Archaeoceramological analysis of the pottery from Orheiul Vechi and Butuceni-Vest settlements (Poieneşti-Lucaşeuca and Getic cultures)

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Abstract

The aim of laboratory analysis carried out on pottery fragments recovered from the Poienești-Lucaşeuca (PL) site of Orheiul Vechi and the Getic site of Butuceni was to verify the hypothesis that there was a continuity in pottery technology traditions and the hypothesis that there was continuity in raw material use. In order to verify these hypotheses, i.e. to determine whether we are dealing with continuity or with changes in pottery manufacturing, two factors must be taken into account: know-how and raw material. This means that it is necessary to perform both technological and raw material analyses. For the purposes of this study the following methods were used: MGR-analysis, chemical analysis by WD-XRF, thin-section studies and an estimation of physical ceramic properties. The results of archaeometric analysis of pottery from the PL site of Orheiul Vechi and the Getic site of Butuceni did not substantiate the hypothesis that there had been a continuity in pottery technology traditions. The results of archaeometric analysis of pottery from the PL site of Orheiul Vechi and the Getic site of Butuceni did, conversely, confirm the hypothesis that there was a continuity in raw material use. At both sites and in both phases there is a marked emphasis on local production of ceramics using locally sourced raw materials. The analyses performed show how vital technological analyses are in the study of ancient pottery. If only chemical composition and/or thin-sections are analysed (which is the most common practice) and a report is then written up based on even the precise findings of a technique such as WD-XRF and on sophisticated statistical methods, there is a chance that the resultant cultural and historical conclusions may be erroneous. Without technological analyses, the conclusions drawn solely from the results of chemical analysis/thin-section studies would be that from an archaeometric point of view, there is nothing to suggest a lack of continuity in ceramic production traditions between the Getic site and the PL site. In summary, the similarities in production between pottery from the Getic site and the PL site are clearly reflected in the raw materials used, both in terms of plastic ingredients and intentional temper. However, the results of preliminary technological analyses suggest that there is a lack of continuity in pottery technology traditions. In this way, given the differences observed in the physical ceramic property values, a broader range of analyses is required that will enable us to more accurately reconstruct the ceramic technology.

Keywords: Pre-Roman Iron Age; Getic culture; Poienești-Lucașeuca culture; pottery; archaeoceramology; archaeometry; ceramic technology; MGR-analysis; thin-section studies; physical ceramic properties.

Research Questions

The subject of this study is the phenomenon of migration from Central and Northern Europe to the North-Western Pontic regions that occurred in the last three centuries of the pre-Christian era. As a result, a range of related cultures was created, including the Poieneşti-Lucaşeuca (further – PL) culture, the one we focused our attention on (Fig. 1). As it was mentioned before and on the occasion of other studies (Daszkiewicz et al., 34), one of the major questions of the Pre-Roman Iron Age settlements in the East part of the Carpathians Region is the relationship between the Getic culture and the PL culture. One of the key problems of this correlation is determined by the insufficient research of PL culture settlements, on the one hand, but also the insufficient comparative studies of vestiges that define the two cultures, on the other hand. This insufficiency has left room to this day for diametrically opposite interpretations regarding the genesis of PL culture and the relationship between the Getic and PL cultures. Certainly, the situation shall be clarified as a result of new researches of habitat sites , but until then, along with the new field investigations, the interdisciplinary studies of older vestiges could be an effective tool. Among them, ceramics would hold an extremely important place for understanding certain realities.

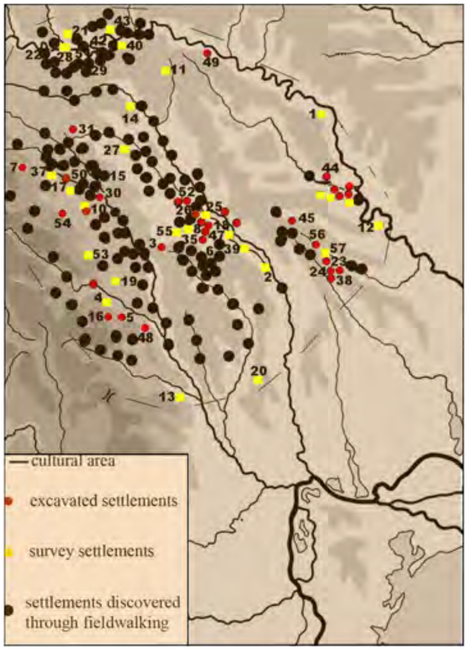

Fig. 1. Distribution of Poieneşti-Lucaşeuca culture settlements (after Meyer et al., 2016).

We assumed that the destruction of settlements and new immigration can be seen in a clearly evident change in ceramic technology and the associated supply of raw materials. It is assumed that extensive continuities in the production of ceramics require an undisturbed knowledge transfer between the actors, which cannot be the case in a complete new settlement. In particular, this can be traced back to archaeometric analyzes of ceramics, whereby local or non-local sound supply, leaning, sound processing and burning techniques have meaning (Daszkiewicz et al. 2017, 35). We shall remind that the first analyzes of this kind have already been carried out. Two years ago, the ceramic discoveries from

Fig. 2. Codrii in the valley of Moțca River. Distribution of Poieneşti-Lucaşeuca settlements. Numbering site on map: 1 – Brăneşti-Partea de Vest; 2 – Ivancea-Sub Pădure; 3 – Ivancea IV; 4 – Ivancea II; 5 – Poharniceni-Petruha; 6 – Brăneşti-Valea Budăi; 7 – Trebujeni-Potârca; 8 – Trebujeni Fantana Joaiei; 9 – Orheiul Vechi Est; 10 – Măşcăuții-Poiana Ciucului. Yellow points-Orheiul Vechi PL settlement and Butuceni-West Getae fortification.

the Getic Horodca Mare fortification and the one of PL type from Ulmu, both from Hancesti district, Republic of Moldova, have been subjected to analysis (Daszkiewicz et al. 2017, 32-74). The results obtained seem to be quite interesting and forward-looking. For this reason, ceramics of the two cultures of two neighboring settlements – Orheiul Vechi, Orhei District, Republic of Moldova (PL culture: Munteanu and Iarmulschi 2017; Postică and Munteanu 1999) and Butuceni, Orhei District, Republic of Moldva (Getic culture: Munteanu et. al. 2014; Munteanu et al. 2015; Munteanu 2015; Munteanu 2016; Munteanu 2017) – were examined for these parameters (Fig. 2, points marked with yellow). The choice was determined by several reasons, the same, in fact, which determine us now to prioritize the examination of namely these settlements (Branesti and Ivancea, Fig. 2, points 1 and 2). First, because it is a microregion adjacent to one that is quite well known thanks to previous research from Lucașeuca (burial sites and the habitat that gave the name of culture). Second, because it is a region where we have a relatively high density of known sites and being investigated (Fig. 2), would open up the prospect of understanding cultural events in clearly defined spaces and will give the opportunity to compare them with those of neighbouring or remote territories. Third – because we already have an investigated site in this area that can be the key to new discoveries. And not least, because the microregion has preserved a significant number of Getic fortifications (Fig. 3), but the correlation of these and PL culture sites (which has not yet been clearly established, at least for the Prut and Dniester area) could be the key to

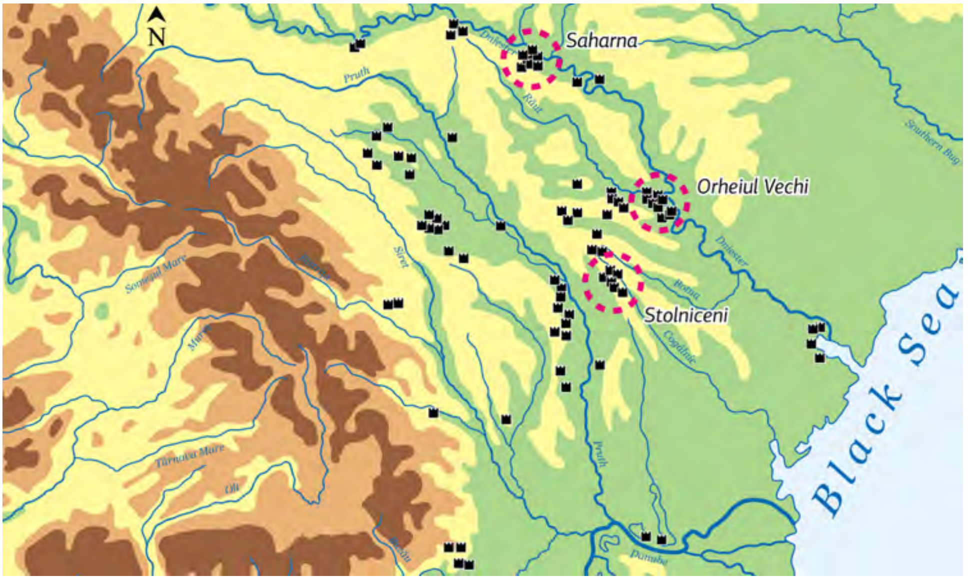

Fig. 3. Distribution of Getic Fortifications in the East Carpathian Space. – (after Niculiță, Zanoci and Băț 2014, fig. 1).

better understand the period when people migrated from north, the way of coming and established relationships with Getae.

The landscape: general characteristics

The micro-region of direct interests is situated on a small area at the north-eastern periphery of the forest region (Codri) occupying the central part of Moldova: it is the highest from the Prut-Dniester region. Codri represents a relief with an increased degree of rough terrain, the depth of the fragmentation ranging from 300 m to 100-150 m, in most landscapes being 200-350 m. The eastern part of the forest consists of the landscapes Periseci and Trebujeni. The relief has an orientation to the east and southeast, where the maximum altitude decreases to 250 m, with a fragmentation density of 3-4 km^2 in the north and 2/3 km^2 in the eastern part. At the basis of the tectonic structure there are colluvial deposits, which are characterized by considerable areas of forest soils with two types: brown and gray forest soils pluspodzol and leached chernozem soils. The brown soils and gray forest soils can be found in the wooded areas, at altitudes typically (Ursu 1977; Krupenikov and Podymov 1987; Conea, Vintilă and Canarache 1977) between 200 and 350 m. These conditions have facilitated the growth of rich forest vegetation which is represented by deciduous forests of Central European type.

The region is crossed by valleys of several rivers that flow into the Prut and Dniester rivers. In the Codri area, the river valleys are well-shaped and deep, becoming less pronounced to the periphery. Răut is the third longest river in Moldova, having its origin in the north of the country. The total length is 286 km. Downstream from the confluence with Ciuluc, the river valley widens sharply, but the riverbeds achieve a width of 6-8 km, which continues down to Orhei. In Orhei downstream and to its confluence with the Dniester River, Răut River crosses deeply Sarmatian average limestones, where the large riverbed narrows to 100-150 m.

The beautiful landscapes start in the immediate proximity of the contemporary town of Orhei and are mainly generated by the very specific meandering of the Răut River between the calcareous rocks that has shaped promontories with high and steep borders of a very peculiar beauty. The landscape becomes truly spectacular nearby Răut's meandering borders between the Butuceni and Trebujeni villages, which, in fact, constitutes to the region of the Orheiul Vechi archaeological reservation. Orheiul Vechi, as such, is one of the most unusual sites in the Prut-Dniester area. It is a true natural landscape and archaeological reserve, situated down the Răut River, at around 18 km from where Răut flow into the Dniester. It is situated very strategically but is also very picturesque. In this area, the water flow shaped two promontories with unique landscape enclosed between the Răut's rocky and steep borders of over 90 m high. The territory is almost isolated and communication with the outside world is possible only from its western side for the "Peştere" promontory, via a narrow saddle in the rock and from the East, for the "Butuceni" promontory (Fig. 4). The strategic importance of the micro zone is confirmed by the sites that it has hosted over time. Human activity on these promontories has been attested since the prehistoric era till the 17thcentury, in our context the most relevant being the fortifications from the Getic period but also the settlements of the PL Culture.

The Getic fortifications on the lower course of the Raut River

The fortifications are located on the promontory Butuceni (Fig. 4, points 1-3, 6), protected from three sides (north, west, and south) by the steep banks of Răut meanders over 100 m high. Now it is one of the best studied sites in Moldova (Smirnov 1964; Niculiță, Teodor and Zanoci 1995, 471-490; Niculiță 1996, 139-167; Niculiță, Teodor and Zanoci 1997, 292-339). It was found that the headland Butuceni began to be inhabited since the Hallstatt era (Niculiță and Zanoci 1999; Niculiță, Teodor and Zanoci 2002). Later, most likely in the

Fig. 4. 1 – The Meanders of the River Răut in the Butuceni Village Microzone with the location of the fortifications: 1 – Butuceni; 2 – Butuceni-Est; 3 – Butuceni-Vest; 4 – Măşcăuţi-Poiana Ciucului; 5 – Măşcăuţi-Dealul cel Mare; 6 – Butuceni-Cetăţuia Nouă; 2 – view of the ditch at the north-eastern extremity of the Butuceni promontory. – (Google Earth). Yellow arrows – the access roads to Butuceni promontory.

early 6th century B.C., the Getae tribes settled in and built an entire defense system (Niculiță, Teodor and Zanoci 1995, 472-490; Niculiță 1996, 139-167; Niculiță, Teodor and Zanoci 1997, 293-339; Niculiță and Zanoci 1999, 135-142; Niculiță, Teodor and Zanoci 2002). The Getae system of fortifications from Butuceni consists of several defense lines, the eastern and the central lines having been studied by Gh. Smirnov and I. Niculiță (Smirnov 1964; Niculice 1987, 88-101; Zanoci 1998; Niculiță, Teodor and Zanoci 2002, 27; Postică et al. 2010, 62). Thus, in the Eastern part we have a very large site of more than 7 ha, delimited from the north by a defensive system that is not too extended but very strong. (Fig. 4, point 2). The central part (Fig. 4, point 1) was fortified with a double palisade and at the extremities it was protected by complex and massive constructions, preceded by deep ditches. In the eastern part of the central citadel, a Hellenistic wall was identified, which has no known analogues in our area. The value of the discoveries made inside the fortification must be noted, which places the site among the most important ones. The discovery of a sanctuary on the promontory was one of the most impressive findings made by the team from Moldova State University – it also served as a calendar (Niculiță 1987, 72-82; Niculiță, Teodor and Zanoci 2002, 41-42; Niculiță, Zanoci and Băț 2014, 267-269). It should be noted that this construction is unique on the current territory of the Republic of Moldova, having similarities to the sites dated at the 2nd century B.C. – 1st century A.D. in the classic Getae-Dacian culture.

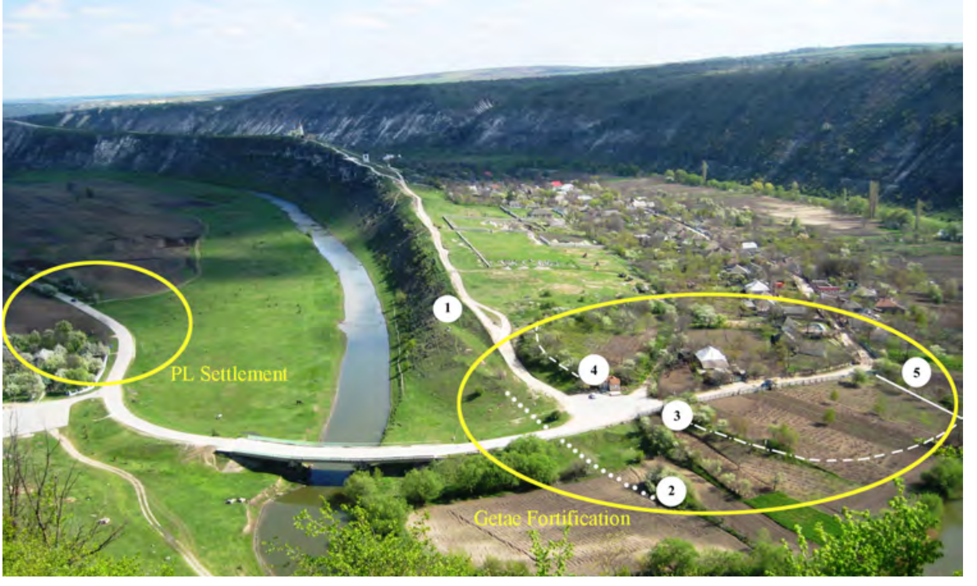

Fig. 5. Butuceni headland. Overview from the northwest, marking points which have been identified traces of fortification (1-5). Dashed line: established trajectory of the defensive line; dotted line: hypothetical trajectory of the defense system.

There are very special the discoveries that show important influences from the Greek world (Mateevici 1999, 177-195; Mateevici, 2007), which was the nucleus of the European civilization over the 1st millennium B.C.

And the western part of the promontory has been fortified (Fig. 4, point 3). Examined in the last few years only, there can be delimited a few defensive lines and only a part of them were researched. Thus, one of the lines bars the promontory, after all, immediately in the area of river curvature that delimits the Butuceni promontory. To this is added a second defensive line, which has been studied partially only, and has a semicircular shape, located behind the first defensive line. It may have been a third defensive line, identified in one single point, but it is still premature to say its trajectory (Fig. 5, Munteanu 2016, 248-250).

Taking all this into consideration, it becomes clear that the Butuceni site belongs to important military, commercial, and religious facilities. But, we note that attention is paid to not only to the defensive consolidation of the site from Butuceni promontory, but to the entire microzone. Opposite the Butuceni promontory, on the other side of Răut, there are two other promontories with abrupt steeps on which two fortifications were built: Măşcăuți-Poiana Ciucului (Fig. 6, No. 4) and Măscăuți“-Dealulcel Mare” (Fig. 6, No.5). So, the Getae citadel of Butuceni is part of a complex defense system that offers highly effective control of the lower course of the Răut River (Fig. 6). Such an arrangement of

Fig. 6 Orheiul Vechi Microregion with Getae fortifications. 1 – Butuceni; 2 – Butuceni-Est; 3 – Butuceni-Vest; 4 – Măşcăuţi-Poiana Ciucului; 5 – Măşcăuţi-Dealul cel Mare; 6 – Butuceni Cetățuia Nouă; 7 – Trebujeni-Selitra; 8 – Trebujeni-Potârca; 9 – Furceni-Cot; 10 – Trebujeni-Piscul Ciobanului;. – (geoportal.md).

fortifications offers an image of the extremely well-ordered protection of the territory from the heights that dominate the Răut valley in the area of Butuceni village. In fact, the river seems to be caught in "pincers" that don't allow anyone to pass the area without consent, and the Greek material, discovered in abundance, suggests the importance of the place for trade with the Greek world from Pontus colonies. Summing up, we notice that the entire microzone between the villages of Furceni and Butuceni, is a system that emerged as a result of a unified strategy of strengthening the area (Fig. 6).

At the same time, it should be mentioned that beyond the fortified settlements, in the microzone there is known a range of open settlements, many of which revolve around the fortified ones.

Poienești-Lucașeuca settlements on the lower course of the Raut River

The Valley of the Lower Raut represents a space in which most of known sites are located, of those assigned to the PL horizon. From the data available, we notice the location of PL-type settlements in nests (Fig. 2). The PL site from Orheiul Vechi is situated in the immediate proximity (about 400 m away from the getic fortress) of the water flow (as most of the PL sites are), on South-oriented slope (Fig. 2/yellow dot, PL). Its size is estimated to around 1,2 hectare. The excavations were not too broad, counting slightly over 1000 sq. m.

Considering the prior research we have performed, we can count today 30 complexes: 6 habitations, 21 auxiliary pits, 2 outbuildings and one tomb. The most representative material has, of course, been the ceramics (Munteanu, Iarmulschi 2019, 140; Munteanu, Iarmulschi 2017, 68; Ткачук 1991, 44-53; Postică, Munteanu 1999, 457-494).

On the same promontory, at a distance of about 2 km in the western direction, there were also discovered traces attributed to the PL horizon (Postică et al. 1998, Fig. 2/9). Given the distance of about 2 km between the discovered tracks and the average dimensions of about 1-1.5 ha of the PL-type settlements, we could admit the existence of two sites.

A third site is reported in the immediate vicinity of the Pestere promontory. It is located southern wards of Orheiul Vechi, on the high and steep promontory on the opposite bank of the river Raut – Mascauti-Poiana Ciucului (Fig. 2/10). The site is located in the immediate vicinity of the Getic fortress (partially overlapping it), located on the Eastern slope of the promontory, occupying a surface of about 1.2 ha. The site has been researched within several archaeological campaigns and the findings were mainly reported to the Getic horizon (Niculițce 1984; Niculice 1986; Niculiță and Arnăut 1996; Musteață 2002; Musteață 2003; Musteață 2004; Musteață 2006).

At relatively equal distances from the Butuceni microzone other three sites are located. One of them is located on the surface of the Getic fortress Potarca. In that place the Raut River makes a second great meander, the fortress being located on the steep bank of the tributary, near its spilling in Raut (Fig. 2/7). The surface of this site would not exceed 2 ha (Niculiță, Matveev and Nicic 2019, 16). The first archaeological digs within the Geto-Dacian Trebujeni-Potarca fortress were carried out by Gh. D. Smirnov in the 1950s and 1957, afterwards they were continued by the team of the State University of Moldova headed by I. Niculita (Niculiță, Matveev and Nicic 2019, 16). There were examined the wall and the defense ditches as well as several sectors of the fortification.

At the distance of about 3 km to the North-East of the Orheiul Vechi site, the Trebujeni Fantana Joaiei site is located (Fig. 2/8) and in the opposite direction, approximately at the same distance - the sites Branesti II Valea Budai (Fig. 2/6). All three sites are known only by surface discoveries, having relatively equal dimensions about 1-1.3 ha, located on slopes with South – South-West orientation (Postică 2009, 214).

To the West of the last settlement there is located another nest consisting three settlements, in each of which the archaeological investigations were carried out. At the distance of about 3 km South-West of the Branesti-Valea Budai site, on the right bank of the creek, on the western side the Branesti West Side site is located (Fig. 2/1). The plot represents a slope leading down to the riverbed, oriented northwest. The archaeological remains since the PL period are concentrated closer to the stream bed and cover an area of about 1,5 ha. The site was subjected to magnetometric prospections, some types of anomalies were verified through archaeological digs which confirmed the presence of three PL features (Meyer et al. 2016). From the last site, at the distance of about 4 km to the West, the Ivancea sub-Padure site is located, on the left bank of the Motca River, at the distance of approximately 1750 m to the NW from the center of the Ivancea village (from the Town Hall's building, Fig. 2/2). The site occupies a surface of about 2 ha and is located on the valley of a creek, with the slope facing North-East. It is worth mentioning, that discoveries of archaeological vestiges were made in the forest too, so it is quite difficult at the moment to appreciate the dimensions of the site. The site was investigated through magnetometric and geographical prospections. It is the only site in the microzone with a single level, which allowed to clearly delimiting the number of complex features. There were discovered and partially researched the traces of 3 dwellings, of two auxiliary potholes and a range of potholes arranged in line which might suggest the existence of a specific type dwelling - long-house (Meyer et al. 2018, 166-171, Meyer et al. 2020, in print). The Poharniceni-Petruha site is located at a distance of about 2.6 km North of Ivancea-sub Padure, in the upper part of a valley with the slope facing North, on the left bank of a creek (Fig. 2/5). Given the multitude of cultural horizons that have been reported within the site, is more difficult to estimate the surface of the site. In the late eighties, the site benefited from little research by which it was clearly delimited including the PL horizon (Postică and Cavruc 1989).

Concluding the above presented, we ascertain, in the microzone of Lower Raut, a cluster of settlements assigned to the PL horizon, which are grouped into nests of two or three sites. The distance between the nests is relatively narrow, about 3.5-4 km, and between the sites it was reported a distance of about 2-3 km. A moment worth taking into account is the fact of mutual visibility between the sites that are in the immediate vicinity (obviously, we refer to the knowledge we have now, being sure that there are enough sites on which we have no information yet).

Archaeoceramological analysis

We reiterate: the aim of laboratory analysis carried out on pottery fragments recovered from the PL site of Orheiul Vechi and the Getic site of Butuceni was to verify the hypothesis that there was a continuity in pottery technology traditions and the hypothesis that there was continuity in raw material use.

In order to verify these hypotheses, i.e. to determine whether we are dealing with continuity or with changes in pottery manufacturing, two factors must be taken into account: know-how (the level of technological knowledge within a given culture or period provides information about continuous or discontinuous transmission of knowledge) and raw material (geological factors – potters working at different ceramic production centres/workshops may have used the same/different clays as well as the same/different non-plastic raw materials to make ceramic bodies). This means that it is necessary to perform both technological and raw material analyses. For the purposes of this study the following methods were used: MGR-analysis, chemical analysis by WD-XRF, thin-section studies and an estimation of physical ceramic properties[1].

The first procedure carried out on all 30 sherds was abridged MGR-analysis. MGR-groups were defined taking into account the thermal behaviour of samples refired at three temperatures (1100°C, 1150°C and 1200°C). Definitive classification was based on thermal behaviour after refiring at 1200°C.

The following types of matrix were identified based on the appearance of samples when refired at 1200°C:

– over-melted matrix type (ovM) = the surface of the sample becomes over-melted and its edges slightly rounded;

– semi-melted matrix type (sMLT) = over-melting of the surface occurs, changes in sample shape are noted (not just rounded edges) but no bloating;

– melted matrix type (MLT) = the sample becomes spherical or almost spherical in shape.

Additionally, nearly all samples also exhibited slight bloating (BL), meaning that they expanded in volume. In some samples this bloating did not affect the entire sample, but only its irregularly arranged small parts[2]. A number of other terms are used to describe characteristics observed after refiring. These include: 'pit', which refers to the fact that the surface of the sample is uneven with visible pitting, and 'few pits' (f-pit), which signifies that only a small number of pits are visible.

Based on the colour of samples after refiring at 1200°C, only one category of matrix can be identified: non-calcareous (NC). Different colours and shades can be distinguished within this category of matrix. This signifies that all analysed samples were made from non-calcareous clays coloured by iron compounds.

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1 For a full description of methods see Appendix.

2 In table 1 irregularly arranged parts are marked with a '\', regular parts with a '/' and small parts are indicated in parentheses.

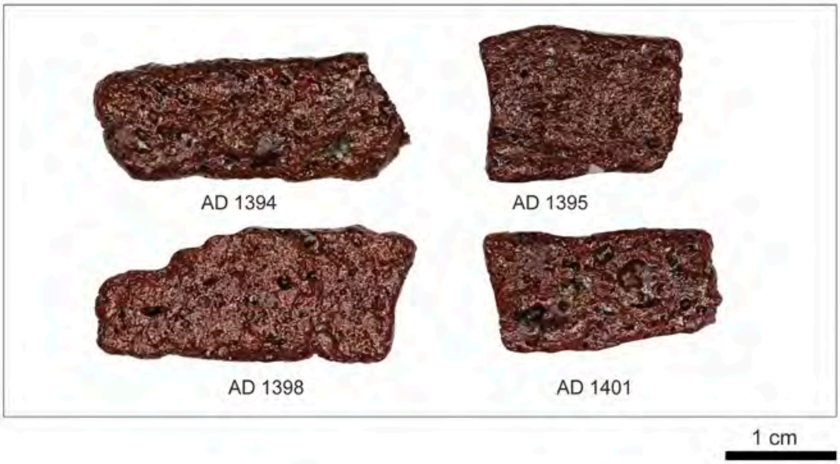

Fig. 7. Butuceni. Samples with ovM matrix type, samples after refiring at 1200ºC. (Graphic preparation: Małgorzata Daszkiewicz/Hanna Baranowska).

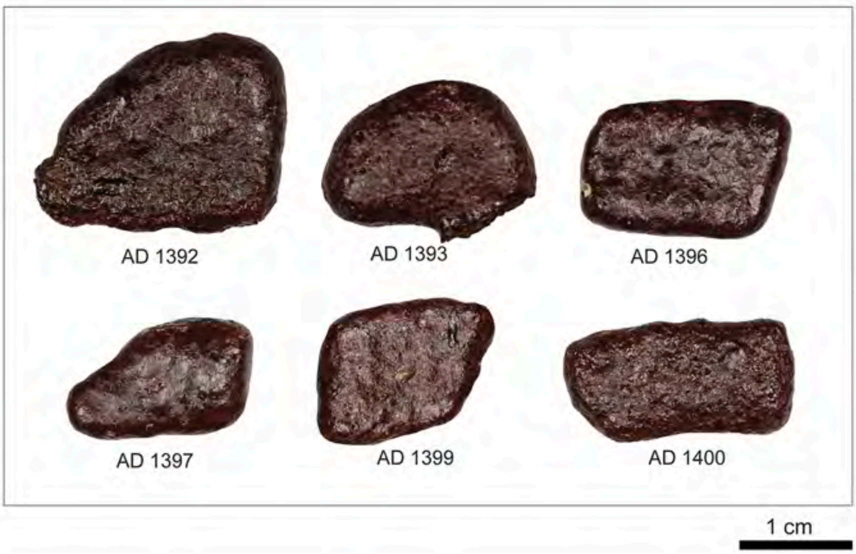

Fig. 8. Butuceni. Samples with sMLT matrix type, samples after refiring at 1200ºC. (Graphic preparation: Małgorzata Daszkiewicz/Hanna Baranowska).

Sherds found in Butuceni can be divided into two main groups based on matrix type: four samples have an ovM matrix type (Fig. 7) and six samples have a sMLT matrix type (Fig. 8). All samples with an ovM matrix type turn the same shade of brownish-red after refiring. They belong to a single MGR-group (BUT-1) in contrast to samples with a sMLT matrix type, each of which

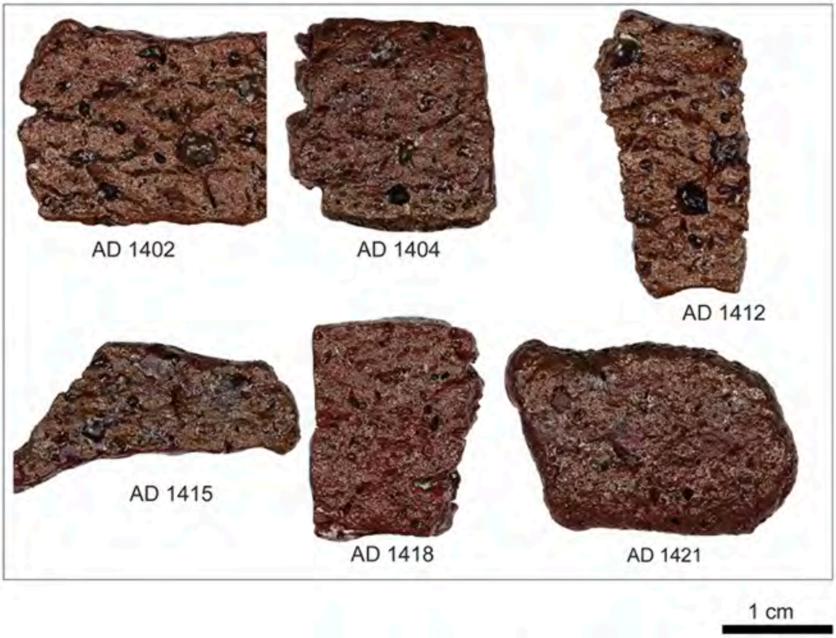

Fig. 9. Orheiul Vechi. Samples with ovM matrix type and one sample (AD1421) with ovM\(sMLT) matrix type, samples after refiring at 1200ºC. (Graphic preparation: Małgorzata Daszkiewicz/ Hanna Baranowska).

represents a different MGR-group[3] (sMLT samples fire to various shades of reddish-brown). Some carbonate aggregates of various grain size fractions are visible in most samples, and some clay lumps[4] are also observed. However, the principal ingredients macroscopically visible in the matrix of each sherd are grog particles. MGR-analysis reveals that this grog comprises crushed sherds made from the same raw material as the ceramic body to which it was added and/or crushed pottery made from different raw materials. In samples AD1394 and AD1401 several grog inclusions exhibit the same thermal behaviour as the dominant type of grog in sample AD1392.

Sherds recovered from Orheiul Vechi can be divided into three main groups based on matrix type: five samples have an ovM matrix type, one sample has an ovM/(sMLT) matrix type (Fig. 9), seven samples have an sMLT matrix type,

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[3] The term 'group' is used even when that group is represented by a solitary sample. Because it is improbable that only a single vessel would have been produced from one ceramic body, it is assumed that the analysed sample represents a group of vessels made from the same material. This is why the term 'group' is used even in those cases where groups are represented solely by a single sample.

[4] It is not always easy to make a distinction between clay lumps (associated with poorly homogenised clay bodies) and grog in sherds made from the same raw material.

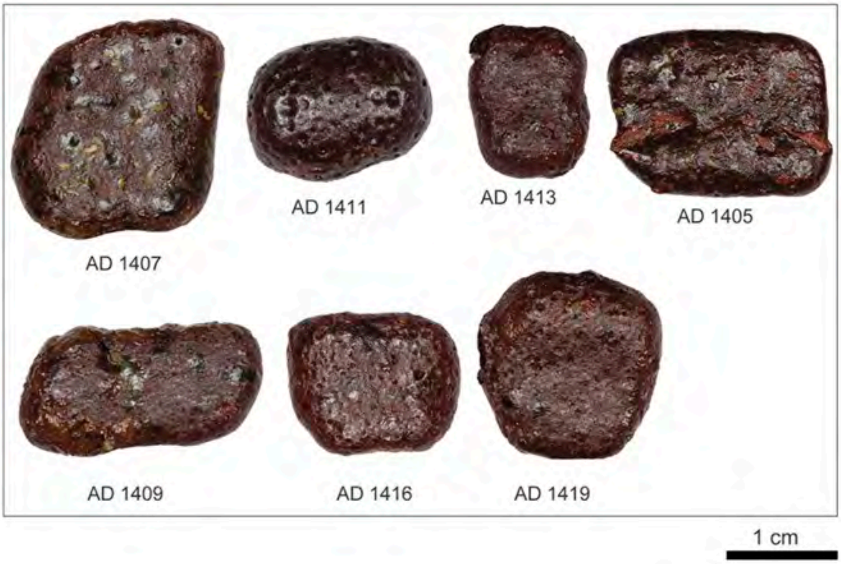

Fig. 10. Orheiul Vechi. Samples with sMLT matrix type, samples after refiring at 1200°C. (Graphic preparation: Małgorzata Daszkiewicz/Hanna Baranowska).

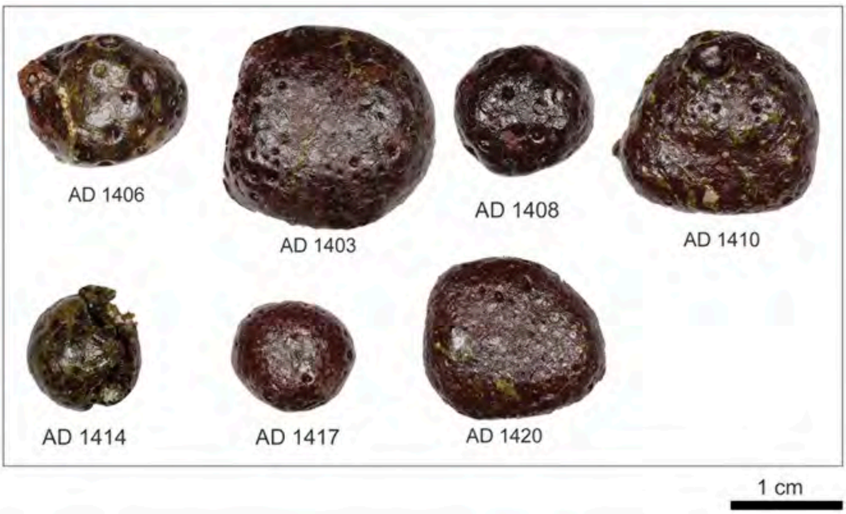

Fig. 11. Orheiul Vechi. Samples with MLT matrix type, samples after refiring at 1200°C. (Graphic preparation: Małgorzata Daszkiewicz/Hanna Baranowska).

two of them have an sMLT matrix type with pits (Fig. 10) and seven samples have an MLT matrix type with varying numbers of pits (Fig. 11). Various MGR-groups can be identified within each group of the same matrix type. Just like the sherds from Butuceni, some carbonate aggregates, some clay lumps and

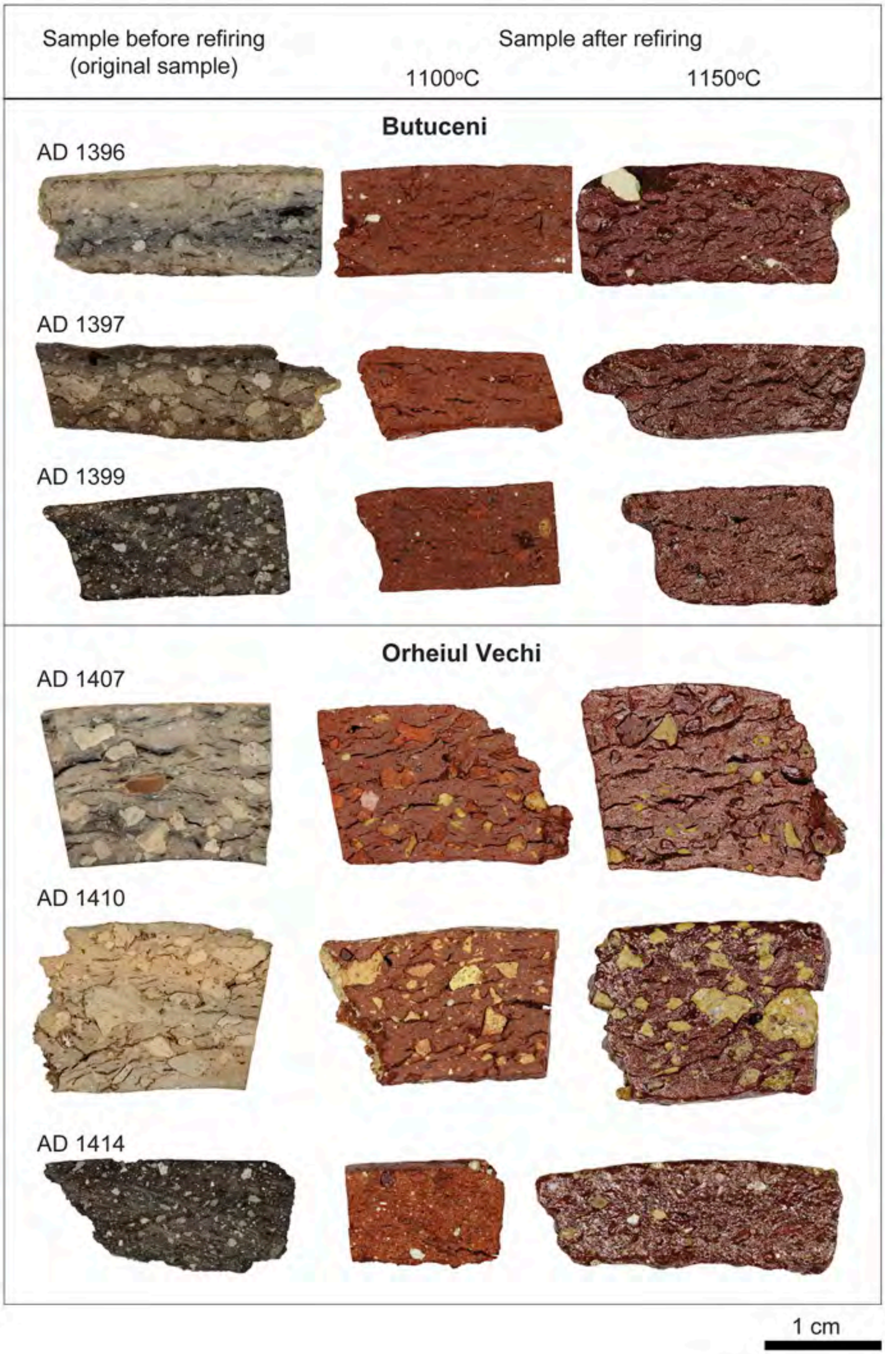

Fig. 12. Example of samples after MGR-analysis. Samples tempered of various sized grog and sample featuring a temper of sand-size carbonates (white grains). (Graphic preparation: Małgorzta Daszkiewicz/Hanna Baranowska).

grog particles of various grain size fractions representing intentional temper are observed in the ceramic fragments found at Orheiul Vechi (Fig. 12). Sample AD1410 is interesting because it features a large number of grog fragments derived from crushed pottery made of calcareous clay. This type of grog was not noted in sherds from Butuceni.

One of the samples with an MLT matrix type (sample no. AD1414) had a lot of very small areas of calcareous matrix, though not enough to warrant the sample being reclassified to the MX (mixed) matrix category or to classify it as being made of an NC cc raw material, hence a non-calcareous clay coloured by iron compounds enriched with carbonates in clay fraction.

Multiple MGR-groups were identified at both sites, but each of these groups was associated with only one of the sites. The exception to this are two MGR-groups to which sherds from both Butuceni and Orheiul Vechi are attributable, namely: MGR-group BUT-5 (samples AD1397 and AD1407) and BUT-6 (samples AD1399 and AD1413). Samples representing the BUT-6 group were made from a ceramic body prepared using the same recipe, but were most probably fired differently. The firing process was assessed solely by macroscopic analysis of original samples – analysis of matrix colour of original samples (on figure 13 and figure 14 are shown the cut-sections of original samples).

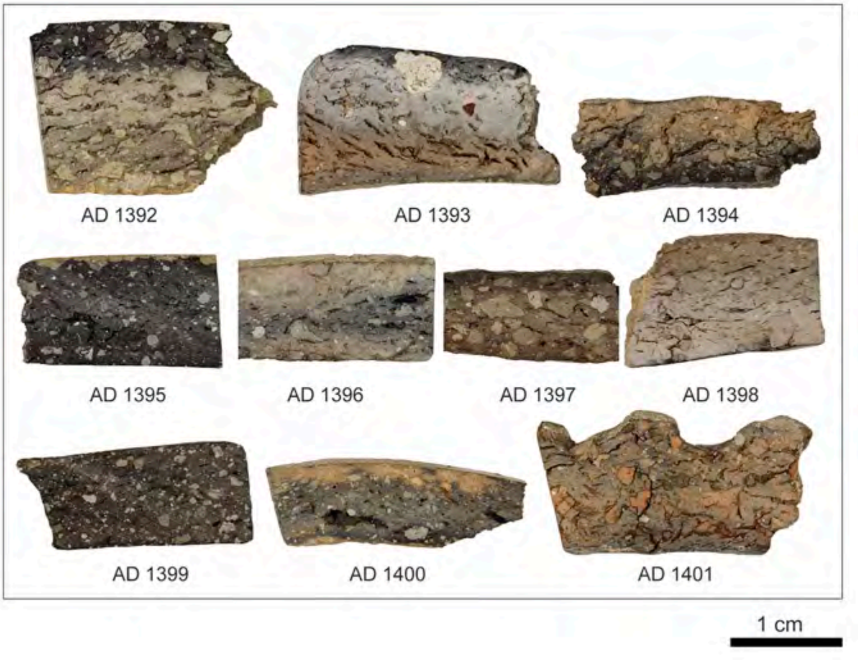

Fig. 13. Butuceni. Samples before refiring (original samples) displayed in order of sample numbers (Graphic preparation: Małgorzata Daszkiewicz/Hanna Baranowska).

Fig. 14. Orheiul Vechi. Samples before refiring (original samples) displayed in order of sample numbers (Graphic preparation: Małgorzata Daszkiewicz/Hanna Baranowska).

The next step involved macroscopic identification of the clastic material. In this instance the field of vision was the surface of four briquettes which were cut out for the purposes of MGR-analysis. Describing temper particles based on optical examination of the four briquettes reduces macroscopic analysis error. Once clastic material classification had been completed, samples were selected for the preparation of thin sections so that these could be examined in order to obtain accurate descriptions of the types of non-plastic inclusions.

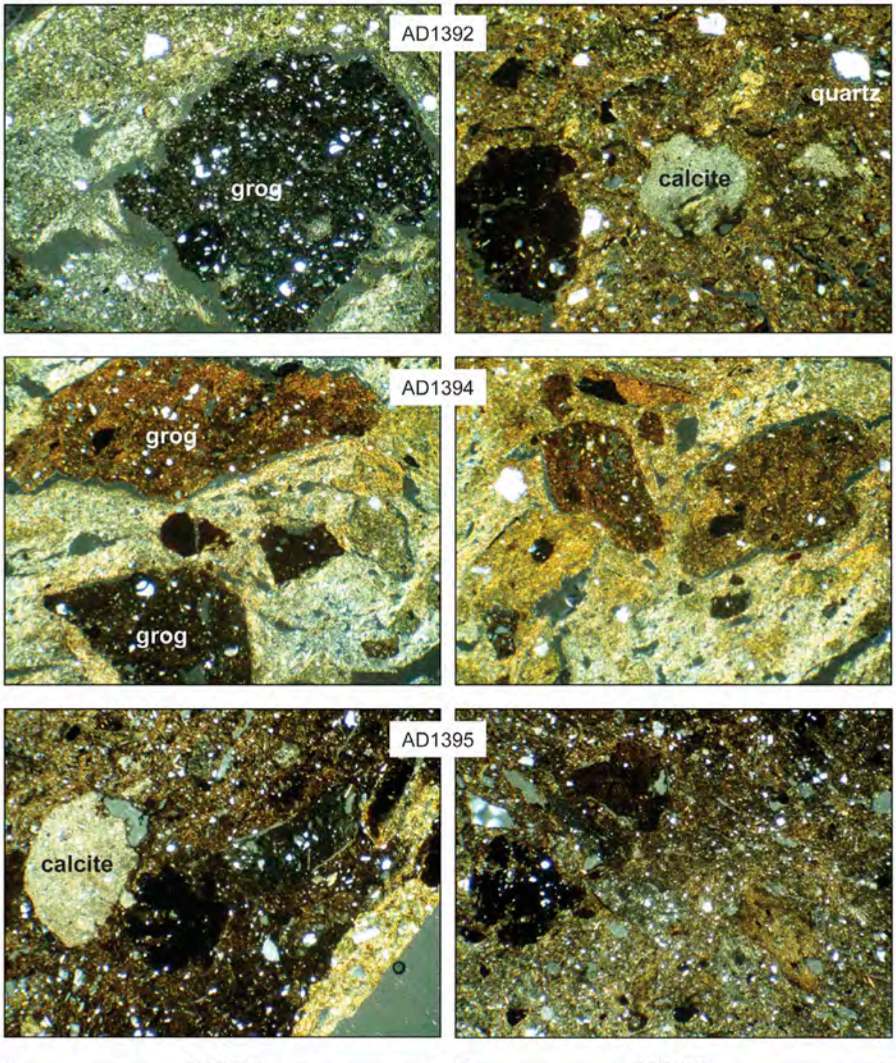

Fig. 15. Butuceni. Thin-sections, microphotos, XPL (Graphic preparation: Małgorzata Daszkiewicz/Hanna Baranowska).

This *step-by-step* strategy makes it possible to reduce the number of analyses performed[5]. Twelve sherds were selected for thin sections: seven of them from the Orheiul Vechi site and five sherds from the Butuceni site. Macrophotographs of typical thin-section images are shown in figures 15 – 18.

[5] This strategy requires far more time for the various analyses, but it significantly reduces their cost.

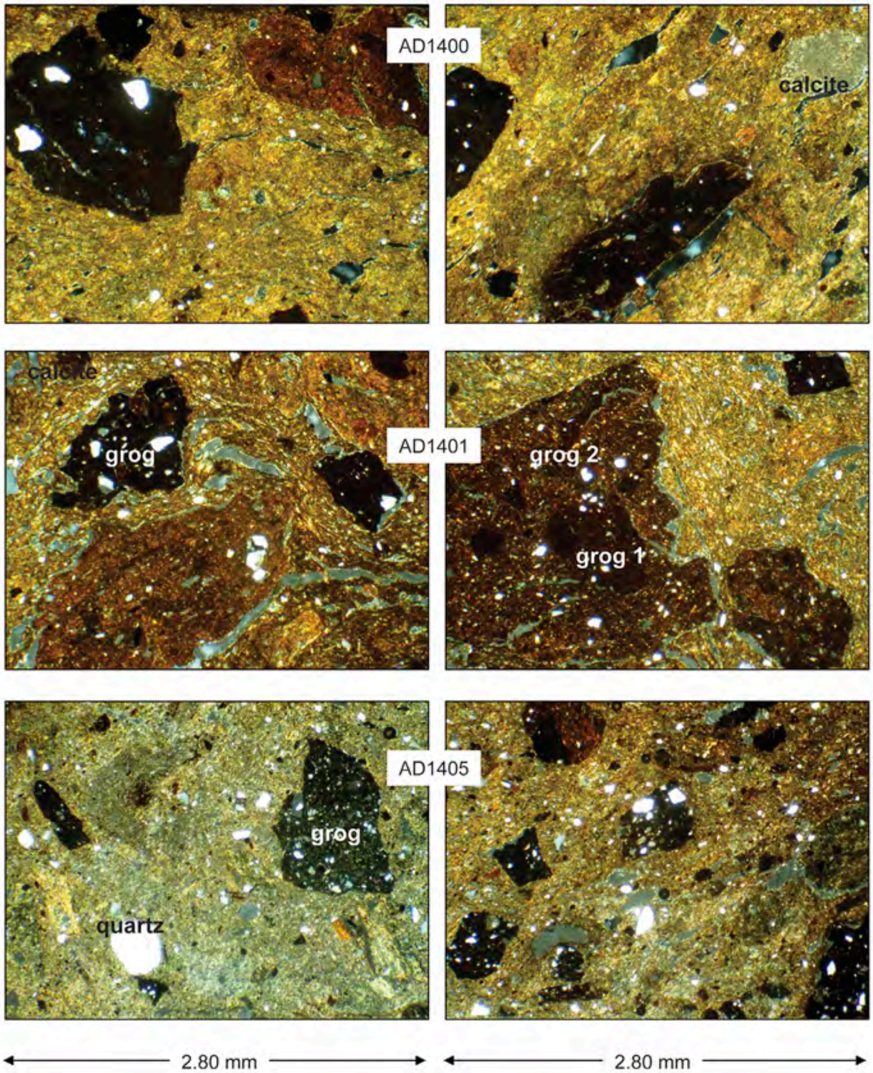

Fig. 16. Butuceni (AD1400 and AD1401) and Orheiul Vechi (AD1405). Thin-sections, microphotos, XPL (Graphic preparation: Małgorzata Daszkiewicz/Hanna Baranowska).

Studies of the thin sections under a polarising microscope reveal a very similar or almost identical petrofabric in terms of the type, number and size of non-plastic particles. Natural temper in all of the samples consists of grains of quartz in fine sand fraction; only single quartz grains are observed in medium sand fraction. Grains of cryptocrystalline carbonates, mostly in coarse sand fraction, are also observed, along with a small number of grains of carbonates in medium sand fraction. Grog was an intentional temper in all 12 sherds. Individual samples differ in the number of grog inclusions and their grain size. Grog

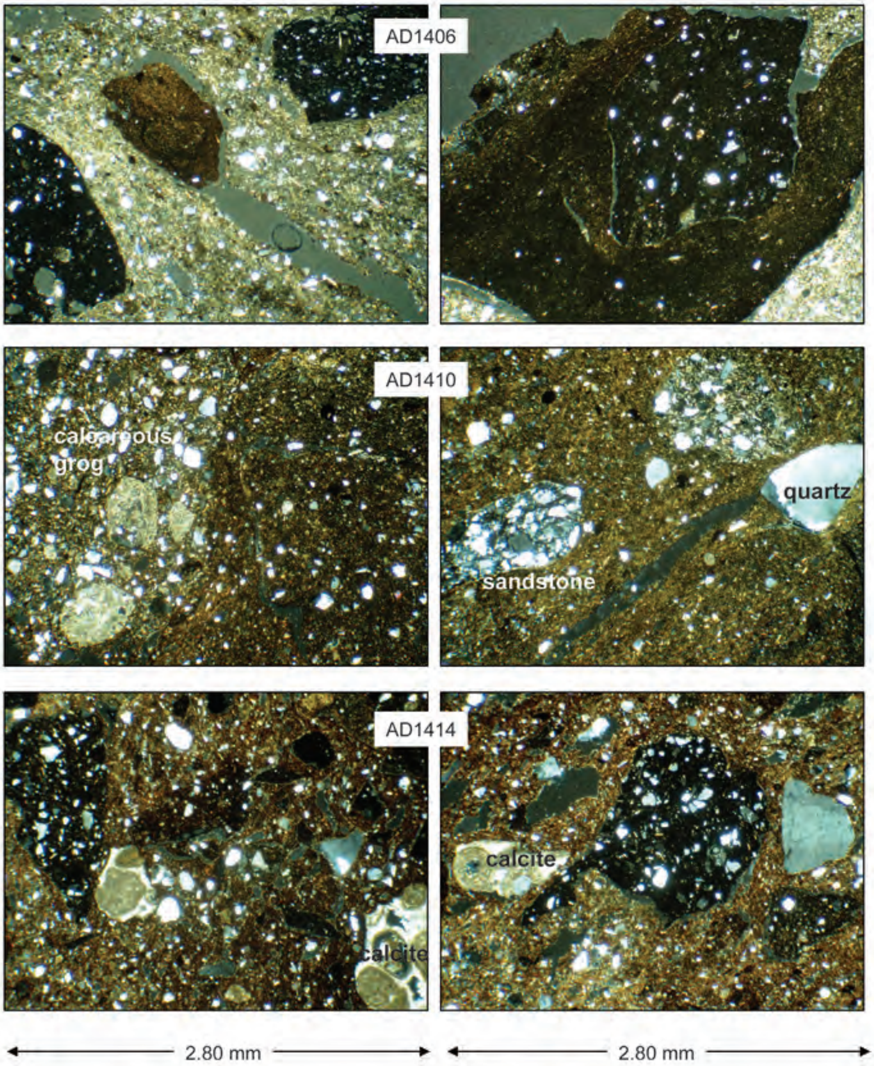

Fig. 17. Orheiul Vechi. Thin-section, microphotos, XPL (Graphic preparation: Małgorzata Daszkiewicz/Hanna Baranowska).

particles of medium sand size are rare; most of the grog is of very coarse sand size, and grog fragments of gravel size (granules[6]) are also observed. These grog particles came from crushed vessels that were originally fired at both higher and lower temperatures than the firing temperature of the sample to which they were intentionally added as a temper.

[6] 2–4 mm, according to geological classification after Uden-Wentworth.

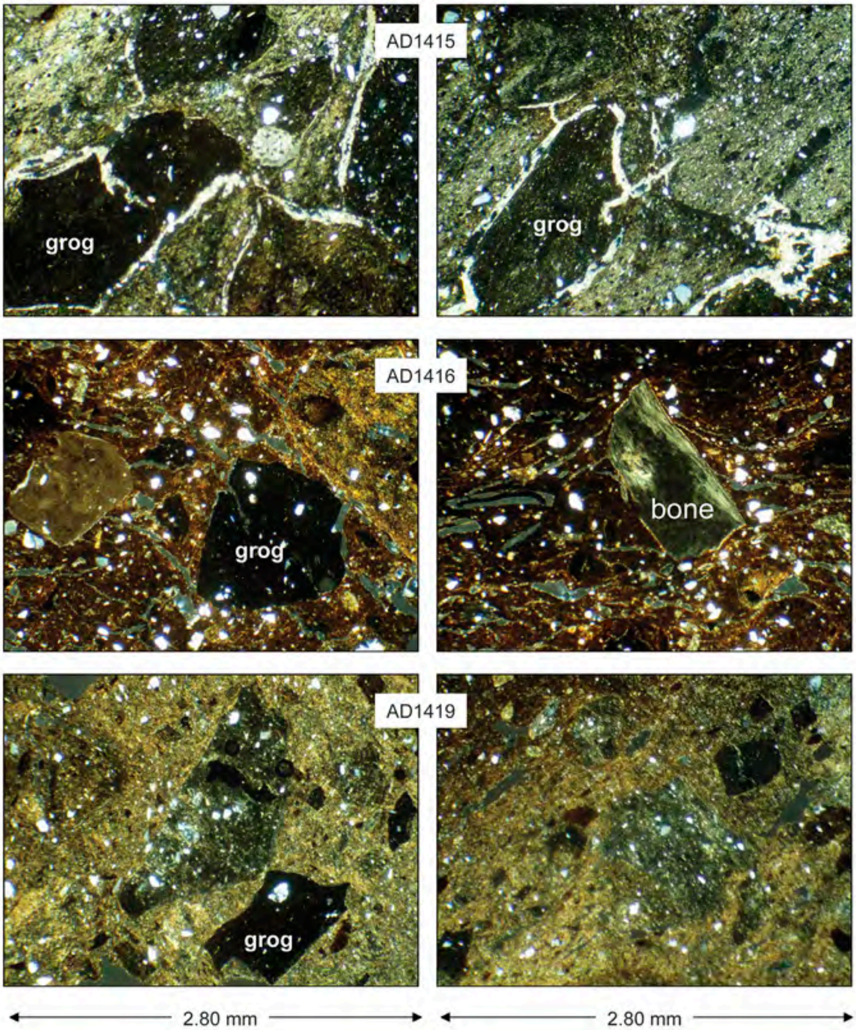

Fig. 18. Orheiul Vechi. Thin-section, microphotos, XPL (Graphic preparation: Małgorzata Daszkiewicz/Hanna Baranowska).

Pottery fragments found in Butuceni, like those found in Orheiul Vechi, have a matrix consisting of a fine clay with some quartz silt. In some sherds there is very little quartz silt (e.g. sample AD1394), and in others (e.g. sample AD1395) it is more abundant (Fig. 15). All 12 analysed samples were fired at low temperatures, therefore the matrix is still anisotropic.

In samples from Butuceni, sand size inclusions of micritic calcite seem to be mostly from recarbonized secondary calcite (AD1392, AD1395); however, a few sparitic calcite crystals are primary. This means the temperature could not have been much above 750°C. A few other inclusions of sand size represent quartz (e.g. AD 1392). The most typical feature of all samples are more-or-less angular inclusions of grog made from a more silty material. The photomicrograph of AD1401 (Fig. 16) shows a larger grog inclusion with the plain surface of an original sherd (grog 2) which had been tempered with grog (grog 1).

In one of the samples from Orheiul Vechi (AD1410) the grog inclusions are made from a sandy calcareous clay (Fig. 17). The difference in clay types between the matrix of the sherd and the matrix of the grog is very clearly evidenced by MGR-analysis (see Fig. 12). Grains of quartz and fine sandstone are also observed in sample AD1410 (Fig. 17). Very typical biogenic calcite inclusions are observed in sample AD1414 (Fig. 17) – biogenic calcite is not observed in samples from Butuceni. A single small piece of crushed bone is observed in sample AD1416 (Fig. 18); this inclusion is certainly not a special temper.

Next, chemical analysis by WD-XRF was performed on all samples. At this point it is important to bear in mind that two sherds made from the same clay (representing the same MGR-group) will only be attributed to the same chemical group if there is no intentionally added temper in one of them. It should also be stressed that MGR-analysis cannot be used in place of chemical analysis in provenance studies. Individual MGR-groups can only be sorted into groups of the same geochemically important parameters on the basis of chemical analysis. On the other hand, the results of MGR-analysis enable the correct interpretation of chemical clusters deriving from multivariate statistics (multivariate cluster analysis is based on the content of elements within a given sample regardless of what phase they occur in[7]).

The content of geochemically important elements (i.e. elements that are significant in determining provenance) indicates that samples from both sites have a very similar chemical composition (Tab. 1) with few exceptions. One of these exceptions is a sample from Orheiul Vechi (sample no. AD1414) which is distinctive because it has much lower levels of titanium (Ti), chrome (Cr) and vanadium (V) than the other samples and a lower potassium (K) and aluminium (Al) content. This sample also has the highest concentration of calcium (Ca) that is not correlated with the highest concentration of strontium (Sr), which is geochemically correlated with calcium – this means that the calcium was of a different origin (sample no. AD1414 also stands out in MGR-analysis and thin-section studies – see above).

[7] Chemical analysis enables the quantity of major and trace elements in the body to be established, although the phases in which individual elements occur cannot be ascertained; giving the major elements as oxides is standard procedure in geochemistry when presenting the results of chemical analysis (CaO content identified by chemical analysis may be attributable to, for example, inclusions of calcite or dolomite or anorthite, or may occur exclusively in clay fraction in the matrix).

Matrix type	Sample No.	SiO_2 per cent by weight	TiO_2	Al_2O_3	Fe_2O_3	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	V ppm	Cr	Ni	Cu	Zn	Rb	Sr	Y	Zr	Nb	Ba	La	Ce	Pb	Th	l.o.i. %
Butuceni																											
ovM	AD1394	63.67	0.796	18.12	7.29	0.053	2.95	3.06	0.25	3.53	0.28	153	115	59	39	120	127	175	30	154	19	626	29	63	22	10	5.49
ovM	AD1395	65.31	0.838	17.51	7.25	0.153	2.52	2.82	0.31	3.15	0.14	143	130	77	37	110	136	206	30	180	19	768	29	62	20	11	5.93
ovM	AD1398	65.13	0.846	17.79	7.05	0.058	2.36	2.52	0.46	3.58	0.21	152	137	68	44	117	147	204	33	171	17	775	42	90	22	12	3.75
ovM	AD1401	63.57	0.782	17.91	7.18	0.043	2.95	3.05	0.32	3.98	0.23	149	115	56	39	123	153	162	29	155	18	528	37	81	21	12	2.25
sMLT/sBL	AD1392	64.02	0.781	16.83	6.87	0.078	2.81	4.60	0.27	3.42	0.32	132	118	63	39	111	120	283	32	175	16	744	34	66	19	10	5.50
sMLT-sBL	AD1393	62.89	0.768	17.37	7.01	0.066	2.81	4.69	0.24	3.83	0.33	154	128	68	26	116	156	206	28	147	15	547	37	66	20	11	1.95
sMLT/sBL	AD1396	61.46	0.744	17.25	6.69	0.057	2.33	7.70	0.24	3.26	0.27	156	129	71	37	109	133	256	26	142	17	846	27	75	21	9	6.63
sMLT/sBL f-pit	AD1397	61.82	0.806	17.76	7.01	0.094	2.96	5.70	0.18	3.43	0.24	152	140	77	49	111	137	205	32	149	16	700	43	72	22	10	7.45
sMLT/sBL	AD1399	63.18	0.792	17.45	7.23	0.067	2.90	4.12	0.29	3.52	0.45	157	130	67	34	117	140	241	32	148	15	1066	40	76	22	10	5.62
sMLT-sBL	AD1400	62.55	0.779	18.23	7.40	0.049	3.26	4.00	0.18	3.35	0.20	165	123	68	43	119	135	198	30	147	17	667	35	74	24	11	5.73
Orheiul Vechi																											
ovM	AD1402	66.32	0.798	17.47	5.92	0.034	2.52	2.47	0.51	3.72	0.24	154	133	51	28	119	155	196	24	166	18	718	32	62	23	11	2.44
ovM	AD1404	66.17	0.791	17.29	5.83	0.035	2.56	2.48	0.52	4.16	0.17	156	132	50	33	115	165	160	26	170	17	424	31	77	19	7	0.93
ovM	AD1412	65.80	0.800	17.82	6.02	0.028	2.59	1.99	0.56	4.02	0.35	160	131	51	29	122	165	164	28	162	17	563	32	82	18	10	1.20
ovM	AD1415	65.53	0.801	17.48	6.03	0.034	2.58	3.03	0.55	3.73	0.22	166	134	49	29	123	168	184	26	170	18	512	24	81	20	7	1.47
ovM	AD1418	69.13	0.780	15.99	6.25	0.098	2.45	1.43	0.58	2.93	0.37	135	114	64	33	107	117	195	31	210	17	840	35	68	19	10	3.97
ovM (sMLT)	AD1421	66.82	0.750	16.36	5.86	0.039	2.35	2.95	0.58	3.98	0.32	143	123	48	30	117	141	225	26	173	15	736	58	63	20	11	4.32
sMLT	AD1405	63.39	0.784	16.18	6.27	0.104	2.61	7.12	0.22	3.10	0.22	143	126	63	52	108	135	215	31	171	18	623	32	68	19	10	7.65
sMLT	AD1409	62.12	0.797	17.92	7.11	0.075	3.07	4.75	0.29	3.50	0.36	156	133	69	36	125	138	208	31	137	18	843	36	60	22	13	6.74
sMLT	AD1416	64.59	0.712	16.32	6.46	0.076	2.62	4.68	0.39	3.82	0.33	137	124	68	38	125	144	200	30	167	15	791	32	70	22	9	6.90
sMLT	AD1419	65.17	0.782	15.95	6.26	0.113	2.50	5.53	0.37	3.08	0.25	121	111	59	37	102	110	206	34	208	17	800	44	73	22	9	7.85
sMLT pit	AD1411	60.31	0.760	16.77	6.67	0.085	3.06	8.50	0.40	3.15	0.29	150	123	64	43	120	133	331	30	145	15	741	37	69	21	12	9.54
sMLT/sBL	AD1413	63.20	0.794	17.50	7.36	0.064	2.86	4.08	0.28	3.46	0.41	152	128	67	35	115	139	222	32	143	17	976	37	62	20	8	6.01
sMLT/sBL f-pit	AD1407	62.35	0.817	17.24	6.76	0.105	2.92	5.84	0.35	3.25	0.38	149	124	65	34	115	136	250	34	150	17	821	37	81	22	9	5.39
MLT f-pit	AD1414	64.76	0.680	13.67	5.39	0.092	2.35	9.81	0.37	2.56	0.31	112	92	51	35	91	102	257	28	181	12	706	45	69	16	5	10.77
MLT f-pit	AD1417	62.40	0.748	16.17	6.46	0.085	3.00	7.26	0.27	3.29	0.32	146	127	62	39	115	144	242	29	157	16	1006	30	64	18	8	9.29
MLT f-pit	AD1420	63.62	0.752	15.74	5.75	0.075	2.67	7.23	0.37	3.46	0.34	142	121	57	40	118	134	287	31	167	16	724	12	83	18	10	8.45
MLT pit	AD1403	59.47	0.766	16.78	7.26	0.122	3.28	8.18	0.35	3.39	0.40	158	127	64	43	122	152	287	32	139	16	594	47	83	22	7	2.15
MLT pit	AD1406	64.08	0.741	14.84	5.16	0.116	2.87	8.31	0.45	3.00	0.42	131	108	51	32	95	126	295	31	211	16	639	36	74	22	5	7.98
MLT pit	AD1408	64.63	0.737	14.96	5.84	0.094	2.89	6.86	0.64	3.05	0.29	128	112	63	46	108	121	225	29	173	16	603	38	67	17	9	6.50
MLT pit	AD1410	61.91	0.757	15.81	6.16	0.111	2.65	8.58	0.37	3.35	0.29	139	120	61	34	110	133	291	30	168	15	746	39	70	19	7	6.11

Tab. 1. Results of chemical analysis by WD-XRF. Analysis on ignited and melted samples. Major elements normalised to 100%. Preparation of samples by M. Daszkiewicz in ARCHEA, calibration of Arbeitsgruppe Archaeometrie by G. Schneider and A. Schleicher in GFZ Potsdam. ovM = over-meletd matrix type; sMLT = semi-melted matrix type; MLT = melted matrix type.

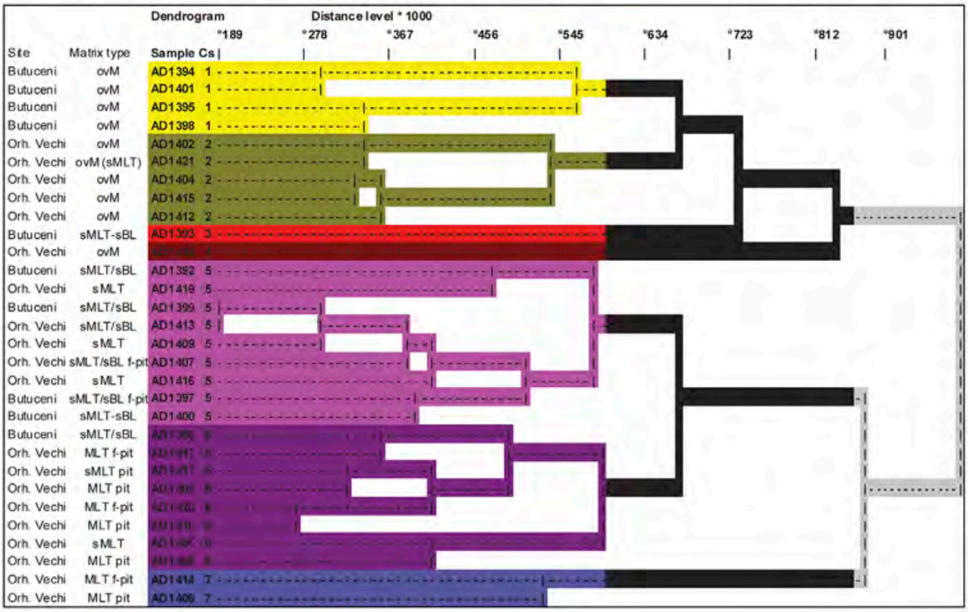

Fig. 19. Dendrogram presenting the results of multivariate cluster analysis. Analysis using Euclidean distance and average linkage aggregative clustering of a distance matrix, data lodged, elements used: Si, Ti, Al, Fe, Mn, Mg, Ca, Na, K, V, Cr, Ni, Cu; Zn, Rb, Sr, Y, Zr, Nb and Ba (Graphic preparation: Małgorzata Daszkiewicz).

Sample AD1406 also has a fairly low concentration of Cr, though not as low as sample AD1414. Cr levels in the remaining 28 sherds range from 112 to 140 ppm, with nickel (Ni) content ranging from 51 to 77 ppm. Magnesium (Mg) content calculated as MgO ranges from 2.35 to 3.28%. Titanium calculated as TiO_2 ranges from 0.74 to 0.85%. The greatest differences were noted in the concentrations of Ca and Sr. These samples (four from Butuceni and six from Orheiul Vechi) are characterised by a calcium content of 1.5–3.1 wt.% (calcium calculated as CaO). All of these samples have an ovM matrix type. The sample with the lowest concentration of CaO (AD1418) also has a low K content and the highest silica content among all of the analysed samples (Si concentration calculated as SiO2 amounts to 69.1 wt.%) as well as an exceptionally high ratio of Sr/Ca. The highest concentrations of calcium are noted in samples with an MLT matrix type, in which CaO content ranges from 6.9 to 9.8 wt.%.

Figure 19 shows the results of multivariate cluster analysis presented in the form of a dendrogram[8]. This dendrogram shows a very clear correlation be-

[8] Analysis using Euclidean distance and average linkage of clustering of a distance, data logged, elements used: Si, Ti, Al, Fe, Mn, Mg, Ca, Na, K, V, Cr, Ni, Cu; Zn, Rb, Sr, Y, Zr, Nb and Ba.

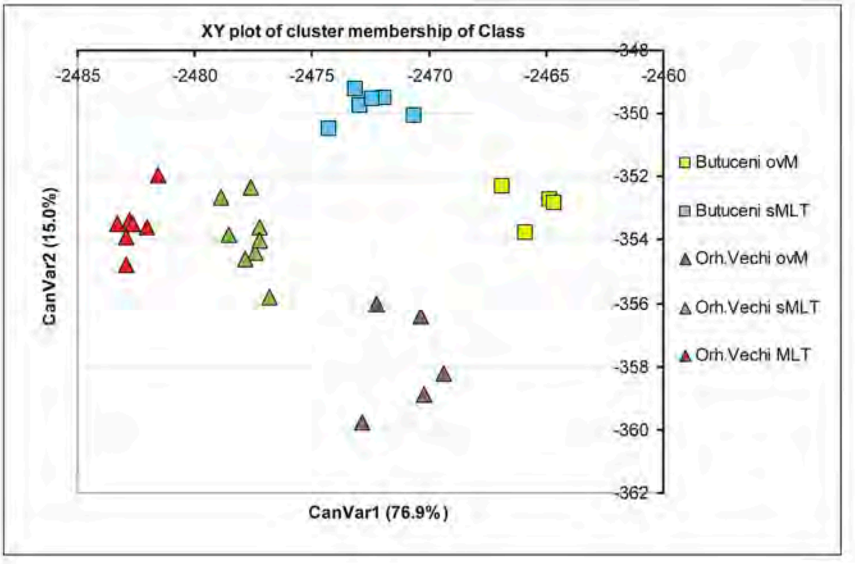

Fig. 20. Results of discriminant analysis, elements used: Si, Ti, Al, Fe, Mn, Mg, Ca, Na, K, V, Cr, Ni, Zn, Rb, Sr, Y, Cu, Zr, Nb and Ba (Graphic preparation: Małgorzata Daszkiewicz).

tween the phase composition of the matrix and the chemical composition of the sherds. One large cluster encompasses samples with an ovM matrix type. Another cluster comprises samples which have sMLT and MLT matrix types, with all but two sMLT-matrix-type samples forming a distinct subcluster. Four samples that are distinctive in terms of both their chemical composition and thermal behaviour as well as their non-plastic particles form separate clusters. The samples in question are: AD1393 (only one grog inclusion is observed in this sample), AD1418 (no carbonate particles are observed), AD1406 (paler matrix after refiring at 1200°C than all other MLT samples), AD1414 (sample with biogenic calcite). It is interesting that within cluster 1 (ovM samples), samples from Butuceni and Orheiul Vechi are very clearly separated from one another (fig. x, cluster 1a and 1b). Samples with an sMLT matrix type are not separated. Two samples, one from Butuceni (AD1399) and the other from Orheiul Vechi (AD1413), share the same chemical composition. Given that these samples belong to the same MGR-group and were made using the same recipe, there is no doubt that they must have been made at the same workshop and as part of the same batch. The same clustering pattern also emerges when taking into consideration discriminant analysis (Fig. 20) demonstrating the good discrimination of matrix type/site groups.

The physical ceramic properties of all samples was also assessed. This means that an estimation was made of their open porosity, water absorption

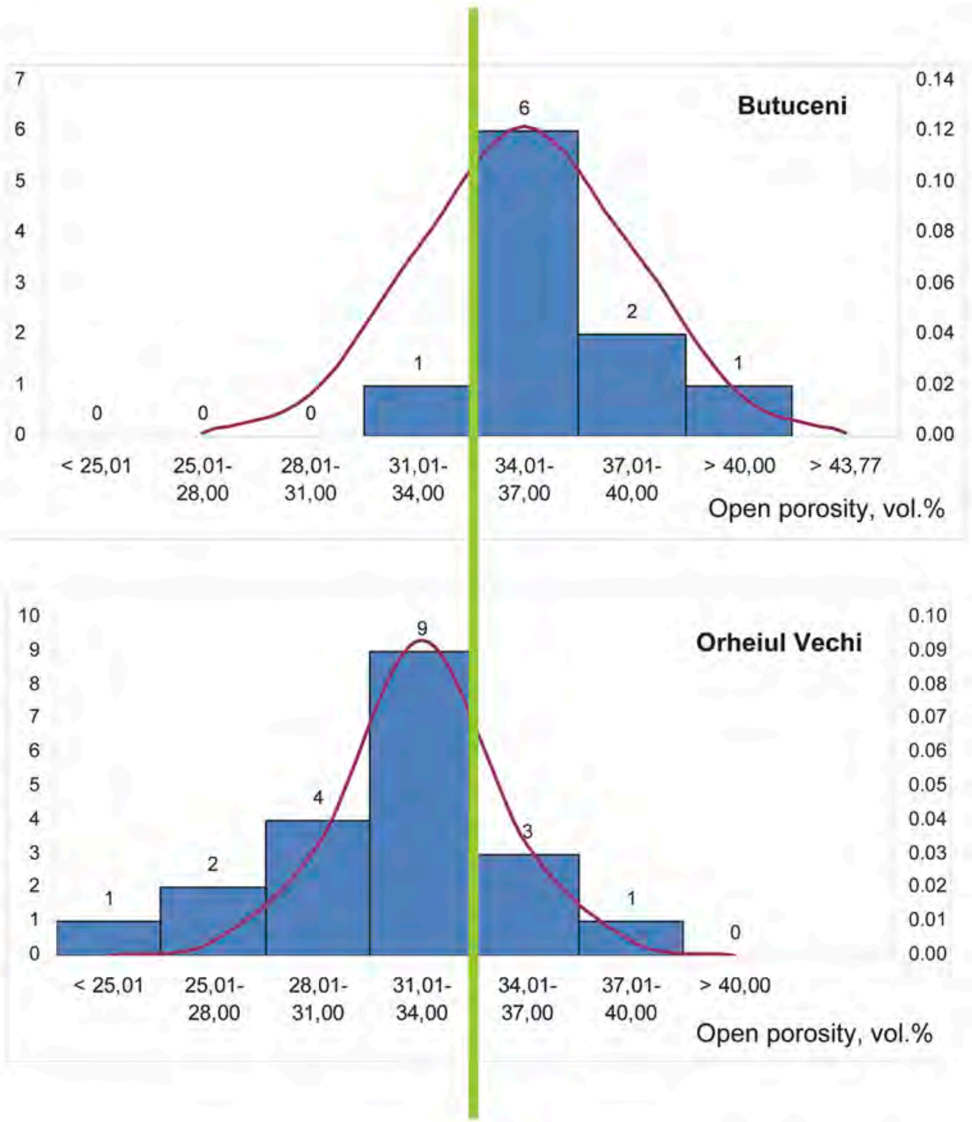

Fig. 21. Histograms showing distribution of samples in individual value ranges together with normal distribution curves for open porosity values (Graphic preparation: Małgorzata Daszkiewicz/Hanna Baranowska).

and apparent density. Figure 21 shows histograms together with normal distribution curves for open porosity values. The open porosity values for pottery from Butuceni is distinctly different from open porosity values for pottery from Orheiul Vechi. The open porosity values of pottery from Butuceni falls within a range of 31.4–43.8%, in contrast to that of pottery from Orheiul Vechi, the

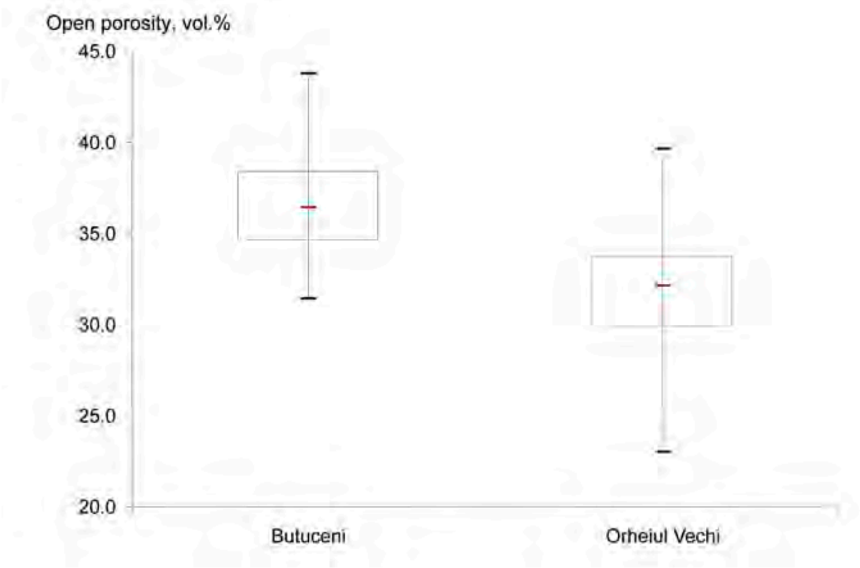

Fig. 22. Box and whisker plots for open porosity values for samples divided according sites (Butuceni and Orheiul Vechi). The boxes indicate the interquartile range (i.e. the compositional range of the central 50% of samples) and the whiskers indicate the full range (Graphic preparation: Małgorzata Daszkiewicz/Hanna Baranowska).

open porosity values of which fall within a range of 23.039.6.8%. The median values are 36.4 vol.% and 32.1 vol.% respectively. Box and whisker plots for open porosity values (Fig. 22) indicate that there is no overlap of the interquartile range (i.e. the compositional range of the central 50% of samples), in fact it is quite the opposite: open porosity values of individual quartiles representing pottery from Orheiul Vechi are distinctly lower than the corresponding values for pottery from Butuceni.

Conclusions

The results of archaeometric analysis of pottery from the PL site of Orheiul Vechi and the Getic site of Butuceni did not substantiate the hypothesis that there had been a continuity in pottery technology traditions. There is no doubt that technology (the particular aspect that was analysed) is attributable to culture. Given the differences observed in the physical ceramic property values, a broader range of analyses is required that will enable us to reconstruct the ceramic technology: analyses that will allow for the adjustment of firing temperature and firing atmosphere and studies examining evidence of shaping and forming techniques (KH analysis, APTMGT or RTI observation of surface phenomena). It would also be advisable to carry out analyses of functional properties. A suite of analyses of this sort would make it possible to determine precisely what differences there were in know-how between potters at the PL site of Orheiul Vechi and the Getic site of Butuceni.

The issue of technology is particularly interesting in the case of two samples, one from Butuceni (AD1399) and the other from Orheiul Vechi (AD1413). These samples came from vessels that were undoubtedly made at the same pottery workshop using a ceramic body prepared according to the same recipe, but were most probably subject to different firing and possibly de-airing processes. Do these two vessels represent a workshop that was operational during the transition period? Does the firing technology represented by vessels found at Butuceni correspond to Getic culture know-how and that represented by vessels found at Orheiul Vechi correspond to PL culture know-how?

The results of archaeometric analysis of pottery from the PL settlement of Orheiul Vechi and the Getic fortification of Butuceni did, conversely, confirm the hypothesis that there was a continuity in raw material use. At both sites and in both phases there is a marked emphasis on local production of ceramics using locally sourced raw materials. This situation was probably dictated by economic factors: transporting ceramic raw materials from further afield is an unnecessary effort if appropriate raw materials are available in the immediate vicinity.

The analyses performed show how vital technological analyses are in the study of ancient pottery. If only chemical composition and/or thin-sections are analysed (which is the most common practice) and a report is then written up based on even the precise findings of a technique such as WD-XRF and on sophisticated statistical methods, there is a chance that the resultant cultural and historical conclusions may be erroneous. Without technological analyses, the conclusions drawn solely from the results of chemical analysis/thin-section studies would be that from an archaeometric point of view, there is nothing to suggest a lack of continuity in ceramic production traditions between the Getic site and the PL site.

In summary, the similarities in production between pottery from the Getic site and the PL site are clearly reflected in the raw materials used, both in terms of plastic ingredients and intentional temper. However, the results of preliminary technological analyses suggest that there is a lack of continuity in pottery technology traditions. This discontinuity in technology can be interpreted as an interruption in the transmission of knowledge between individuals. These preliminary technological analyses suggest a higher level of know-how among potters of the PL culture.

Appendix

Description of analytical procedures

MGR-analysis

Four thin slices were cut from each sample in a plane at right angles to the vessel's main axis. One of these sections was left as an indicator of the sample's original appearance, whilst the remaining three were refired, each one at a different temperature, in a Carbolite electric laboratory resistance furnace using the standard procedure. Firing was carried out at the following temperatures: 1100, 1150 and 1200˚C in air, static (this means without air flow), at a heating rate of 200˚C/h and a soaking time of 1h at the peak temperature, and cooled at a cooling rate of 5°C/min to 500ºC, followed by cooling with the kiln for 1 hour. They were subsequently removed from the kiln and left to continue cooling until they reached room temperature. The fragments were then glued on to paper and a photograph was taken with a macro lens for each slice.

Chemical analysis

In this instance, chemical analysis by WD-XRF (Wavelength-dispersive X-ray fluorescence) was used to determine the content of major elements, including phosphorus and a rough estimation of sulphur and chlorine. Total iron was calculated as Fe_2O_3. Samples were prepared by pulverising fragments weighing *c*. 2g (sample size was determined by the number and size of the non-plastic components), having first removed their surfaces and cleaned the remaining fragments with distilled water in an ultrasonic device. The resulting powders were ignited at 900˚C (heating rate 200˚C/h, soaking time 1h), melted with a lithium-borate mixture (Merck Spectromelt A12) and cast into small discs for measurement. This data is, therefore, valid for ignited samples but, with the ignition losses given, may be recalculated to a dry basis. For easier comparison the major elements are normalised to a constant sum of 100%. Major elements are calculated as oxides.

The long-term precision (coefficient of variation) for major elements is better than 2% (6% for Na). WD-XRF was used to determine levels of the trace elements V, Cr, Ni, Zn, Rb, Sr, Y, Zr, and Ba with long-term precision (measurement and preparation) ranging up to 3%; for Nb, Cu and Ce long-term precision was as high as 6% (rising to 1520% for trace elements at very low concentrations). Accuracy was tested by analysing over fifty certified international standard reference samples (CRMs) and by multiple exchange of samples with other laboratories. For major elements in CRMs the maximum deviations are predominantly below 5%, and for sodium and trace elements they are below 10% (except for low concentrations of Cu, Nb, Ba, La, Ce, Pb and Th).

Samples were prepared for analysis by M. Daszkiewicz at ARCHEA, and measurements were performed using the calibration by G. Schneider and a PANalytical AXIOS XRF-spectrometer (courtesy of Anja Schleicher, Helmholtz-Zentrum Potsdam, Deutsches GeoForschungsZentrum GFZ, Sektion 4.2, Anorganische und Isotopengeochemie).

Thin sections

A laboratory saw with a diamond-tipped blade was used to remove thin slices perpendicular to the wall of the sherd and to the rim of the vessel. Each piece was impregnated multiple times with epoxy resin, ground and polished to a thickness of 0.0300.025 mm, after which it was mounted on a glass slide and covered with a thin cover glass. These thin sections were examined under an Olympus polarising microscope using crossed polarizers (XPL) and plane polarizers (PPL). A photographic record (consisting of a series of microphotographs taken at magnifications of 25×, 100× and 400×) was compiled for each thin section.

Physical ceramic properties

Physical ceramic properties (apparent density, open porosity, water absorption) were estimated by hydrostatic weighing; this was carried out on original pottery fragments.

Prior to weighing, all of the samples were boiled in distilled water for two hours in order to fully saturate their open pores with water. Subsequently, the samples were cooled to room temperature and then weighed twice: during the first weighing the samples were immersed in water, and during the second the wet samples were weighed in air. Each sample was then dried to a constant mass in a dryer at 105°C and cooled to room temperature in a desiccator, before being weighed for a third time in air. This process yielded three values: m_s – mass of dry sample; m_w – mass of wet sample weighed in air; m_{ww} – mass of sample weighed in water (with pores saturated by boiling in water). Physical ceramic properties were only calculated after all of these procedures had been completed.

Bibliography

Arnăut, Tudor 1977. *Vestigii ale sec. VII-III a Chr. în spaţiul de la răsărit de Carpaţi*. Chişinău: Universitatea de Stat.

Conea, Ana, Irina Vintilă and Andrei Canarache 1977. *Dicţionar de ştiinţa solului*. Bucureşti: Editura Ştiinţifică şi Enciclopedică.

Daszkiewicz, Małgorzata 2014. "Ancient pottery in the laboratory – principles of archaeological investigations of provenance and technology." *Novensia* 25: 177-197.

Daszkiewicz, Małgorzata and Lara Maritan 2017. "Experimental Firing and Re-firing." Chapter 27. In *The Oxford Handbook of Archaeological Ceramic Analysis,* edited by Alice Hunt, 487-508. Oxford: Oxford University Press.

Daszkiewicz Malgorzata, Michael Meyer, Octavian Munteanu and Vasile Iarmulschi 2017. "Pottery found at the Horodca Mică and Ulmu Iron Age settlements – results of archaeoceramological analysis." In *Pre-Roman and Roman Iron Age in Central and Southeastern European Barbaricum,* edited by Octavian Munteanu and Vasile Iarmulschi. *Plural: History. Culture. Society,* seria archaeologica I, vol. 5, 2: 32-74.

Daszkiewicz, Malgorzata, Gerwulf Schneider and Ewa Bobryk 2012. „Wozu brauchen wir kombinierte Methoden für Keramikanalysen?" In *Archäometrie und Denkmalpflege: Jahrestagung an der Eberhard Karls Universität Tübingen,* edited by Frank Schlütter, Susanne Greiff and Matthias Prange. Metalla Sonderheft 5, 160-162. Bochum: Deutsches Bergbau-Museum.

Igor A. Krupenikov and Boris P. Podymov 1987. *Klassifikacija I sistematicheskij spisok pochv Moldavii*. Kishinev : Shtiinca.

Mateevici, Natalia 1999. „Contribuții la cercetarea și studierea materialului ceramic grecesc de la cetatea getică de la Butuceni." In *Studia în honorem I. Niculiță,* edited by Tudor Arnăut, Aurel Zanoci and Sergiu Matveev, 177-195. Chișinău: Cartdidact.

Mateevici, Natalia 2007. *Amforele grecești în mediul barbar din nord-vestul Pontului Euxin în sec. VI - în-ceputul sec. II a. Chr.* Chișinău: Bons Offices.

Matveev, Sergiu 2004. „Reconstrucția sistemului de fortificații a cetății Potârca (jud. Orhei). Studiu de caz." In *Studii de istorie veche şi medievală: Omagiu Profesorului Gheorghe Postică,* edited by Tudor Arnăut, Octavian Munteanu and Sergiu Mustață, 115-120. Chişinău: Pontos.

Meyer, Michael, Octavian Munteanu, Vasile Iarmulschi, Bjorn Rauchfuß and Franca Höppner 2016. "The Poienesti-Lucaseuca site from Branesti – *The West Side,* Orhei district, Republic of Moldova (researches of the period 2014 – 2015)". In *Culturi, Procese și Contexte în Arheologie. Volum omagial Oleg Levițki la 60 de ani,* edited by Livia Sîrbu, Nicolae Telnov, Larisa Ciobanu, Ghenadie Sîrbu and Maia Kașuba, 310-330. Chişinău: Garamont-Studio.

Meyer, Michael, Octavian Munteanu, Vasile Iarmulschi and Torben Schatte 2018. „Prospecțiuni geomagnetice și sondaje realizate în așezarea de tip Poienești-Lucașeuca de la Ivancea-sub Pădure." In *Cercetări interdisciplinare la siturile din epoca fierului în spațiul tiso-nistrean. Materialele colloquium-ului de* *vară de la Saharna* (Saharna, 13-16 iulie 2017), edited by Aurel Zanoci, Mihail Băţ, S.-C. Ailincăi and Alexandra Târlea, 145-179. Cluj-Napoca: Mega.

Meyer, Michael, Octavian Munteanu, Vasile Iarmulschi, Bjorn Rauchfuß and Torben Schatte 2020, „Reluarea cercetării siturilor Poienești-Lucașeuca în spațiul Pruto-nistrean: campaniile de la Brănești și Ivancea în anii 2015-2018." Iași, in print.

Munteanu, Octavian, Vasile Iarmulschi and Sergiu Popovici 2014. „Cercetările arheologice de la Butuceni în anul 2013. Preliminarii." *Arheologia Preventivă în Republica Moldova,* Vol. I-nr.1-2: 55-67.

Munteanu, Octavian, Sergiu Moraru and Maria Vetrilă 2015. „Cercetările arheologice din anul 2014 în fortificația Butuceni, raionul Orhei". In *Arheologia preventivă în Republica Moldova*, vol. II: 33-42.

Munteanu, Octavian 2017. „Butuceni: general and particular features of the defense system from the west side of promontory." In *Iron Age fortifications on the Tisa-Dniester space, Proceeding of Saharna Summer Colloquim, July 14th-17th, 2016*, edited by Aurel Zanoci, Valeriu Sîrbu and Mihail Băţ, 65-113. Chişinău-Brăila: Istros.

Munteanu, Octavian 2016. „Noi descoperiri defensive în partea de vest a promontoriului Butuceni (cercetările din anul 2015)." *Tyragetia S.N.*, vol. 1, X (XXV): 237-252.

Munteanu, Octavian 2015. "Landscape and Getae Populations in the upper course of the Botna River." In *Fortified sites from the 1st millennium BC. Materials of the Moldovan-Romanian-German Colloquim, July 24th-26th 2014*, edited by Aurel Zanoci, Peter Ettel and Mihail Băţ, 63-80. Chisinau: Bons Offices.

Munteanu, Octavian and Vasile Iarmulschi 2019. „Regarding the dwellings discovered in Poieneşti-lucaşeuca culture settlement." In *Archaeological structures at the Iron Age settlelements in the Tisza-Dniestr region. Proceedindg of Saharna Summer Colloqium July 12th-15th 2018*, edited by Aurel Zanoci, Mihail Băţ, A. Țârlea and Sorin-Cristian Ailincăi, 139-156. Tulcea-Chisinau: Mega Publishing House.

Munteanu, Octavian and Vasile Iarmulschi 2017. **„**Pottery from the Poieneşti-Lukaševka Culture Settlement of Orheiul Vechi, Republic of Moldova." In *Settlements Pottery on the pre-Roman Iron Age in Central European Barbaricum – new research perspectives,* edited by Michałowski, Andrzej, Milena Teska, Przemysław Niedzielski and Marek Żółkiewski, 67-96. Poznań: Biblioteka Telgte Wydawnictwo.

Musteață, Sergiu 2003. *Raport ştiinţific privind rezultatele investigaţiilor arheologice din anul 2002 în cadrul monumentului Maşcauţi-Cetate*, Chişinău: Arhiva MNAIM.

Musteață, Sergiu 2002. *Raport ştiinţific privind rezultatele investigaţiilor arheologice din anul 2001 în cadrul monumentului Maşcauţi-Cetate,* Chişinău: Arhiva MNAIM.

Musteață, Sergiu 2004. *Raport ştiinţific privind rezultatele investigaţiilor arheologice din anul 2003 în cadrul monumentului Maşcauţi-Cetate,* Chişinău: Arhiva MNAIM.

Musteață, Sergiu 2006. *Raport ştiinţific privind rezultatele investigaţiilor arheologice din anul 2005 în cadrul monumentului Măşcăuţi-Cetate,* Chişinău: Arhiva MNAIM.

Nikulicje, Ivan T. 1984. Otchet o rezul'tatah polevyh arheologicheskih issledovanij v zone muzejnogo kompleksa „Staryj Orhej" v 1983 g., Kishinjov: Arhiva MNAIM.

Nikulicje, Ivan T. 1986. Otchet o rezul'tatah arheologicheskih issledovanij v muzejnom komplekse «Staryj Orhej» i na prilegajushhih territorijah v 1985 g. Kishinjov: Arhiva MNAIM.

Nikulicje, Ivan 1987. *Severnye frakijcy VI-I vekov do nashej jery*. Kishinjov: Shtiinca.

Niculiță, Ion T. 1996. „Habitatul traco-getic de la Butuceni". *Thraco-Dacica* XVII/1-2: 139-167.

Niculiță, Ion 1999. „Cercetarea arheologică a cetății traco-getice Trebujeni-Potărca din preajma Orheiului Vechi în anii 1996-199." In *Orheiul Vechi. Buletin istorico-arheologic,* 33-35. Chişinău: Ruxanda.

Niculiță, Ion and Tudor Arnăut 1996. *Raport preliminar al cercetărilor arheologice din cadrul aşezării şi cetăţii Măşcăuţi din anul 1995*. Chişinău: Arhiva MNAIM.

Niculiță, Ion, Sergiu Matveev and Andrei Nicic 2019. *Cercetările sitului arheologic Potârca din Rezervația Cultural-Naturală Orheiul Vechi*. Chișinău: Cartdidact.

Niculiță, Ion, Sergiu Matveev and Eduard Potângă 1999. „Cetatea traco-getică Potârca". In *Cercetări arheologice în aria nord-tracă*, III, 279-343. Bucureşti: Institutul Român de Thracologie.

Niculiță, Ion, Sergiu Matveev and Eduard Potângă 1999a. „Săpăturile arheologice de la cetatea getică Potârca din anul 1998." *Symposia Professorum. Seria Istorie:* 8-10.

Niculiță, Ion and Silvia Teodor 2001. *Raport preliminar despre rezultatele săpăturilor arheologice la cetatea getică Potârca din rezervația muzeală "Orheiul Vechi" din anul 2001,* Chişinău: Arhiva MNAIM.

Niculiță, Ion, Silvia Teodor and Aurel Zanoci 1995. „Săpăturile arheologice de la Butuceni, raionul Orhei, 1993-1994." In *Cercetări arheologice în aria* *nord-tracă*, edited by Marian Gumă, I, 472-490, Bucureşti: Institutul Român de Tracologie.

Niculiță, Ion, Silvia Teodor and Aurel Zanoci 1996. *Raport preliminar despre rezultatele săpăturilor arheologice la situl traco – getic de la Butuceni în anul 1995,* Chișinău: Arhiva MNAIM.

Niculiță, Ion, Silvia Teodor and Aurel Zanoci 1997. „Săpăturile arheologice de la Butuceni, raionul Orhei, 1995-1996." In *Cercetări arheologice în aria nord-tracă*, II, 292-339. Bucureşti: Institutul Român de Tracologie.

Niculiță, Ion, Silvia Teodor and Aurel Zanoci 2002. *Butuceni. Monografie arheologică*, Bucureşti: Vavila Edinf.

Niculiță Ion and Aurel Zanoci 1999. „Leş vestiges du type Saharna-Solonceni decouverts sur le promontoire de Butuceni", *Thraco-Dacica*, XX: 135-142.

Niculiță, Ion and Aurel Zanoci 2001. *Raport preliminar despre rezultatele cercetărilor arheologice la cetățile getice Butuceni, Potârca şi Măşcăuți din Codrii Moldovei. Campania 2000*, Chişinău: Arhiva MNAIM.

Niculiță, Ion, Aurel Zanoci and Andrei Nicic 2003. *Raport despre rezultatele cercetărilor arheologice la obiectivele traco-getice Maşcauți "Dealul cel Mare" şi Potârca din 2002*, Chişinău: Arhiva MNAIM.

Niculiță, Ion, Aurel Zanoci and Mihail Băț 2014, „Administrative, religious and cult centers in the East-Carpathian area during the 2nd half of the 1st millennium BC". In *Residential Centres (dava, emporium, oppidum, hillfort, polis) and Cult Places in the Second Iron Age of Europe, Proceedings of the International Colloquium Buzău (Romania), 23rd-26th October. Musaios* XIX: 259-276.

Postică, Gheorghe, Ion Hîncu and Octavian Munteanu, *Raport științific privind rezultatele investigațiilor arheologice din anul 1997 de la Orheiul Vechi,* Chișinău: Arhiva MNAIM.

Postică, Gheorghe, Nicolae Boboc, Lazăr Chirică, Varvara Buzilă, Ștefan Lazu, Nicolae Corcimari and Nicolae Zubcov 2010. *Peisajul Cultural Orheiul Vechi*. Chișinău: CEP USM.

Postică, Gheorghe 2009. „Istoricul cercetării arheologie in zona Orheiului Vechi" In *Miscellanea historica et arhaeologica in honorem professoris Ionel Cândea,* edited by Valeriu Sârbu and Cristian Luca, 209-248. Brăila: Istros.

Postică, Gheorghe and Valeriu Cavruc 1989. *Investigații arheologice a așezării Petruha din anul 1988*. Chișinău: Arhiva MNIM.

Postică, Gheorghe and Octavian Munteanu 1999. „Așezarea de tip Poienești-Lucașeuca de la Orheiul Vechi." In *Cercetări Arheologice in Aria Nord-Tracă,* III, 457-494. București: Institutul Român de Tracologie.

Smirnov, Georgij D. 1964. „Arheologicheskie razvedki v nizhnem techenii Reuta" In *Materialy i issledovanija po arheologii i jetnografii Moldavskoj SSR*, 248-254. Kishinev: Kartja Moldovenjaskje.

Ursu, Andrei. F. 1977. *Prirodnye uslov'ja i geografija pochv Moldavii*. Kishinev: Shtiinca.

Tkachuk, Mark E. 1991. „Novye dannye k issledovaniju pamjatnikov tipa Pojanesht'-Lukashevka po materialam Starogo Orheja." In *Arheologicheskie issledovanija v Starom Orhee,* edited by Pavel P. Byrnja and Nikolaj P. Tel'nov, 44-53. Kishinev: Shtiinca.

Zanoci, Aurel 1998. *Fortificațiile geto-dacice din spațiul extracarpatic în secolele VI-III a. Chr*. Bucureşti: Vavila Edinf.

Analiza arheoceramologică a vestigiilor din siturile Orheiul Vechi şi Butuceni-Vest (culturile getică şi Poieneşti-Lucaşeuca)

Rezumat

În articol sunt prezentate rezultatele analizelor de laborator efectuate pe fragmentele de ceramică recuperate în două situri învecinate: în situl de tip Poienești-Lucașeuca de la Orheiul Vechi și cel getic de la Butuceni. Scopul acțiunii întreprinse a urmărit verificarea ipotezei conform căreia, între culturile menționate mai sus există continuitate în tradițiile tehnologice de producție a ceramicii și cele de utilizare a materiei prime. Pentru a verifica această ipoteză, adică pentru a determina dacă avem de-a face cu continuitatea sau cu modificări în modul de producere a ceramicii, a trebuit să se țină seama de doi factori: know-how și materia primă. Aceasta înseamnă că a fost necesar să se efectueze atât analize tehnologice, cât și analize ale materiei prime, fiind utilizate următoarele metode: analiza MGR, analiza chimică prin WD-XRF, studii în secțiune subțire și estimarea proprietăților fizice ale ceramicii. Rezultatele analizei arheometrice a ceramicii descoperite în situl Poienești-Lucașeuca de la Orheiul Vechi și în situl getic de la Butuceni nu au confirmat ipoteza că ar fi existat o continuitate în tradițiile tehnologice de producție a ceramicii. În schimb, rezultatele analizei arheometrice au confirmat ipoteza că a existat o continuitate în utilizarea materiei prime: în ambele situri și în ambele faze se pune accentul pe producția locală de ceramică, folosind materii prime locale. În acest fel, analizele efectuate arată cât de importante sunt aspectele tehnologice în studiul ceramicii antice. Dacă sunt analizate doar compozițiile chimice și/sau secțiunile subțiri (care este cea mai obișnuită practică), atunci este foarte probabil să ajungem la concluzii eronate atât de ordin cultural, cât și de ordin istoric, chiar dacă la bază sunt puse rezultate exacte ale unei tehnici precum WD-XRF și metode statistice sofisticate. Astfel, fără analize tehnologice, am ajunge la concluzia că din punct de vedere arheometric, nu există nimic care să sugereze lipsa de continuitate în tradițiile producției ceramice între situl getic și cel de tip Poienești-Lucașeuca. De facto, rezultatele analizelor tehnologice preliminare ne sugerează că există o lipsă de continuitate în tradițiile tehnologiei de producție a ceramicii între cele două comunităţi învecinate – purtătorii culturii Poienești Lucașeuca de la Orheiul Vechi și apărătorii cetățuii Butuceni-Vest din perioada getică. În acest fel, având în vedere diferențele observate în valorile fizice ale proprietății ceramice, pentru reconstruirea mai exactă a tehnologiei ceramice este necesară o gamă mai largă de analize.

Cuvinte cheie: epoca pre-romană a fierului; cultura getică; Cultura Poienești-Lucașeuca; ceramica, arheoceramologie; arheometrie, tehnologia producției ceramice; analiza MGR; cercetări ale secțiunilor subțiri; caracteristici fizice ale ceramicii.

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