su Bojan Pajić i Ivan Đurović, istovremeno i autor akvarela i naslovne strane izložbe. Kustos Antičke arheološke zbirke je arheolog Aleksandra Gojgić, koja je, zajedno sa Đurovićem i Bogojevićem, radila na konceptu fotografija i postavci izložbe. Dizajn izložbe potpisuje Miloš Vuk Aleksić.

Izložba je posvećena prezentaciji i zaštiti antičkog nasleđa Grada Čačka i ima za cilj da široj publici ukaže na značaj očuvanja kulturnog, odnosno arheološkog nasleđa. Izložbena postavka menja perspektivu antičkog i savremenog, ali i osvetljava novi vid muzejske interpretacije i zaštite nasleđa. Smeštajući antičku prošlost u umetnički kontekst, izložba pokriva niz tema oslikavajući antičko nasleđe počev od arheološkog lokaliteta, ali i epigrafskih spomenika, umetničkih i upotrebnih predmeta iz zbirke muzeja u Čačku. Izložbu prate odgovarajući katalog, pozivnica i plakat.

Dodir arheološke supstance
natopljene sećanjem...
Tako drevna i istinska...
Ona koja nadvladava vreme...
Toliko puta uništavana,
preoblikovana i oživljena.

Posetioci mogu da se na interesantan i nesvakidašnji način upoznaju sa antičkim i savremenim nasleđem Čačka. Atmosfera izložbe vodi publiku na metafizičko putovanje u vremenske dubine prošlosti današnjeg Čačka, nekadašnjeg naselja, još nepotvrđenog imena, na obodu rimske provincije Dalmacije. Autori naglašavaju globalni fenomen *provincija*, koji oličava pasivnost i mir, ali i prostor udaljen od centara zbivanja. Kroz tri tematske celine izložbe zapravo je predstavljena suprotnost ovom utisku, odnosno tragovi bujnog života ispunjenog raznovrsnim sadržajima i raskošnim koloritima čiji odsjaji daju pečat i današnjici.

Objedinjujući fotografske kadrove, poetski izraz, slike, crteže i neposredne antičke fragmente, izložba povezuje vremenske dubine antičkog i savremenog prostora grada Čačka, čineći nevidljivom granicu između imaginarnog i stvarnog.

Modeli-protagonisti, odnosno sadašnji stanovnici Čačka, zajedno sa arheološkim i arhitektonskim detaljima, dekorativnim i upotrebnim predmetima iz antičke epohe, stvaraju vizuelni ambijent u kome su zamagljene razlike između prošlosti i sadašnjosti, života i umetnosti, ali i tela i skulpture, odnosno originala i kopije.

Odrazi stanja duha antičkih i savremenih stanovnika nalaze se u fokusu prve tematske celine izložbe pod nazivom *Osećanje uvek novo, a ono koje se ne menja...* Osećanja, kroz poigravanje sličnostima i razlikama antičkog i sadašnjeg trenutka, osciliraju od tuge i nade, napetosti, iščekivanja, pa do sugestivne tišine, telesnog i duhovnog udaljavanja.

Ciklus *Izgubljeni fragmenti, a oni koje vreme spaja...* posvećen je arheološkim fragmentima, odnosno arheološkoj supstanci preplavljenoj pamćenjem. U ovom segmentu izložbe osvetljavaju se detalji, motivi, urezi, ožiljci prisutni na antičkim fragmentima, ali se i ruše granice između živog i neživog, materijalnog i duhovnog, tela i skulpture... Autori pronalaze alegoriju u zamišljenom plesu arheološke supstance sa ljudskim telom.

Svedeni ambijent današnjeg Čačka dominira u poslednjoj celini pod nazivom *U tako neumoljivom vremenu...* Na fotografijama su predstavljeni

prepoznatljivi arhitektonski detalji i elementi zgrade Instituta za voćarstvo, kao i objekta Umetničke galerije *Nadežda Petrović* u antičkom kontekstu izložbe. U prikazanim scenama autori dočaravaju prožimanje slojeva antičkog horizonta sa simbolima današnjice iz koje izranja savremeni čovek, povezan istom teritorijom, osećanjima i supstancom koje su posedovali i savremenici antičke epohe.

Cilj izložbe je da se sagleda i prezentuje arheološko nasleđe Čačka u novom svetlu, odnosno da se probude i iniciraju nove forme i vidovi zaštite. Autori teže da otrgnu od zaborava tragove prošlih epoha kroz izložbu koja predstavlja interesantno mesto gde se prepliću antički ostaci i umetnički mediji. Tim putem se ukrštaju nova tumačenja, mašta, kreativnost i, na zanimljiv način, stiče potpunije i sadržajnije iskustvo antičke epohe. Na izvestan način, u okviru izložbe, antički ostaci gube svoje klasično materijalno i utilitarno postojanje vezujući se za umetnički kontekst i sadašnji trenutak.

Vreme će iznedriti zaborav...
Brisaće tragove, udaljavati, rasipati,
atomizirati, razrešavati...
A tragovi će prkositi i povremeno izranjati
iz čudesnih i sve tajanstvenijih dubina...
Neke će budućnost oživeti i oslikati
kao što smo mi izmaštali prošle...

Ljubiša VASILJEVIĆ
Narodni muzej Kruševac

Teodora Branković, KONZERVIRANA PLASTIKA IZ ANTIČKE ZBIRKE NARODNOG MUZEJA POŽAREVAC, izdavač Narodni muzej Požarevac, Požarevac 2024. Publikacija sadrži 60 stranica (uvod, četiri tematske celine, spisak literature sa 62 bibliografske jedinice i 5 jedinica iz muzejske dokumentacije, rezime na engleskom jeziku (prevod: Natalija Milojković) i katalog sa 32 kataloške jedinice raspodeljene u okviru četiri tipa spomenika). ISBN 978-86-84147-57-0.

Nakon publikacije posvećene antičkim spomenicima izloženim u lapidarijumu muzeja, autorka Teodora Branković priredila je i izdanje posvećeno konzerviranoj plastici iz antičke zbirke Narodnog muzeja Požarevac. Čitalac ima priliku da se upozna sa istorijatom prikupljanja i stručne obrade navedenih eksponata, nalazima zastupljenim u okviru zbirke, realizovanom projektu konzervacije kamene plastike, vidovima promocije i popularizacije zbirke, problemima vezanim za izlaganje i prezentaciju kamene plastike i kata- logom sa stručnom obradom kataloških jedinica.

U okviru *Uvoda* dat je osvrt na antičku arheološku zbirku požarevačkog muzeja. Pored spomenika iz lapidarijuma (obrađenim u publikaciji iste autorke iz 2022. godine), u okviru zbirke pohranjena je i kamena plastika zastupljena portretima (privatnim, carskim i božanskim), skulpturama različitih dimenzija, votivnim ikonama i reljefnom plastikom, spomenicima manjih dimenzija i fragmentovanim natpisima. Zbirka ukupno broji 90 predmeta (63 delova skulptura i 27 komada reljefne plastike). Autorka posebno naglašava da se, po monumentalnosti, izdvajaju mermerna skulptura Togatusa i krečnjačka skulptura Velike Herkulane, dok se, kada je reč o značaju, prvenstvo daje carskom portretu Kara, portretima mlađeg i starijeg muškarca i glavi žene iz Petke.

Drugo poglavlje bavi se podrobnom klasifikacijom predmeta u okviru zbirke. Naglašeno je da kolekcija pruža značajne podatke o zastupljenosti rimskih, autohtonih i istočnjačkih kultova koji su uticali na političko-ekonomska i demografska kretanja u rimskom periodu na našim prostorima. Posebno je primetan veliki pečat maloazijskih radionica što svedoči i o migracijama stanovništva unutar Carstva. Skulpture se dele u tri grupe: portreti, portretna skulptura i kultna skulptura, sa brojnim podgrupama. Konzervirano je 29 komada kamene plastike i tri reljefne plastike. Konzervirani eksponati dele se na portrete (18 komada), skulpture/torza (10), kultnu grupu (1) i reljefnu plastiku (3 – reljef Viktorije i dve ikone kulta Podunavskog konjanika). Poglavlje se zaokružuje kratkim pregledom istorijata rimske skulpturalne umetnosti na prostorima današnje Srbije.

Treće poglavlje pruža podatke o projektu pod nazivom *Konzervacija kamenih spomenika iz lapidarijuma Antičke zbirke Narodnog muzeja u Požarevcu*, koji je, u saradnji sa tadašnjim Centralnim institutom za konzervaciju (CIK), realizovan u periodu od 2012. do 2020. godine, paralelno sa konzervacijom spomenika iz lapidarijuma.

Prilikom snimanja spomenika iz lapidarijuma, izvršen je i preliminarni pregled predmeta kamene plastike iz antičke zbirke koji se nalaze u izložbenom prostoru i u depou požarevačkog muzeja kako bi se odabrali predmeti za konzervaciju. Snimanje stanja je obavio stručni tim konzervatora CIK-a, u saradnji sa rukovodiocem antičke zbirke Narodnog muzeja Požarevac.

Konzervatorski radovi su izvedeni u Ateljeu za konzervaciju kamena i mozaika CIK-a u Beogradu. Konzervirana su ukupno 32 predmeta. Za sve tretirane predmete izrađeni su konzervatorski kartoni sa detaljnim opisima zatečenog stanja, predlozima za konzervatorske tretmane, izvršenim intervencijama, opisima predmeta nakon završenih tretmana i preporukama zaštite, kao i spisak korišćenog potrošnog materijala. Muzeju u Požarevcu je dostavljena digitalna foto--dokumentacija.

Tokom procesa konzervacije izvedena je i izrada postamenata koji bi omogućili izlaganje skulptura. Bez novoizrađenih postamenata izlaganje eksponata bilo bi znatno otežano, a u pojedinim slučajevima i nemoguće. Stav struke glasio je da se ne rekonstruišu delovi spomenika koji nedostaju.

U okviru četvrtog poglavlja navedene su sve izložbe na kojima su izlagani predmeti od mermera/kamena iz Antičke zbirke Narodnog muzeja Požarevac. Peto poglavlje donosi zaključna razmatranja vezana za probleme izlaganja i prezentacije kamene plastike. Spisak literature sadrži 62 bibliografske jedinice i pet jedinica iz muzejske dokumentacije. Zastupljen je i rezime na engleskom jeziku.

Publikaciju zaokružuje katalog sa 32 kataloške jedinice podeljene u četiri kategorije: skulpture, kultne grupe, portreti (privatni i božanski) i votivne ikone. Svaka kataloška jedinica sadrži podatke o inventarnom broju predmeta, lokalitetu, dimenzijama, materijalu i tehnikama izrade, literaturi u kojoj je naveden i sprovedenim konzervatorskim tretmanima. Svaki opis prate fotografije predmeta pre i posle konzervacije.

Na predstavljenim stranicama nalaze se veoma značajni podaci o predmetima iz antičke zbirke, konzervatorskim tretmanima eksponata i praktičnim rešenjima u vezi sa njihovim izlaganjem i prezentacijom.

Publikacija predstavlja važan doprinos oblastima arheologije, muzeologije i konzervacije i pruža smernicu za nove poduhvate i projekte.

Ljubiša VASILJEVIĆ
Narodni muzej Kruševac

UREĐIVAČKA POLITIKA ČASOPISA *ARHEOLOGIJA I PRIRODNE NAUKE*

Časopis ***Arheologija i prirodne nauke*** posvećen je temama iz humanističkih naučnih disciplina: arheologije, istorije, klasične filologije, istorije umetnosti i arhitekture, socijalne i kulturne antropologije; temama iz multidisciplinarnih istraživanja koja povezuju arheologiju i prirodne nauke: fizičke (bio) antropologije, arheometrije, geonauka u arheologiji, tehnologija u arheološkoj prospekciji; temama koje se bave zaštitom i prezentacijom arheološkog nasleđa: konzervacijom i restauracijom kulturnog nasleđa, eksperimentalnom arheologijom, interpretacijom arheološkog nasleđa, digitalnom arheologijom, kompjuterskim i informacionim tehnologijama, arheološkom dokumentacijom; i drugim temama povezanim sa arheologijom.

Časopis ***Arheologija i prirodne nauke*** kao periodična publikacija izlazi od 2006. godine, i predstavlja glasilo Arheološkog instituta iz Beograda i Centra za nove tehnologije Viminacium.

Časopis ***Arheologija i prirodne nauke*** objavljuje originalne, prethodno neobjavljene rukopise: istraživačke radove, pregledne radove, izveštaje (saopštenja), metodološke radove, studije slučaja i prikaze.

Časopis ***Arheologija i prirodne nauke*** je dostupan u režimu otvorenog pristupa.

Postupak predavanja rukopisa, recenzija i objavljivanje rukopisa su besplatni.

Jezici na kojima se mogu predati rukopisi su engleski, nemački ili francuski. Rezime mora biti na srpskom jeziku - latinica (za domaće autore) ili engleskom jeziku - standardni britanski (za inostrane autore).

Rukopisi za objavljivanje u časopisu predaju se pomoćnom uredniku redakcije, a prema UPUTSTVU ZA AUTORE o načinu pripreme rukopisa.

Časopis ***Arheologija i prirodne nauke*** izlazi jedanput godišnje.

Časopis ***Arheologija i prirodne nauke*** se indeksira u bazi ERIH+.

Digitalne kopije svezaka časopisa ***Arheologija i prirodne nauke*** arhiviraju se na veb sajtu *Viminacium – Rimski grad i vojni logor* (http://viminacium.org.rs/e-biblioteka/arheologija-i-prirodne-nauke/), kao i u Narodnoj biblioteci Srbije, kojoj se predaje obavezni elektronski primerak, a pojedinačni radovi se arhiviraju u RAI – Repozitorijumu Arheološkog instituta (https://rai.ai.ac.rs/).

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Plagijarizam

Plagiranje, odnosno preuzimanje tuđih ideja, reči ili drugih oblika kreativnog izraza i predstavljanje kao svojih, predstavlja grubo kršenje naučne i izdavačke etike. Plagiranje može da uključuje i kršenje autorskih prava, što je zakonom kažnjivo.

Plagijat obuhvata sledeće:

- doslovno ili gotovo doslovno preuzimanje ili smišljeno parafraziranje (u cilju prikrivanja plagijata) delova tekstova drugih autora bez jasnog ukazivanja na izvor ili obeležavanje kopiranih fragmenata (na primer, korišćenjem navodnika);
- kopiranje slika ili tabela iz tuđih rukopisa bez pravilnog navođenja izvora i/ili bez dozvole autora ili nosilaca autorskih prava.

Svi rukopisi podležu proveri plagijarizma. Rukopisi kod kojih postoje jasne indicije da se radi o plagijatu biće automatski odbijeni i autorima će biti privremeno zabranjeno da objavljuju u časopisu ***Arheologija i prirodne nauke***.

Ako se ustanovi da je rukopis koji je objavljen u časopisu plagijat, isti će biti povučen u skladu sa procedurom opisanom pod *Povlačenje već objavljenih rukopisa*, a autorima će biti privremeno zabranjeno da objavljuju u časopisu ***Arheologija i prirodne nauke***.

Autoplagijarizam

Autoplagiranje, odnosno preuzimanje već objavljenih sopstvenih ideja, reči ili drugih oblika kreativnog izraza bez adekvatnog ukazivanja na izvor, predstavlja grubo kršenje naučne i izdavačke etike. Autoplagiranje može da uključuje i kršenje autorskih prava, što je zakonom kažnjivo.

Autoplagijat obuhvata sledeće:

- doslovno ili gotovo doslovno preuzimanje ili smišljeno parafraziranje (u cilju prikrivanja autoplagijata) delova već objavljenih sopstvenih tekstova bez jasnog ukazivanja na izvor ili

obeležavanje kopiranih fragmenata (na primer, korišćenjem navodnika);
- kopiranje slika ili tabela iz već objavljenih sopstvenih tekstova bez pravilnog navođenja izvora i/ili bez dozvole drugih autora originalnog dela (ako rad ima više autora) ili nosilaca autorskih prava.

Svi rukopisi podležu proveri autoplagijarizma. Rukopisi kod kojih postoje jasne indicije da se radi o autoplagijatu biće automatski odbijeni i autorima će biti privremeno zabranjeno da objavljuju u časopisu ***Arheologija i prirodne nauke***.

Ako se ustanovi da je rukopis koji je objavljen u časopisu autoplagijat, isti će biti povučen u skladu sa procedurom opisanom pod *Povlačenje već objavljenih rukopisa*, a autorima će biti privremeno zabranjeno da objavljuju u časopisu ***Arheologija i prirodne nauke***.

Sukob interesa

Autori su dužni da u rukopisu ukažu na finansijske ili bilo koje druge sukobe interesa koji bi mogli da utiču na iznesene rezultate i interpretacije. Ako sukob interesa ne postoji, treba navesti sledeće: „Autori izjavljuju da nisu u sukobu interesa".

Sukob interesa može biti finansijski i nefinansijski. Neki od primera sukoba interesa su:

- organizacija koja finansira neko lice, isplaćuje mu zaradu ili drugu vrstu materijalne nadoknade, ili kod koje je to lice deoničar, mogla bi imati finansijsku korist (ili gubitak) u slučaju objavljivanja rezultata;
- pojedinci, organizacija koja ih finansira, ili poslodavac su vlasnici patenta koji je u vezi sa rezultatima rada, ili su u procesu prijave takvog patenta;
- zvanična afilijacija i članstvo u interesnim grupama koje su u vezi sa objavljenim sadržajem;
- politički, verski ili ideološki sukob interesa.

Autori zaposleni u kućama ili komercijalnim organizacijama koje sponzorišu klinička ili terenska ispitivanja ili neki drugi vid istraživanja treba da navedu tu činjenicu kao sukob interesa prilikom dostavljanja rukopisa. U odeljku „Sukob interesa" treba objasniti odnos svakog pojedinačnog autora sa takvim organizacijama. Radovi objavljeni u časopisu ne smeju da reklamiraju komercijalne proizvode.

Podaci o finansiranju

Ako je rad nastao kao rezultat projekta, autori su dužni da navedu izvore finansiranja u skladu sa ugovorom sa finansijerom.

Greške u objavljenim rukopisima

U slučaju da autori otkriju važnu grešku u svom rukopisu nakon njegovog objavljivanja, dužni su da momentalno o tome obaveste glavnog i odgovornog urednika ili izdavača i da sa njima sarađuju kako bi se rukopis povukao ili ispravio.

ORCID

ORCID (Open Researcher and Contributor ID) identifikatori svih autora navode se prilikom slanja rukopisa i biće objavljeni u radu, ako bude prihvaćen za objavljivanje. ORCID je jedinstven i trajan identifikator koji omogućava preciznu identifikaciju autora i lakše pronalaženje objavljenih radova, kao i ispravnu atribuciju autorstva.

* * *

Predavanjem rukopisa redakciji ***Arheologija i prirodne nauke*** autori se obavezuju na poštovanje navedenih obaveza.

OBAVEZE RECENZENATA

Recenzenti su dužni da stručno, argumentovano, nepristrasno i u zadatim rokovima dostave uredniku ocenu naučne vrednosti rukopisa.

Recenzenti evaluiraju rukopise u odnosu na usklađenost teme rukopisa sa profilom časopisa; način ukazivanja na problem ili cilj istraživanja; doprinos discipini kojoj pripada; jasnoću i konciznost apstrakta; organizaciju teksta; doslednost istraživačke metodologije; jasnoću i produktivnost diskusije; razvijanje zaključaka; relevantnost upotrebljene i citirane literature;

jedinstvenost i preciznost stila izlaganja i naučnog aparata; kao i kvalitet priloga.

Recenzent koji ima osnovane sumnje ili saznanja o kršenju etičkih standarda od strane autora dužan je da o tome obavesti urednika. Recenzent treba da prepozna važne objavljene rukopise koje autori nisu citirali. On treba da upozori urednika i na bitne sličnosti i podudarnosti između rukopisa koji se razmatra i bilo kojeg drugog objavljenog rukopisa ili rukopisa koji je u postupku recenzije u nekom drugom časopisu, ako o tome ima lična saznanja. Ako ima saznanja da se isti rukopis razmatra u više časopisa u isto vreme, recenzent je dužan da o tome obavesti urednika.

Recenzent ne sme da bude u sukobu interesa sa autorima i/ili finansijerom istraživanja. Ukoliko postoji sukob interesa, recenzent je dužan da o tome momentalno obavesti urednika.

Recenzent koji sebe smatra nekompetentnim za temu ili oblast kojom se rukopis bavi dužan je da o tome obavesti urednika.

Recenzija mora biti objektivna. Komentari koji se tiču ličnosti autora smatraju se neprimerenim. Sud recenzenata mora biti jasan i potkrepljen argumentima.

Rukopisi koji su poslati recenzentu smatraju se poverljivim dokumentima. Recenzenti ne smeju da koriste neobjavljen materijal iz predatih rukopisa za svoja istraživanja bez izričite pisane dozvole autora, a informacije i ideje iznesene u predatim rukopisima moraju se čuvati kao poverljive i ne smeju se koristiti za sticanje lične koristi.

POSTUPAK RECENZIJE

Svi primljeni rukopisi podležu recenziji. Cilj recenzije je da redakciji pomogne u donošenju odluke o tome da li rad treba prihvatiti ili odbiti i da kroz proces komunikacije sa autorima poboljša kvalitet rukopisa.

Svaki rukopis predat redakciji časopisa ***Arheologija i prirodne nauke*** dobija po dva recenzenta. Recenzenti mogu biti saradnici Arheološkog instituta ili spoljni saradnici, kompetentni u oblasti kojom se rukopis bavi. Predlog recenzenata daje redakcija, a usvaja glavni i odgovorni urednik.

Rukopisi se recenziraju po sistemu *double-blind*, koji podrazumeva anonimnu recenziju: identitet autora je nepoznat recenzentima i obrnuto.

Recenzent je dužan da recenziju pošalje redakciji najkasnije u roku od 30 dana nakon prijema rukopisa. Recenzenti za svoj rukopis ne dobijaju honorare.

Ukoliko recenzenti traže izmene u rukopisu, autori su dužni da u roku od 30 dana redakciji vrate izmenjen rukopis, ili ukoliko ne izmene, dostave argumentovano obrazloženje zašto izmena nije učinjena. Isto važi i za rukopise koji nisu pripremljeni u skladu sa UPUTSTVOM ZA AUTORE.

Odluku o prihvatanju rukopisa za štampu donosi redakcija časopisa ***Arheologija i prirodne nauke*** većinom glasova na predlog recenzenata, a u skladu sa izmenama na rukopisu koje su autori izvršili ili u skladu sa dostavljenim obrazloženjem.

Nakon konačnog formiranja sadržaja broja, rukopisi idu na lekturu, a potom se šalju grafičkom dizajneru koji treba da uradi prelom za štampu. Pre odlaska u štampu rade se još dve korekture u PDF formatu. Konačno odobrenje za štampanje časopisa ***Arheologija i prirodne nauke*** daje glavni i odgovorni urednik. Rukopis celog broja u štampariji treba da bude 20. decembra tekuće godine.

Predloženi recenzenti od strane redakcije, dobijaju recenzentski obrazac koji sadrži niz pitanja na koja treba odgovoriti, a koja recenzentima ukazuju koji su to aspekti koje treba obuhvatiti kako bi se donela odluka o sudbini jednog rukopisa. Nakon toga, odlučuju se za jednu od četiri opcije: prihvatanje rada u obliku u kome je predat; prihvatanje rada nakon revizije manjeg obima; potreba revizije većeg obima; ili odbijanje rada. U završnom delu obrasca, recenzenti navode svoja zapažanja i predloge kako da se podneti rukopis poboljša. Identitet recenzenata ostaje nepoznat autorima pre, tokom i nakon postupka recenzije. Identitet autora je nepoznat recenzentima pre, tokom i nakon postupka recenzije (dok se rad ne objavi). Autorima se preporučuje da prilikom pisanja rukopisa izbegavaju formulacije koje bi mogle otkriti njihov identitet. Redakcija garantuje da će pre slanja rukopisa na recenziju iz njega biti uklonjeni lični podaci autora (pre svega, ime i afilijacija) i da će se preduzeti sve razumne

mere kako bi identitet autora ostao nepoznat recenzentima do okončanja postupka recenzije.

Izbor recenzenata spada u diskreciona prava redakcije. Recenzenti moraju da raspolažu relevantnim znanjima u vezi sa oblašću kojom se rukopis bavi i poželjno je da to ne budu autori koji su u skorije vreme objavljivali publikacije zajedno (kao koautori) sa bilo kojim od autora podnesenog rukopisa.

Tokom čitavog procesa, recenzenti deluju nezavisno jedni od drugih. Recenzentima nije poznat identitet drugih recenzenata. Ako odluke recenzenata nisu iste (prihvatiti / odbiti), glavni i odgovorni urednik može da traži mišljenje drugih recenzenata.

Tokom postupka recenzije urednici mogu da zahtevaju od autora da dostave dodatne informacije (uključujući i primarne podatke), ako su one potrebne za donošenje suda o naučnom doprinosu rukopisa. Urednici i recenzenti moraju da čuvaju takve informacije kao poverljive i ne smeju ih koristiti za sticanje lične koristi.

Redakcija je dužna da obezbedi kontrolu kvaliteta recenzije. U slučaju da autori imaju ozbiljne i osnovane zamerke na račun recenzije, redakcija će proveriti da li je recenzija objektivna i da li zadovoljava akademske standarde. Ako se pojavi sumnja u objektivnost ili kvalitet recenzije, urednik će tražiti mišljenje drugih recenzenata.

Članovi redakcije i gostujući urednici mogu da šalju svoje rukopise za objavljivanje u časopisu ***Arheologija i prirodne nauke***. Autor rukopisa koji je uključen u izdavački proces biće izuzet iz postupka recenzije i odlučivanja o prihvatanju ili neprihvatanju rukopisa, a nadgledanje postupka recenzije biće povereno drugom članu redakcije.

DISKUSIJA NAKON OBJAVLJIVANJA RADA

Časopis ***Arheologija i prirodne nauke*** podstiče diskusiju nakon objavljivanja, bilo kroz pisma glavnom i odgovornom uredniku ili na spolj-nim platformama, kao što je PubPeer.

UPOTREBA VELIKIH JEZIČKIH MODELA I GENERATIVNE VEŠTAČKE INTELIGENCIJE

Časopis ***Arheologija i prirodne nauke*** postupa u skladu sa sledećim preporukama: World Association of Medical Editors (WAME) recommendations on chat bots, ChatGPT and scholarly manuscripts i Committee on Publication Ethics (COPE)'s position statement on Authorship and AI tools.

Alati kao što je ChatGPT ne mogu biti navedeni kao autori rukopisa.

Autori moraju jasno da navedu da li su koristili alate zasnovane na velikim jezičkim modelima i generativnoj veštačkoj inteligenciji (koje alate su koristili i u koje svrhe) na odgovarajućem mestu, kao što su odeljak u kom se opisuje metodologija ili zahvalnica.

Autori snose punu odgovornost za preciznost, tačnost i primerenost sadržaja generisanih uz pomoć alata zasnovanih na velikim jezičkim modelima i generativnoj veštačkoj inteligenciji, kao i za tačnost citiranih referenci, i garantuju da u rukopisu nema plagijarizma.

Glavni i odgovorni urednik, urednici i recenzenti moraju da garantuju da će informacije iznesene u rukopisima tokom postupka recenzije biti čuvane kao poverljive. Urednici ne smeju da dele informacije o poslatim rukopisima i izveštaje recenzenata sa alatima zasnovanim na velikim jezičkim modelima i generativnoj veštačkoj inteligenciji, a recenzenti ne smeju da koriste takve alate za generisanje recenzentskih izveštaja.

RAZREŠAVANJE SPORNIH SITUACIJA

Svaki pojedinac ili institucija mogu u bilo kom trenutku da glavnom i odgovornom uredniku, urednicima i/ili članovima redakcije prijave saznanja o kršenju etičkih standarda i drugim nepravilnostima i da o tome dostave neophodne informacije/dokaze.

Provera iznesenih navoda i dokaza

- Glavni i odgovorni urednik će u dogovoru sa urednicima i članovima redakcije

odlučiti o pokretanju postupka koji ima za cilj proveru iznesenih navoda i dokaza.
- Tokom tog postupka svi izneseni dokazi smatraće se poverljivim materijalom i biće predočeni samo onim licima koja su direktno uključena u postupak.
- Licima za koja se sumnja da su prekršila etičke standarde biće data mogućnost da odgovore na optužbe iznesene protiv njih.
- Ako se ustanovi da je zaista došlo do nepravilnosti, proceniće se da li ih treba okarakterisati ako manji prekršaj ili grubo kršenje etičkih standarda.

Manji prekršaj

Situacije okarakterisane kao manji prekršaj rešavaće se u direktnoj komunikaciji sa licima koja su prekršaj učinila, bez uključivanja trećih lica, npr.:

- obaveštavanjem autora/recenzenata da je došlo do manjeg prekršaja koji je proistekao iz nerazumevanja ili pogrešne primene akademskih standarda;
- pismom upozorenja autoru/recenzentu koji je učinio manji prekršaj.

Grubo kršenje etičkih standarda

Odluke u vezi sa grubim kršenjem etičkih standarda donosi glavni i odgovorni urednik u saradnji sa urednicima i članovima redakcije i, ako je to potrebno, malom grupom stručnjaka. Mere koje će preduzeti mogu biti sledeće (i mogu se primenjivati pojedinačno ili istovremeno):

- objavljivanje saopštenja ili uvodnika u kom se opisuje slučaj kršenja etičkih standarda;
- slanje službenog obaveštenja rukovodiocima ili poslodavcima autora/recenzenta;
- povlačenje objavljenog rukopisa u skladu sa procedurom opisanom pod *Povlačenje već objavljenih rukopisa*;
- autorima će biti zabranjeno da tokom određenog perioda šalju rukopise u časopis;
- upoznavanje relevantnih stručnih organizacija ili nadležnih organa sa slučajem kako bi mogli da preduzmu odgovarajuće mere.

Prilikom razrešavanja spornih situacija redakcija časopisa se rukovodi smernicama i preporukama međunarodne organizacije *Committee on Publication Ethics – COPE*: https://publicationethics.org/guidance/Flowcharts .

POVLAČENJE VEĆ OBJAVLJENIH RADOVA

U slučaju kršenja prava izdavača, nosilaca autorskih prava ili autora, povrede profesionalnih etičkih kodeksa, tj. u slučaju slanja istog rukopisa u više časopisa u isto vreme, lažne tvrdnje o autorstvu, plagijata, autoplagijata, manipulacije podacima u cilju prevare, neprijavljivanja korišćenja alata zasnovanih na velikim jezičkim modelima i generativnoj veštačkoj inteligenciji, nenamerne greške koju je autor prijavio (npr. greške nastale zbog pomešanih uzoraka ili korišćenja uređaja i opreme za koje je naknadno utvrđeno da su neispravni), objavljeni rad se mora opozvati. U nekim slučajevima, objavljeni rad se može opozvati i kako bi se ispravile naknadno uočene greške. Osnovni razlog za povlačenje rukopisa je ispravljanje greške u cilju očuvanja integriteta nauke, a ne kazna autora.

Prilikom opozivanja objavljenog rada navodi se razlog za opozivanje, kao i na čiji se zahtev rad opoziva. Standardi za razrešavanje situacija kada mora doći do povlačenja rukopisa definisani su od strane biblioteka i naučnih tela, a ista praksa je usvojena i od strane časopisa ***Arheologija i prirodne nauke***: u elektronskoj verziji izvornog rukopisa (onog koji se povlači) uspostavlja se veza (HTML link) sa obaveštenjem o povlačenju. Povučeni rukopis se čuva u izvornoj formi, ali sa vodenim žigom na PDF dokumentu, na svakoj stranici, koji ukazuje da je rukopis povučen (RETRACTED).

ISTRAŽIVAČKI PODACI

Časopis podstiče autore da učine dostupnim istraživačke podatke koji potkrepljuju rezultate objavljene u rukopisu i/ili obogaćuju objavljeni

rad, tako da podaci budu otvoreni u najvećoj mogućoj meri, odnosno da budu zatvoreni samo ako je to zaista neophodno. Časopis ***Arheologija i prirodne nauke*** prihvata prateće softverske aplikacije, slike visoke rezolucije, skupove podataka, zvučne ili video snimke, obimne priloge, tabele sa podacima i druge relevantne dodatke koje nije moguće uključiti u sam rad.

Autori deponuju relevantne podatke u repozitorijum koji je u skladu sa FAIR principima, a to može biti institucionalni, tematski ili repozitorijum opšte namene. Više informacija o pronalaženju adekvatnog repozitorijuma možete naći na adresi: https://repositoryfinder.datacite.org/. U repozitorijum treba deponovati i sve informacije koje bi bile neophodne za repliciranje, validaciju i/ili korišćenje rezultata, odnosno analizu podataka – informacije o softveru, instrumentima i drugim alatima koji se koriste za obradu rezultata. Ako je moguće, treba deponovati i same alate i instrumente.

Izuzeci: Javno objavljivanje podataka nije uvek izvodljivo. U sledećim slučajevima podaci koji potkrepljuju rezulate objavljene u radovima ne moraju biti javno dostupni: ako postoji obaveza zaštite rezultata i poverljivosti, bezbednosna ograničenja, obaveza zaštite ličnih podataka i druga legitimna ograničenja. Kada podatke neophodne za validaciju objavljenih zaključaka nije moguće objaviti u otvorenom pristupu, autori bi trebalo da obezbede pristup u meri koja omogućava validaciju zaključaka uz poštovanje legitimnih interesa ili ograničenja.

ETIČKA PITANJA I ZAŠTITA PODATAKA

Ako je pristup podacima ograničen iz etičkih razloga ili zato što podaci moraju biti zaštićeni, u rukopisu se mora navesti: opis ograničenja koja se odnose na podatke; stav etičkog odbora ili drugog nadležnog tela o objavljivanju podataka; i na koji način čitaoci ili recenzenti mogu da zatraže pristup podacima i uslove pod kojima će pristup biti odobren.

Zaštita podataka

U cilju zaštite privatnosti ispitanika, istraživački podaci se ne smeju objavljivati ako iz skupa podataka nije moguće efikasno ukloniti informacije o ličnosti na osnovu kojih se mogu identifikovati konkretni pojedinci, osim ako pojedinci nisu dali izričitu pisanu saglasnost za javno objavljivanje podataka koji sadrže informacije o ličnosti.

Ako podaci ne mogu da budu javno dostupni, rukopis rada mora da sadrži: obrazloženje zašto je neophodna zaštita podataka; povezane podatke iz kojih je moguće ukloniti informacije o ličnosti; stav etičkog odbora ili drugog nadležnog tela o objavljivanju podataka; i na koji način čitaoci ili recenzenti mogu da zatraže pristup podacima i uslove pod kojima će pristup biti odobren.

Pored toga, adrese na kojima se nalaze podaci treba navesti u *Izjavi o dostupnosti podataka u okviru dostavljenog rukopisa*. Ako podaci nisu dostupni, u izjavi treba objasniti zašto nisu dostupni. Kada deponujete podatke koji su u vezi sa rukopisom poslatim za objavljivanje, u obzir treba uzeti sledeće:

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Model politike je razvio EIFL inspirisan sledećim dokumentima:

Principles of transparency and best practice in scholarly publishing. Directory of Open Access Journals.https://doaj.org/apply/transparency/ (accessed 2023-01-06).

Core practices. COPE: Committee on Publication Ethics. https://publicationethics.org/core-practices (accessed 2022-12-10).

Policies. Open Research Europe. https://open-research-europe.ec.europa.eu/about/policies (accessed 2022-11-08).

Journal Policies. Glossa: a journal of general linguistics. https://www.glossa-journal.org/site/journal-policies/ (accessed 2023-01-06).

UPUTSTVO AUTORIMA O NAČINU PRIPREME RUKOPISA ZA ČASOPIS *ARHEOLOGIJA I PRIRODNE NAUKE*

Redakcija časopisa ***Arheologija i prirodne nauke*** odlučila je da primenom važećeg pravilnika Ministarstva nauke, tehnološkog razvoja i inovacija Republike Srbije, kojim se uređuje opremanje naučnih časopisa u celini, unapredi kvalitet časopisa i na taj način doprinese njegovom potpunijem uključivanju u međunarodni sistem razmene naučnih informacija.

Časopis ***Arheologija i prirodne nauke*** posvećen je temama iz humanističkih naučnih disciplina: arheologije, istorije, klasične filologije, istorije umetnosti i arhitekture, socijalne i kulturne antropologije; temama iz multidisciplinarnih istraživanja koja povezuju arheologiju i prirodne nauke: fizičke (bio) antropologije, arheometrije, geonauka u arheologiji, tehnologija u arheološkoj prospekciji; temama koje se bave zaštitom i prezentacijom arheološkog nasleđa: konzervacijom i restauracijom kulturnog nasleđa, eksperimentalnom arheologijom, interpretacijom arheološkog nasleđa, digitalnom arheologijom, kompjuterskim i informacionim tehnologijama i arheološkom dokumentacijom; i drugim temama povezanim sa arheologijom.

Časopis ***Arheologija i prirodne nauke*** objavljuje originalne, prethodno neobjavljene rukopise: istraživačke radove, pregledne radove, izveštaje (saopštenja), metodološke radove, studije slučaja i prikaze.

Jezici na kojima se mogu predati rukopisi su engleski (standardni britanski), nemački ili francuski. Rezime mora biti na srpskom jeziku - latinica (za domaće autore) ili engleskom jeziku (za inostrane autore).

Rukopisi koji se predaju redakciji časopisa ***Arheologija i prirodne nauke*** moraju biti opremljeni na standardni način. Svaki tekst koji se predaje treba da sadrži: naslov; ime autora; naziv ustanove (afilijacija); apstrakt; ključne reči; osnovni tekst; rezime; grafičke i numeričke priloge sa popisom (ilustracija, crteža, dijagrama i tabela); bibliografiju; kontakt podatke.

1. Naslov treba da bude kratak i jasan, i da što vernije opiše sadržaj rukopisa. Poželjno je da sadrži 10-12 reči (maksimalna dužina naslova je 20 reči). U naslovu treba da se koriste reči prikladne za indeksiranje i pretraživanje. Ako takvih reči nema u naslovu, poželjno je da se naslovu pridoda podnaslov. Naslov se piše u petom ili šestom redu ispod gornje margine velikim masnim (bold) slovima veličine 14.
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3. Autor ili autori treba da navedu zvaničan naziv i sedište ustanove u kojoj su zaposleni, a eventualno naziv i sedište ustanove u kojoj su obavili istraživanja čije rezultate sada objavljuju. Kod složenih intstitucija navodi se ukupan naziv (npr.: Univerzitet u Beogradu, Filozofski fakultet, Odeljenje za arheologiju, Beograd, Srbija). Navod se piše slovima veličine 12.
4. Apstrakt je kratak prikaz sadržaja rukopisa (oko 200 reči). Piše se kurzivom (italic) veličine 12. Poželjno je da sadrži termine koji se često koriste za indeksiranje i pretraživanje rukopisa. Apstrakt treba da pruži podatke o cilju istraživanja, metodama, rezultatima istraživanja i zaključku. U apstraktu ne treba navoditi reference.

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6. Tekst rukopisa ne bi trebalo da prelazi dva autorska tabaka (32 strane), u formatu A4, odnosno 60.000 slovnih znakova (karaktera) sa razmakom, uključujući: osnovni tekst sa naslovom, podnaslovima, međunaslovima, napomenama i formulama; potpise ispod ilustracija, crteža, dijagrama i tabela, bibliografiju i ostale delove teksta. Tekst treba uraditi kompjuterski u fontu Times New Roman ili Arial (12), MS Office Word 97 ili novijim (formati .doc ili .docx), sa proredom 1,5 i marginama 2,54 cm. Osnovni tekst ne sme da sadrži grafičke i numeričke priloge (ilustracije, crteže, dijagrame, tabele), već se one predaju kao posebni fajlovi.
7. Reči, navodi i naslovi pisani na nekom od stranih jezika treba da budu napisani u svom izvornom obliku.
8. Osnovni tekst mora sadržati *Uvod* i *Zaključak*. Ostala poglavlja imenuje autor. Napomene (fusnote) mogu biti sastavni deo osnovnog teksta. Treba da sadrže manje važne podatke ili odgovarajuća objašnjenja. One nisu zamena za citiranu literaturu. (Poseban odeljak ovog Uputstva govori o načinu citiranja koji treba primenjivati prilikom pisanja tekstova).
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10. Grafički i numerički prilozi (fotografije, crteži, dijagrami, tabele) treba da budu dati na jednoobrazan način. Table i dijagrami se prilažu u .doc, .docx, .xls, ili .xlsx formatu, ili kao ilustracije. Skenirane priloge treba priložiti u rezoluciji 600 dpi, a ilustracije u rezoluciji najmanje 300 dpi u formatima TIFF, PSD ili JPG. Grafički i numerički prilozi se predaju kao poseban deo rada i ne treba da budu u sastavu osnovnog teksta. Maksimalan broj grafičkih i numeričkih priloga je 20 (prilozi koji imaju zaseban potpis).
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Način navođenja u bibliografiji:

Popović, I. 2009

Gilt Fibula with Christogram from Imperial Palace in Sirmium (Резиме: Позлаћена фибула са христограмом из царске палате у Сирмијуму), *Starinar* LVII (2007): 101–112.

Publikacije štampane ćiriličnim, grčkim ili bilo kojim drugim nelatiničnim pismom, transkribuju se na latinicu u skladu sa standardima Američkog bibliotečkog društva i Kongresne biblioteke SAD (http://www.loc.gov/catdir/cpso/roman.html), npr:

Citat u tekstu: (Поповић 1988: 67)

Način navođenja u bibliografiji:

Поповић, И. 1988
Античко оруђе од гвожђа у Србији,

Београд: Народни музеј.
(Popović, I. 1988

Antičko oruđe od gvožđa u Srbiji, Beograd: Narodni muzej).

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I KNJIGE (MONOGRAFIJE)

1. Autorizovane knjige

a. jedan autor
u tekstu: (Popović 2006)
u Literaturi:
Prezime, Inicijal imena. Godina
***Naslov monografije* (*u kurzivu*), Mesto izdanja: Izdavač.**
Popović, I. 2006
Roma aeterna inter Savum et Danubium, Works of Roman Art from the Petrović-Vasić Collection, Belgrade: Archaeological Institute.

- Potrebno je navesti i naziv serije i broj:
Mirković, M. 1968
Rimski gradovi na Dunavu u Gornjoj Meziji, Dissertationes 6, Beograd: Arheološko društvo Jugoslavije.
Papazoglu, F.1969
Srednjobalkanska plemena u predrimsko doba (Tribali, Autarijati, Dardanci, Skordisci i Mezi), Djela 30, Centar za balkanološka ispitivanja 1, Sarajevo: Akademija nauka i umjetnosti Bosne i Hercegovine.

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Između imena prvog i drugog autora, ili drugog i trećeg u bibliografskoj jedinici na srpskom jeziku treba da stoji veznik **i (**ćiriličnim pismom, ako je bibliografska jedinica na ćirilici, a latiničnim**,** ako je na latinici). Ako je rad naveden u literaturi na engleskom ili nekom drugom stranom jeziku, treba da stoji (bez obzira na korišćeni jezik) engleski veznik **and**.
u tekstu: (Popović i Borić-Brešković 1994: 16–18)
u Literaturi:
Popović, I. i Borić-Brešković B. 1994
Ostava iz Bele Reke, Arheološke monografije 7, Beograd: Narodni muzej.
Ivanišević, V., Kazanski, M. and Mastykova, A. 2006
Les necropoles de Viminacium a l'Epoque des Grandes Migrations, Monographies 22, Paris: Association des Amis du Centre d'Histoire et Civilisation de Byzance.

c. četiri i više autora
Za knjige štampane na srpskom jeziku ćirilicom koje imaju četiri i više autora, navodi se samo ime prvog autora i dodaje se u nastavku **и др.;** kod latinice se koristi **i dr.** Za knjige štampane latinicom u bilo kom drugom jeziku koristi se u nastavku skraćenica ***et al.*** Skraćenica ***etc.*** koristi se u slučajevima kada ima više od tri suizdavača ili mesta izdanja.

2. Autorizovane knjige sa pridodatim imenom urednika

u tekstu: (Jeremić 2009: 40)
u Literaturi:
Jeremić, G. 2009
Saldum, Roman and Early Byzantine Fortification, Perić, S. (ed.), Cahiers des Portes de Fer, Monographies 6, Belgrade: Institute of Archaeology.

3. Priređene knjige (umesto autora - urednik, priređivač, prevodilac) - (ur.), (ed., eds.), (prev.).

u tekstu: (Поповић 1994)

u Literaturi:
Поповић, И. (ur.) 1994
Античко сребро у Србији, Београд: Народни музеј.
u tekstu: (Morris 2002)
u Literaturi:
Morris, I. (ed.) 2002
C*lassical Greece-Ancient Histories and Modern Archaeologies*, Cambridge: Cambridge University Press.
u tekstu: (Hurst and Owen 2005)
u Literaturi
Hurst, H. and Owen. S.(eds.) 2005
Ancient Colonizations-Analogy, Similarity and Difference, London: Duckworth.
u tekstu: (Радојчић 1960)
u Literaturi:
Радојчић, Н. (prev.) 1960
Законик цара Стефана Душана 1349. и 1354, Београд: Српска академија наука и уметности.

4. Knjiga bez naznačenog autora

u tekstu: (Anon. 1985)
u Literaturi:
Anon. 1985
Anonymi Peri strategias, The Anonymous Byzantine Treatise on Strategy, *Three Byzantine Military Treatise* (trans. G.T. Dennis), Washington DC.

5. Istovremeno citiranje i navođenje više knjiga istog autora

a. pisanih različitim pismom

u tekstu: (Поповић 2002: 23-26; Popović 2006: 33)
u Literaturi:
Поповић, И. 2002
Накит са Јухора, остава или сакрални тезаурус, Археолошке монографије 14, Посебна издања 36, Београд: Народни музеј и Археолошки институт.
Popović, I. 2006
Roma Aeterna inter Savum et Danubium, Works of Roman Art from the Petrović-Vasić Collection, Belgrade: Archaeological Institute.

b. pisanih iste godine

u tekstu: (Dawkins 1996a; Dawkins 1996b)
u Literaturi:
Dawkins, R. 1996a
Climbing Mount Improbale, London: Viking.

Dawkins, R. 1996b
River out of Eden, London: Pfoenix.

6. Citiranje i navođenja poglavlja i odeljka u knjizi (zborniku radova)

u tekstu: (Петровић 1997: 87–90)
u Literaturi:
Петровић, Б. 1997
Накит, у: *Античка бронза Сингидунума,* Крунић, С. (ур.), Београд: Музеј града, 85–117.
u tekstu: (Samson 1970: 44–68)
u Literaturi:
Samson, C. 1970
Problems of information studies in history, in: *Humanities Information Research*, Stone, S. (ed.), Sheffield: CRUS, 44–68.

7. Prevedene knjige

u Literaturi:
Bajron, Dž. G. 2005 (1812)
Čajld Harold, predgovor Z. Paunović, prevod i predgovor N. Tučev, Beograd: Zavod za udžbenike i nastavna sredstva.

8. Knjige i članci objavljeni u elektronskom obliku

u tekstu: (Fishman 2005: 11)
u Literaturi:
Fishman, R. 2005
The Rise and Fall of Suburbia, [e-book], Chester: Castle Press. Available through Anglia Ruskin University Library, http://libweb.anglia.ac.uk> (accessed on June 5th 2005).

II RADOVI OBJAVLJENI U ZBORNICIMA, AKTIMA KONGRESA I SLIČNO

Prezime, Inicijal imena. Godina
Naslov rada, u: *Naslov zbornika (kurziv)*, Prezime, Inicijal imena. (ur.), Mesto izdanja: Izdavač, broj strana.

Брукнер, О. 1987

Импортована и панонска керамичка продукција са аспекта друштвено-економских промена, у: *Почеци романизације у југоисточном делу провинције Панониje*, Стојанов, М. (ур.), Нови Сад: Матица српска, 25–44.

Potrebno je navesti i podatke o seriji:

Петровић, П. 1997

Римљани на Тимоку, у: *Археологија источне Србије* (Научни скуп Археологија источне Србије, Београд-Доњи Милановац, децембар 1995), Лазић, М. (ур.), Центар за археолошка истраживања 18, Београд: Филозофски факултет, 115–131.

III PERIODIKA

Prezime, Inicijal imena. Godina
Naslov rada, *Naziv časopisa (*kurziv) broj časopisa: broj strane.

Бајаловић-Хаџи-Пешић, М. 2001

Налази хабанске и постхабанске керамике у Србији, *Годишњак града Београда* 47–48 (2000-2001): 107–121.

- Za časopise čiji su nazivi slični, iza naziva časopisa u zagradi treba navesti mesto izdanja:

Анђелковић, Б. 1988

Праисторијски налази са локалитета Јелица-Градина, *Зборник радова Народног музеја* (Чачак) 18: 81–85.

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Први резултати анализе мумије из Народног музеја у Београду, *Зборник Народног музеја* (Београд) 15-1: 153–159.

- *Старинар* se, zavisno od godine izdanja, navodi punim nazivom:

godine 1884-1895 *Старинар Српског археолошког друштва*

godine 1906-1914 [novog reda] *Старинар* (н.р.)

godine 1922-1942 [treća serija] *Старинар* (т.с.)

godine 1950-2010 [nova serija] *Старинар* (т.с.)

- Ukoliko se godina izlaženja i godina za koju časopis izlazi razlikuju, navesti i drugu godinu u zagradi:

Жеравица, З., и Жеравица, Л. 1979

Средњовековно насеље у Поповици код Неготина, *Старинар* (н.с.) 28-29 (1977-1978): 201–211.

Rad u štampi / u pripremi
- u štampi, u tekstu (in print)
- u pripremi, u tekstu (forthcoming).

u tekstu: (Јовановић, in print)
u literaturi:
Јовановић, А. (in print)
Бор и околина у античком периоду, у: *Бор и околина у праисторији, антици и средњем веку*, Лазић, М. (ур.), Бор: Музеј рударства и металургије; Београд: Филозофски факултет.

IV ČLANCI IZ ELEKTRONSKIH ČASOPISA

Članci preuzeti sa interneta iz elektronskih časopisa navode se na isti način kao štampani članci, ali se na kraju dodaje puna veb adresa sa http://...

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Umesto mesta izdanja i izdavača navodi se naziv fakulteta/univerziteta gde je teza odbranjena.

u literaturi:

Ilić, O. 2005

Ranohrišćanski pokretni nalazi na području dijeceze Dakije od IV do početka VII veka, Magistarski rad, Filozofski fakultet, Univerzitet u Beogradu.

Patch, D. C. 1991

The Origin and Early Development of Urbanism in Ancient Egypt: A regional Study, Ph.D Thesis, University of Pennsylvania.

VI POPULARNI MAGAZINI/ ČASOPISI I NOVINSKI ČLANCI

u tekstu: Кашанин, М. 1929
u literaturi:
Кашанин, М. 1929
Музеј савремене уметности, *Политика, 23. јул, 7–8.*

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ARHEOLOGIJA I PRIRODNE NAUKE

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Where human data cannot be effectively de-identified, data must not be shared in order to protect participant privacy unless the individuals have given explicit written consent that their identifiable data can be made publicly available.

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In addition, data should be linked to from a *Data Accessibility Statement* within the submitted paper, which will be made public upon publication. If data is not being made available within the journal publication, a statement from the author should be provided to explain why. When depositing data for a submission, the below should be considered:

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license that permits unrestricted access (e.g., CC0, CC-BY). More restrictive licenses should only be used if a valid reason (e.g., legal) is present. The deposited data must include a version that is in an open, non-proprietary format. The deposited data must have been labeled in such a way that a 3rd party can make sense of it (e.g., sensible column headers, descriptions in a readme text file).

Research involving human subjects, human material, or human data, must have been performed in accordance with the Declaration of Helsinki. Where applicable, the studies must have been approved by an appropriate Ethics Committee. The identity of the research subject should be anonymized whenever possible. For research involving human subjects, informed consent to participate in the study must be obtained from participants (or their legal guardian).

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Principles of transparency and best practice in scholarly publishing. Directory of Open Access Journals. https://doaj.org/apply/transparency/ (accessed 2023-01-06).

Core practices. COPE: Committee on Publication Ethics. https://publicationethics.org/core-practices (accessed 2022-12-10).

Policies. Open Research Europe. https://open-research-europe.ec.europa.eu/about/policies (accessed 2022-11-08).

Journal Policies. Glossa: a journal of general linguistics. https://www.glossa-journal.org/site/journal-policies/ (accessed 2023-01-06).

SUBMISSION INSTRUCTIONS FOR THE JOURNAL *ARHEOLOGIJA I PRIRODNE NAUKE* (*ARCHAEOLOGY AND SCIENCE*)

Editorial Board of the periodical ***Arheologija i prirodne nauke* (*Archaeology and Science*)** decided to apply the current rulebook issued by the Ministry of Science, Technological Development and Innovation of the Republic of Serbia. By applying these acta, complete editing of scientific periodicals is determined, quality of periodicals is promoted and their integration into the international system of exchanging academic information shall become more complete.

The journal ***Arheologija i prirodne nauke* (*Archaeology and Science*)** is dedicated to the topics in the humanistic scientific disciplines: archaeology, history, classical philology, history of art and architecture, social and cultural anthropology; the topics from multidisciplinary research that connect archaeology and sciences: physical (biological) anthropology, archaeological science, geosciences in archaeology, technologies in archaeological survey; the topics dealing with protection and presentation of archaeological heritage: conservation and restoration of cultural heritage, experimental archaeology, interpretation of archaeological heritage, digital archaeology, computing and information technologies and archaeological documentation; and other topics connected to archaeology.

The journal ***Arheologija i prirodne nauke* (*Archaeology and Science*)** publishes original manuscripts that have not been published previously: research articles, review articles, report articles, methodology articles, case study articles and book (or other publication) reviews.

Manuscripts can be submitted in English (standard British), German or French. The summary needs to be in Serbian-Latin (for authors from Serbia) or in English (for international authors).

Manuscripts submitted to the Editorial Board of the periodical ***Arheologija i prirodne nauke* (*Archaeology and Science*)** must be formed in a standard way. Each manuscript submitted has to contain: title; author's name; name of the institution (affiliation); abstract; key words; main text; resume; figures and tables with captions; bibliography; contact address.

1. Titles need to be short and clear, describing content in the best possible way. The preferred length of the title is 10-12 words (maximum length is 20 words). Words used in titles should be apropriate for indexing and web-searching. If there are no such words withing titles, it is advised to add a subtitle. Titles are to be written in the fifth or sixth line, under the top margin, in capitals, bold and with font size 14.
2. Author(s) should give their full name(s), including first name, middle name (if used), and surname, in capitals, font size 12.
3. Author(s) need to state official names and addresses of their employees, including names and addresses of institutions in which the research was conducted, that led to the publication of results. With complex institutions, complete title is to be named (ex.: University Belgrade, Faculty of Philosophy, Department of Archaeology, Belgrade, Serbia). It should be written with font size 12.
4. Abstract, consisting of about 200 words, describes shortly content of the manuscript. It should be written in italics, font size 12. Within abstracts, it is advised to use terms convenient for indexing and web-searching. Abstracts

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8. Main text must contain *Introduction* and *Conclusion*. Other chapters are named by the author(s). Footnotes can be incorporated within the main text. They should contain less important data or apropriate explanations. They are not to be replaced with quoted literature. (Separate section of these Instructions explains the way of quoting to be applied).
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10. Figures (photographs, drawings, diagrams) and tables should be submitted in a proposed manner. Scanned illustrations should be submitted in a 600 dpi resolution, while photographs are to be submitted in a resolution of at least 300 dpi, in formats TIFF, PSD or JPG. Figures and tables are to be submitted as separate files and should not be incorporated into the main text.
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In the list of references:

Popović, I. 2009

Gilt Fibula with Christogram from the Imperial Palace in Sirmium (Резиме: Позлаћена фибула са христограмом из царске палате у Сирмијуму), *Starinar* LVII (2007): 101–112.

Publications published in Cyrillic, Greek or any other non Latin alphabet should be transliterated into the Latin alphabet in accordance with the standards of The American Library Association and The Library of Congress of the United States (http://www.loc.gov/catdir/cpso/roman.html), for example:

Quotation within a footnote: (Поповић 1988: 67)

In the list of references: **Поповић, И. 1988**

Античко оруђе од гвожђа у Србији, Београд: Народни музеј.

(Popović, I. 1988
Antičko oruđe od gvožđa u Srbiji, Beograd: Narodni muzej).

12. Bibliography's structural elements (author's name, title of work, source etc.) should be written according to standard forms of quoting. Editorial Board of the periodical accepted the reccomendation of the Ministry of Science, Technological Development and Innovation of the Republic of Serbia, and decided that authors should precisely follow quotation rules named below.

The following examples describe the most frequently quoted kinds of references:

I BOOKS (MONOGRAPHS)

1. Author's books

a. single author

within main text: (Popović 2006)

in bibliography:

Surname, name's initial. Year of publishing
***Title of book* (*italic),* Place: Publisher.**

Popović, I. 2006
Roma aeterna inter Savum et Danubium, Works of Roman Art from the Petrović-Vasić Collection, Belgrade: Archaeological Institute.

- Series' name and number is also needed:
Mirković, M. 1968
Rimski gradovi na Dunavu u Gornjoj Meziji, Dissertationes 6, Beograd: Arheološko društvo Jugoslavije.
Papazoglu, F.1969
Srednjobalkanska plemena u predrimsko doba (Tribali, Autarijati, Dardanci, Skordisci i Mezi), Djela 30, Centar za balkanološka ispitivanja 1, Sarajevo: Akademija nauka i umjetnosti Bosne i Hercegovine.

b. two or three authors

Between the names of the first and second author, or the second and third in the bibliographic reference in the Serbian language, there should be the conjunction (in Cyrillic script **и**, if the bibliographic unit is in Cyrillic, and in Latin **i**, if it is in Latin). If the work is cited in the literature in English or another foreign language, it should appear (regardless of the language used) the English conjunction **and**.

within main text: (Popović i Borić-Brešković 1994)
in bibliography:
Popović, I. i Borić-Brešković B. 1994
Ostava iz Bele Reke, Arheološke monografije 7, Beograd: Narodni muzej.
Ivanišević, V., Kazanski, M. and Mastykova, A. 2006
Les necropoles de Viminacium a l'Epoque des Grandes Migrations, Monographies 22, Paris: Association des Amis du Centre d'Histoire et Civilisation de Byzance.

c. four or more authors

Books written by four or more authors in Serbian, and in cyrillic, only the first name is written and **и др.** is added; with the Latin alphabet, **i dr.** is used. For books printed in other languages, and in Latin alphabet, the abbrevation ***et al.*** is applied. The abbrevation ***etc.*** is used in cases when there are more than three editors or places of editing.

2. Author's books with added name of the editor

within main text: (Jeremić 2009: 40)
in bibliography:
Jeremić, G. 2009
Saldum, Roman and Early Byzantine Fortification, Perić, S. (ed.), Cahiers des Portes de Fer, Monographies 6, Belgrade: Institute of Archaeology.

3. Edited books (instead of the author – editor, translator) - (ed., eds.), (trans.).

within main text: (Поповић 1994)
in bibliography:
Поповић, И. (ур.) 1994
Античко сребро у Србији, Београд: Народни музеј.

within main text: (Morris 2002)
in bibliography:
Morris, I. (ed.) 2002
C*lassical Greece-Ancient Histories and Modern Archaeologies*, Cambridge: Cambridge University Press.
within main text: (Hurst and Owen 2005)
in bibliography:
Hurst, H. and Owen. S.(eds.) 2005
Ancient Colonizations-Analogy, Similarity and Difference, London: Duckworth.
within main text: (Радојчић 1960)
in bibliography:
Радојчић, Н. (prev.) 1960
Законик цара Стефана Душана 1349. и 1354., Београд: Српска академија наука и уметности.

4. Way of quoting books without author's name

within main text: (Anon. 1985)
in bibliography:
Anon. 1985
Anonymi Peri strategias, The Anonymous Byzantine Treatise on Strategy, *Three Byzantine Military Treatise* (trans. G.T. Dennis), Washington DC.

5. Simultaneous quoting of several books of the same author

a. written in different alphabets
within main text: (Поповић 2002: 23–26; Popović 2006: 33)
in bibliography:
Поповић, И. 2002
Накит са Јухора, остава или сакрални тезаурус, Археолошке монографије 14, Посебна издања 36, Београд: Народни музеј и Археолошки институт.
Popović, I. 2006
Roma Aeterna inter Savum et Danubium, Works of Roman Art from the Petrović-Vasić Collection, Belgrade: Archaeological Institute.

b. written in the same year
within main text: (Dawkins 1996a, Dawkins 1996b)
in bibliography:
Dawkins, R. 1996a
Climbing Mount Improbale, London: Viking.
Dawkins, R. 1996b
River out of Eden, London: Pfoenix.

6. Quoting chapters in books (acta)

within main text: (Петровић 1997: 87–90)
in bibliography:
Петровић, Б. 1997
Накит, у: *Античка бронза Сингидунума,* Крунић, С. (ур.), Београд: Музеј града, 85–117.
within main text: (Samson 1970: 44–68)
in bibliography:
Samson, C. 1970
Problems of information studies in history, in: *Humanities Information Research*, Stone , S. (ed.), Sheffield: CRUS, 44–68.

7. Translated books

in bibliography:
Bajron, DŽ. G. 2005 (1812)
Čajld Harold, Z. Paunović (predgovor), N. Tučev (prevod), Beograd: Zavod za udžbenike i nastavna sredstva.

8. Books and articles published in electronic form

within main text: (Fishman 2005: 11)
in bibliography:
Fishman, R. 2005
The Rise and Fall of Suburbia, [e-book], Chester: Castle Press. Available through Anglia Ruskin University Library, http://libweb.anglia.ac.uk> (accessed on June 5th 2005).

II PAPERS PUBLISHED IN PERIODICALS, CONGRESS ACTA AND SIMILAR

within main text: (Vasić 2008: 69, fig.3)

in bibliography:
Surname, name's initial. Year
Title, in: *Title of the acta (italic)*, Surname, Name's initial. (ed.), Place of publishing:

Publisher, page numbers.

Vasić, M. 2006.

Stibadium in Romuliana and Mediana, in: *Felix Romvliana 50 Years of Archaeological Excavations*, Vasić, M**.** (ed.), October, 27-29 2003, Zaječar, Serbia, Belgrade, Zaječar: Institute of Archaeology, Committee on Archaeology of Serbian Academy of Sciences and Arts, and National Museum Zaječar, 69–75.

Series' data are also needed:

Петровић, П. 1997

Римљани на Тимоку, у: *Археологија источне Србије* (Научни скуп Археологија источне Србије, Београд-Доњи Милановац, децембар 1995), М. Лазић (ур.), Центар за археолошка истраживања 18, Београд: Филозофски факултет, 115–131.

III PERIODICALS

within main text: (Бајаловић-Хаџи-Пешић 2001: 108)

Surname, Name's initial. Year

Title, *Name of the periodical (italic*) number of the periodical: page number.

Бајаловић-Хаџи-Пешић, М. 2001

Налази хабанске и постхабанске керамике у Србији, *Годишњак града Београда* 47-48 (2000-2001): 107–121.

- For periodicals with similar titles, behind the name of the periodical, place of publishing should be stated in brackets:

Анђелковић, Б. 1988

Праисторијски налази са локалитета Јелица-Градина, *Зборник радова Народног музеја* (Чачак) 18: 81–85.

Анђелковић, Б. 1994

Први резултати анализе мумије из Народног музеја у Београду, *Зборник Народног музеја* (Београд) 15-1: 153–159.

- Depending on the year of publishing *Старинар* is named in its full title:

years 1884-1895 *Старинар Српског археолошког друштва*

years 1906-1914 [novog reda] *Старинар* (н.р.)

years 1922-1942 [treća serija] *Старинар* (т.с.)

years 1950-2010 [nova serija] *Старинар* (н.с.)

- If there is a difference between the year of actual printing and the year of publishing, the second is stated in brackets:

Жеравица, З., и Жеравица, Л. 1979, Средњовековно насеље у Поповици код Неготина, *Старинар* (н.с.) XXVIII-XXIX, (1977-1978): 201–211.

Paper in print / forthcoming

- in print, in the text (in print)
- forthcoming, in the text (forthcoming).

within main text: (Јовановић, in print)

in bibliography:

Јовановић, А. (in print)

Бор и околина у античком периоду, у: *Бор и околина у праисторији, антици и средњем веку*, М. Лазић (ур.), Бор: Музеј рударства и металургије; Београд: Филозофски факултет.

IV ARTICLES FROM ELECTRONIC PERIODICALS

Papers overtaken from the internet, from electronic periodicals, are quoted in the same way as printed papers, only there is a full web-address written at the end with http://...

V DOCTORAL AND MASTER THESES

Instead of place of editing and editor, the full name of faculty/university is given, where the thesis was conducted.

within main text: (Ilić, 2005)

in bibliography:

Ilić, O. 2005

Ranohrišćanski pokretni nalazi na području dijeceze Dakije od IV do početka VII veka, Magistarska teza, Filozofski fakultet, Univerzitet u Beogradu.

within main text: (Patch, 1991)

in bibliography:

Patch, D. C. 1991

The Origin and Early Development of

Urbanism in Ancient Egypt: A regional Study, Ph.D Thesis, University of Pennsylvania.

VI ARTICLES FROM NEWSPAPERS

within main text: (Кашанин, 1929)
in bibliography:
Кашанин, М. 1929, Музеј савремене уметности, *Политика, 23. јул, 7-8.*

13. All of the quoted referrences are listed after alphabetic order, initial's order within author's surname or the initial letter within the quoted title (if the author or editor are not stated).

SUBMITTING MANUSCRIPTS

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17. Manuscripts shall be accepted only if they are written and submitted according to the rules stated above. Shold author not agree to the requests of the Editorial Board, does not accept remarks of the reviewers (according to the EDITORIAL POLICY) or the proof-reader, manuscript shall not be printed.

18. It is not allowed to change manuscripts after reviews have been submitted, unless they are in accordance with these remarks or according to the proofreading request. Editorial Board holds the right to demand Figures of lesser quality to be replaced with Figures of better quality if necessarry.

* * *

For additional explanations, please contact the assistant editor Emilija Nikolić, PhD (address: Arheološki institut, Knez Mihailova 35/IV 11000 Beograd; phone: 381 (0)11 2637 191 or send an e-mail to: archaeo.sci@viminacium.org.rs.

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