Pottery found at the Horodca Mică and Ulmu Iron Age settlements – results of archaeoceramological analysis

**Malgorzata DASZKIEWICZ, Michael MEYER,
Octavian MUNTEANU, Vasile IARMULSCHI**

Abstract

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 Poieneşti-Lukaşevka culture. There are any connections between the settlers of both cultures, or are we dealing with a demolition of the settlements and a complete resettlement by "immigrants" from the north part of Europe? The "getics" pottery in the settlements of the Poieneşti-Lukaşevka culture speaks against a radical discontinuity, the extensive restructuring of the settlement system, the new burial grounds and ceramic molds are used for a far-reaching resettlement. The following article assumes 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. For this reason, ceramics of the two cultures of two neighboring settlements – Ulmu (Ialoveni District, Republic of Moldva – Poieneşti-Lukaşevka culture) and Horodca Mică (Hânceşti district, Republic of Moldova, Getic culture) – were examined for these parameters.

Archaeoceramology is a narrow specialist branch of archaeometry dealing with multiple aspects of historical pottery analysis. It includes the analysis of chemical composition, mineralogical and petrographic composition, analysis of physical and mechanical ceramic properties, as well as the estimation of firing temperature and atmosphere and assessment of functional properties. Comprehensive analysis of this type can provide insights relating to the provenance of ceramic raw materials and to the technology of ceramic production. Studying ceramic technology is important because differences in know-how are not only indicative of the level of technological knowledge within a given culture or period, but they can also reflect the transfer of technological knowledge at the level of individuals (e.g. a potter migrates and starts making stylistically local ceramic vessels in his new location using local raw materials but employing the technology already known to him). Furthermore, geological factors may have dictated that potters based at different ceramic production centers used the same clay as well as the same non-plastic raw materials to make ceramic bodies. In this scenario it is only technological analysis that has the potential to identify individual production centers.

A standard package of analyses was used to investigate the provenance of 19 pottery fragments found in Ulmu and 15 pottery fragments found in Horodca Mică. The methods used were MGR-analysis, chemical analysis by WD-XRF, thin-section studies and an estimation of physical ceramic properties.

The our aim of thin-section studies was to identify the mineralogical-petrographic content and grain size distribution of the non-plastic (clastic) components of the body. Thin-section analysis can provide only very general information about the matrix owing to the resolution of the microscope, the size of the clay minerals making up the plastic part of the body and the fact that they undergo transformation when fired.

When using three analytical methods in provenance studies, pottery groups are determined independently using: MGR analysis, chemical analysis and thin-section studies. Each of these methods yields a different type of classification (matrix groups, geochemical groups and clastic material groups). Collectively, these three types of classification allow provenance groups to be established, which not only highlight differences in chemical composition but can also demonstrate what these differences are associated with (e.g. ceramic vessels belonging to two different groups, such as tableware and kitchenware, may be locally produced using the same clay with the addition of different tempers depending on the intended function of the vessel).

The physical ceramic properties (apparent density, open porosity, water absorption) of the original pottery fragments were also evaluated. Physical ceramic properties depend on the type of raw material from which the vessel was made, the temperature at which it was fired, how it was formed, and in particular on the method used to de-air the ceramic body, which is very individual to each potter (de-airing is a very time-consuming process and as such is less susceptible to random problems). If we have products made of the same ceramic body, formed using the same technique, thoroughly dried and fired at the same temperature, their porosity will be entirely dependent on how well the ceramic body was de-aired. The more poorly de-aired the ceramic body the greater the pottery's porosity and commensurate degree of water absorption, and the lower its density.

A step by step strategy was adopted for provenance analysis, allowing for a reduction in the number of analyses carried out. All samples underwent MGR-analysis, the results being used as the basis for raw material classification, after which samples were selected for chemical analysis. Following further classification, samples were subsequently selected for examination in thin-section. The apparent density, open porosity and water absorption of all sherds was evaluated. As a result of the methods applied, a number of findings have been reached.

Ceramic wares found at both sites were made using a body intentionally tempered with crushed potsherds (grog). At both sites pottery was made using similar, non-standardised technology: various amounts of grog temper were used and firing was carried out at various temperatures in an incompletely oxidizing atmosphere.

None of the analysed sherds found in Ulmu were made of the same raw material as those used for pottery manufacturing at the neighbouring site in Horodca Mică. As the sites differ chronologically this demonstrates a discontinuity in raw material use.

Taking into consideration the results of MGR-analysis, chemical analysis and thin-section studies it can be concluded that the analysed samples represent wares made at local pottery workshops, except for facetted pot sample no. 11 found at the site in Ulmu. This sample most probably represents a non-regional import. The same might be true of another facetted pot sample (sample no. 16), which was notable for having the highest Al/Si ratio. Interestingly, both sample no. 16 and sample no. 11 have an unusually high open porosity value for facetted pots.

Most of the pottery found in Ulmu (11 of the 19 analysed samples) was made from the same raw material (MGR-4). This raw material was used to produce coarse (GK) and fine ware (FK) as well as facetted pots. This clearly points towards a local production of pottery of all types. Matrix groups that were restricted to the production of facetted bowls (MGR-groups 1, 2 and 6) might additionally show a specific selection of raw materials for these particular forms (samples no. 1, 4 and 6), but there is no evidence that these MGR-groups represent imports.

In summary, the similarities in production between ceramics from the Getic site and the Poienești-Lukașevka-site are clearly visible. The only change is connected to a new group of vessel types. From the archaeometric point of view, there is nothing to suggest a lack of continuity in ceramic production traditions. This continuity in technology can be understood as a continuous transmission of knowledge between individuals. We assume that a complete change of population involving a deserted landscape after the end of the Getic settlements and the arrival of new settlers would yield very different results. As the results presented herein are only based on a small number of samples it is clear that the interpretation is only of a preliminary nature.

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

Research Questions

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 Poieneşti-Lukaşevka culture. Are there any connections between the settlers of both cultures, or are we dealing with a demolition of the settlements and a complete resettlement by "immigrants" from the north part of Europe? The "getics" pottery in the settlements of the Poieneşti-Lukaşevka culture speaks against a radical discontinuity, the extensive restructuring of the settlement system, the new burial grounds and ceramic molds are used for a far-reaching resettlement. The following article assumes 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 For this reason, ceramics of the two cultures of two neighboring settlements – Ulmu (Ialoveni District, Republic of Moldva, Romanovskaja 1987) and Horodca Mică (Munteanu, Iarmulschi 2007; Munteanu et. al 2010; Munteanu 2013) (Hânceşti district, Republic of Moldova) – were examined for these parameters.

The landscape: general characteristics.

Speaking broadly from the territorial point of view, we will focus our attention on the central forested region Codri in Republic of Moldova, and if we narrow the optics then we will refer to the upper valley of Botna River on the micro-zone in which are located the fortifications Horodca Mare, Horodca Mica and Ulmu settlement (Fig. 1). Codri Region is located in the central part of Moldova (Fig. 2) and is the highest in the space between Prut and Dniester with the absolute height of 429.5 m recorded near Bălăneşti village. It is a rather hilly relief with a fragmentation depth ranging from 300 m to 100-150 m, in most landscapes being 200-350 m. The region is fragmented by valleys of rivers Cula, Ichel, Bâc, Botna and Cogâlnic, but also by other smaller ones that flow into the Prut River. River valleys are well delimited and are deep. In general, the right side slopes are steep and affected by landslides, and the left side slopes are gentler and more developed, affected to a much lesser extent by erosion and landslides. In the middle of the forest area we are interested in, the relief is oriented from northwest to southeast, where the altitude decreases from 350 to 250 m. These conditions

Fig. 1. Map indicating the location of the Moldavian Codri and the upper stream of the river Botna.

made space for rich forest vegetation represented by deciduous forests of central European type occupying an area of approximately 16% of the territory. Representative for the vegetation of Codri is the beech (*Fagus silvatica*), holm oak (*Quercus petraea*) and common oak (*Quercus robur*). This region is characterized by considerable areas of forest soils with mainly two types – brown and gray forest soils and chernozem podzolic soils. The investigated micro-region is fragmented by Botna River, which flows from the southern slopes of the central part of Codri Plateau at 4 km southwest of Lozova village, near the village of Horodca Nouă. Floodplain is generally 0.5-1.0 km and only in the lower part it is 2.0-2.5 km, sloughing on some segments. On the upper course, Botna is much narrower, but forms a well defined valley with many streams flowing from the slopes into Botna. This particular area was chosen by a number of Getae communities, which they used and protected by the two fortifications around Horodca Nouă village. Therefore, in our focus falls the upper course of Botna River, from its springs up to Ruseştii Noi village.

Fig. 2. The central part of the Republic of Moldova – Codrii. Orthophotomap (www.geoportal.md)

The fortifications of the upper Botna River

The existence of fortifications in the upper Botna River course micro-zone (see localization in Fig. 1-3, 14) was reported back in the initial phase of extensive surveys conducted on the territory of Moldova in the immediate post-war period. Short descriptions of these sites can be found in several publications, however no extensive investigation was conducted in the past (G. Smirnov, 1949, 198-199; T. Passek, 1949, 59; T. Zlatkovskaja, 1969, 50; V. Lapuşnean, 1974, 49, Hîncu, 1993, 70). Since 2006 was initiated systematic research at Horodca Mică (promontory is called by Horodca villagers “La Hultan”) and later, the investigations were extended on the surrounding headland, known

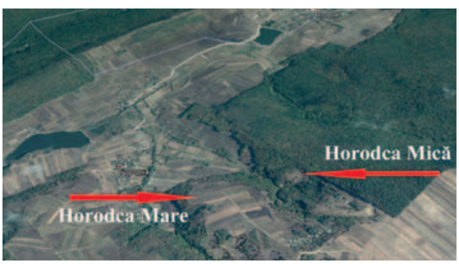

Fig. 3. Fortifications location Horodca Mare and Horodca Mică. Orthophotomap. View from the west. (Google Earth + PRO).

Fig. 4. View of the fortifications Horodca Mare and Horodca Mică. View from the South.

among local inhabitants as "La Cetate" and among researches as Horodca Mare (Munteanu, 2012; Munteanu, 2011; Munteanu, 2010; Munteanu, 2009).

Horodca Mică fortification is located on the penultimate Botna River terrace, (on the right bank of the river, altitude 269 m) in the close vicinity to its sources, on a promontory bordered by two ravines at about 700 m southwest of the last row of houses on the eastern alignment of Horodca Nouă village (Hanceşti District) (Fig. 3, 4). The headland is shaped like a triangle with cut off corners, covering an area of about 1.6 ha (Fig. 4, 11). The ravine is very deep and steep on the west while the slopes get more gentle in the north and northeast, however remaining hardly accessible. The access ways go though the south-west, south and southeast directions with reinforcements made by the inhabitants of space. The fortification consists of several defensive elements: wall with adjacent ditch, scarp and bastion. (Fig. 5, 6). The wall was raised in the south and south-east of the headland and represents two broken segments, placed at an angle of about 160 degrees with the outside quite rounded and

Fig. 5. Horodca Mică. View of the defensive system, from its inner area.

Fig. 6. Horodca Mică. View of curvature of the defense system and of the bastion from the extra-muros.

Fig. 7. Horodca Mică. 1. View of the defensive system from the site. 2. View of the defensive system from the extra-muros.

an overall semicircular character (Fig. 6). The fortified segment length in the south is 65 m inside and 75 m outside. The southeastern segment length is 45 m both outside and inside. The wall width is relatively homogeneous in the west and is 32-33 m long, widening slightly at the junction with the "bastion" up to 35 m (Fig. 6). The southeast segment is slightly narrower. Its width varies from 25 m (in the east) and 30 m. The height of the wall varies between 5 and 6.5 m (from the top of the wave to the footstep level of the precinct Fig. 7). The adjacent ditch width is mainly 12-13 m. In some areas it becomes wider while in others it shrinks. At present, the difference in level between the top of the wall and the wedge of the ditch is 5,2 m. The bastion currently represents a circular mound which has a height of over 9 m from the present footstep level (Fig. 6). The "bastion" diameter is about 16.5 m. There is a ditch on the outside of the bastion which makes a direct connection in the west with the adjacent ditch of the western segment of the fortification. Ditch width is smaller than that of the wall and is 6 m in the west and 9 m in the east.

Horodca Mare fortification is situated at the distance of about 300 m northwest from Horodca Mică fortification (on the right bank of the river, altitude 260 m.; (Fig. 3, 4). It is separated from the later by a deep ravine whose slopes form the promontories *La Hultan* (on which Horodca Mică fortress is located) and *La Cetate* were discovered remains of Horodca Mare fortification. The headland *La Cetate* is bordered by the already mentioned ravine and another

Fig. 8. Horodca Mare. View of the headland from the North-East.

one located slightly toward north-west. Both ravines are sufficiently deep with steep sloped especially in the north and east (Fig. 3, 4, 8). The promontory itself is quite large occupying an area of about 32 ha with the site holding a surface of about 8 ha in its northeast part (Fig. 3). The precise area of the site can hardly be defined at present because of destructions to the defensive system during the collectivization period when intra-mural territories were part of farming land. However, their existence was mentioned by our forefathers in the immediate post-war period (without pointing it's exact location) when these sites were mapped, also they are preserved in the memories of the elder villages. This information may be supplemented by data drawn from the analysis of satellite images (Fig. 9) and geo-magnetic prospecting carried inside the fortification (Popa et All 2010, 146). And while the defensive line that was meant to bar the access to intra-mural fortification was not preserved, the defensive elements on the perimeter of fortification's steep bank luckily are still visible today. It is true that their current size is relatively small and do not allow a clear view, neverthe-

Fig. 9. Horodca Mare. Location of the potential defensive systems. Orthophotomap. (Google Earht + PRO).

Fig. 10. Horodca Mare. View of the defensive system from the north-eastern part of the promontory.

less traces can be observed from a closer examination of the territories in the north-eastern and northern edge of the promontory (Fig. 10). Moreover, these spaces have been studied through field research and a fairly clear picture was obtained about the fortification structure. (Munteanu, Iarmulschi 2013; Munteanu 2012; Munteanu 2011; Munteanu 2010; Munteanu 2009; Munteanu et. al. 2009).

Thus, balancing the above of mentioned facts the following picture emerges. In the area immediately surrounding Botna River springs, the inhabitants from Pre-Roman Iron Age conducted actions that require serious physical, intellectual, and material effort in order to fortify two spaces placed at relatively short

Fig. 11. View of the Botna river valley from the promontory At Hultan (Horodca Mică).

Fig. 12. View of the promontory *At Hultan* (Horodca Mică) from the promontory *The Citadel* (Horodca Mare).

distance from each other (Fig. 3, 4). Both sites offer perfect vision over the valley of Botna and open a wide corridor of movement in areas of hills covered with forests (Fig. 4, 11). Moreover, there is a perfect viewing from each fortress over the other one providing opportunities for communication and coordination of actions of the defenders of these fortifications (Fig. 12, 13). It is to mention that at the base of Horodca Mare fortification were discovered traces of a synchronous settlement occupying an area estimated to 4 ha which cannot be studied at the moment because of the plantations of plum trees (a situation which generally compromises the conservation status of the site.

Getae settlements in the upper course of the Botna River

We would like to mention a number of archaeological monuments dated with La Tène period and located around the two mentioned sites (Fig. 14). Only in the micro-zone of Horodca village other four Getae sites were identified: Horodca XII (Fig. 14/3); Horodca VI, (fig. 14/4; Polevoj 1969, 193; Lapushnjan, Nikulice, Romanovskaja 1974, 58). Horodca XIII (Fig. 14/5) and Horodca XIV (Fig. 14/6). Moving eastward from the nest of Getae settlements

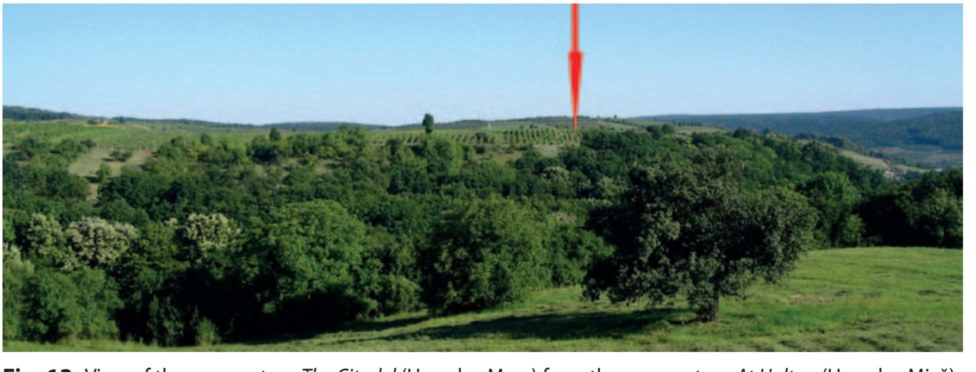

Fig. 13. View of the promontory *The Citadel* (Horodca Mare) from the promontory *At Hultan* (Horodca Mică).

around Horodca village we will reach other four settlements situated on the east of Ulmu village: Ulmu III, (Fig. 14/7: Romanovskaja, 1969, 81-95; Romanovskaja, 1982, 207-226); Ulmu IV (Fig. 14/8: Polevoj 1969, 195; Lapushnjan, Nikulice, Romanovskaja 1974, 57), (Ulmu VII, Fig. 14/9: Polevoj 1969, 198; Lapushnjan, Nikulice, Romanovskaja 1974, 57) and (Ulmu V, Fig. 14/10: Polevoj 1969, 195; Barnea 1974, 99). Around the village Vasieni were recorded other two Getae settlements: one in the west, at a distance of 2.5 km from the south-eastern site of Ulmu (Văsieni II, Fig. 14/11: Polevoj 1969, 198; Dergachev 1973, 94), and, on the opposite side of Vasieni village, at a distance of 4.5 km, the second Getae site (Văsieni V, Fig. 14/12: Polevoj 1969, 199). The last in the array of sites from this area of Botna, is a settlement located at a distance of 1.8 km in the south-eastern direction and closer to the western edge of Ruseştii Noi village (Ruseştii Noi IV, Fig. 14/13: Polevoj 1969, 139-200; Lapushnjan, Nikulice, Romanovskaja 1974, 60). Thus, along the upper Botna River other 11 open settlements were located, starting straight from the fortification near Horodca Mare. Six of them are situated on the right bank of the river, and five – on the left one.

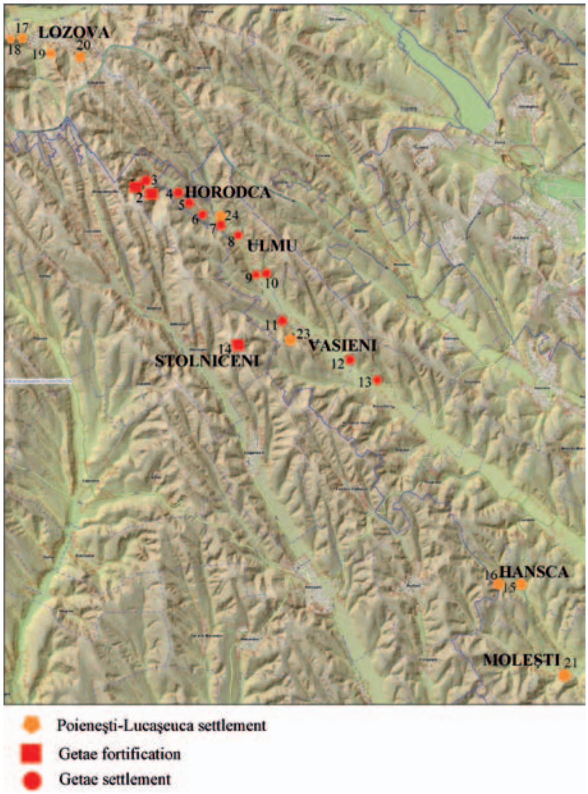

Fig. 14. The micro zone of the Botna river upper course indicating the site's location (www.geoportal.md). 1 – Horodca Mare; 2 – Horodca Mică; 3 –Horodca XII; 4 – Horodca VI; 5 – Horodca XIII; 6 – Horodca XIV; 7 – Ulmu III; 8 – Ulmu IV;9 – Ulmu VII; 10 – Ulmu V; 11 – Văsieni II; 12 – Văsieni V; 13 – Ruseştii Noi IV; 14 – Stolniceni; 15 – Hansca "La Matca" 16 – Hansca "Limbari Caprarie"; 17-20 – Lozova; 21 – Molesti PL; 23 – Vasieni PL; 24 – Ulmu PL.

We can notice that the distances between the settlements are not too big, in a way that walks from one to the other did not require much time or effort, thus being assured an easy and continuous communication between the settlements. All the settlements are located nearby Botna River, practically in the River Valley, but in the same time, their surfaces of the location rise slightly above the valley. The location altitude for the settlements from Ruseştii Noi and Văsieni (those situated in the downside of the micro zone) is lower than 115 m. The settlements near Ulmu village are situated at altitudes that are only few bellow 155 m, but those nearby Horodca village are located at higher levels – approximately 185-188 m. The only settlement situated at a high enough level is the one from the foot of the Horodca Mare fortification – approximately 220 m above sea level, thus being only 40 m lower than the *La Cetate* promontory and 40 m higher than the Botna River level at its nearest point.

Near these sites, wide areas of very high quality farming land have been attested, presenting a comfortable exposure and therefore perfect conditions for practicing agriculture. The necessary amount of water can be sufficiently provided by the main water artery of the micro zone, as well as the by the multiple streams flowing into the Botna river, this being an additional favorable conditions for practicing land works. To these factors, has to be added the surrounding Codri area, which represents an enormous source of wooden raw material, used in a wide range of activities: from building the living spaces (with all its potential annexes) and the defensive systems to the confection of various daily use artifacts. These being given, the communities settled along upper Botna were provided with sufficient resources for organizing autonomously their daily life. In the same context, we should note that farther, on the other side of Ruseştii Noi, the Botna valley begins to slightly widen, therefore in the micro region formed by the villages from the lower course of the Botna River, the situations appears to be different, being determined by another kind of circumstances and natural conditions which would be worthy being treated separately, considering that the big number of opened settlements are gravitating around other fortifications than those discussed above, such as those from Pojăreni, Hansca and Sociteni.

As a final thought, We would like to draw the attention to the Stolniceni site – its particularities classify it among those having a deep spiritual signification and, considering its location, it can be regarded as a sacred place, common for a number of more Getae groups from the upper Botna region, although this situation requires additional research and specifications, their framework rising beyond the purposes set for this work.

Poienești-Lukașevka settlements in the upper course of the Botna River

As evidenced by the archaeological investigations carried out so far, sites type Poienești-Lukașevka have a relatively large density of distribution in the Botna River region, where the settlement of Ulmu is located (Romanovskaja

1987, 207-226). In this area are known 9 sites attributed to this cultural aspect (fig. 14). Regretfully, only five of these archaeological objectives, namely Hansca "La Matca" (fig. 14/15, Niculice 1981, 71-89, Arnaut 2003, 220), Hansca "Limbari Caprarie" (fig. 14/16, Niculice 1987, 110-111, Arnaut 2003, 220), Molesti (fig. 14/21, Tentiuc 2012, 117-118, note 1), Ulmu (fig. 14/24, Romanovskaja 1987, 207-226) and Vasieni (fig. 14/23, Fedorov 1960, 239-240; Lapusnian, Niculice, Romanovscaja 1974, 84) have been researched through excavations or archaeological surveys. Another five settlements were recently discovered near the village of Lozova (fig. 14/17-20).

The Ulmu site, the settlement from which ceramic fragments were taken to carry out chemical analyzes is located about 1.5 km northeast of the village, on a right hill to the Botna River (fig.). On the occasion of the archaeological rescue excavations organized by M.A. Romanovskaja in 1960[1] were discovered two dwellings (?), six pits and an impressive amount of ceramics type Poienești-Lukașevka (Romanovskaja 1987, 207-226). In 2005, O. Munteanu resumed the research on the site in order to check whether the settlement of the lake near the locality left untouched spaces covered by the settlement researched by M.A. Romanovskaja. Regretfully, it seems that the leveling of the land around the lake has destroyed the site, archaeological complexes not being certified, the results being summed up at the collection of a small number of ceramic fragments. Of the two (?) dwellings discovered at Ulmu, one is a ground-mounted construction, and the second – at the surface of the soil (Romanovskaja 1987, 208-209, 215). In one of them, more precisely in a deepened dwelling, numbered as L. 1, a furnace most probably used for the reduction of iron ore was discovered (Romanovskaja 1987, 209). That is why in the literature it was assumed that this complex is, in fact, a workshop (Iarmulschi 2017, 35). As for the six pits noted in this site, we mention that they usually had the oval shape in the plan and the right walls. Regarding the chronology of the settlement, we mention that the author of the archaeological investigations dated the site within the boundaries of the end of the III Century BC – the beginning of the I Century BC. (Romanovskaja 1987, 223), and V. Iarmulschi placed the functioning of this settlement between the middle of the century II and the first half of the century I BC (Iarmulschi 2013, 47; Iarmulschi 2016, 489).

Archaeoceramological analysis

As we said above, archaeoceramological analysis was carried out on pottery recovered from excavations at the Iron Age settlements of Horodca Mică and

1 In 1960, a water reservoir was set up in that place.

Ulmu. Archaeoceramology is a narrow specialist branch of archaeometry[2] dealing with multiple aspects of historical pottery analysis. It includes the analysis of chemical composition, mineralogical and petrographic composition, analysis of physical and mechanical ceramic properties, as well as the estimation of firing temperature and atmosphere and assessment of functional properties. Comprehensive analysis of this type can provide insights relating to the provenance of ceramic raw materials and to the technology of ceramic production. Studying ceramic technology is important because differences in know-how are not only indicative of the level of technological knowledge within a given culture or period, but they can also reflect the transfer of technological knowledge at the level of individuals (e.g. a potter migrates and starts making stylistically local ceramic vessels in his new location using local raw materials but employing the technology already known to him). Furthermore, geological factors may have dictated that potters based at different ceramic production centers used the same clay as well as the same non-plastic raw materials to make ceramic bodies. In this scenario it is only technological analysis that has the potential to identify individual production centers.

A standard package of analyses[3] was used to investigate the provenance of 19 pottery fragments found in Ulmu and 15 pottery fragments found in Horodca Mică. The methods used were MGR-analysis, chemical analysis by WD-XRF, thin-section studies and an estimation of physical ceramic properties[4].

MGR-analysis (Matrix Group by Refiring) was applied in order to determine the composition of the ceramic matrix. Matrix types can be identified using this analytical method because of the fact that the thermal behavior of the plastic components during firing is governed by their chemical and phase composition (Daszkiewicz 2014, Daszkiewicz 2017, Daszkiewicz and Schneider 2001). After the sherds are refried at a higher temperature than their original firing temperature (i.e. once the effects caused by the original firing temperature and conditions are 'removed'), the colour, shade and appearance of the matrix relate to the chemical and phase composition of the plastic part of the body. MGR-analysis made it possible to divide the examined pottery into groups of sherds made of the same plastic raw material.

2 Archaeometry is a scientific discipline which deals with the development and application of physico-chemical, mathematical and natural scientific methods in order to answer questions about cultural history. Archaeometrical analysis is carried out on historical materials, including both artefacts and natural products recovered from excavation.

3 This a standard package of basic analyses used by the team of M. Daszkiewicz, G. Schneider and E. Bobryk in analysing the provenance and some aspects of technology of ancient ceramics.

4 For a full description of methods see Appendix.

Chemical analysis of sherds was used to determine the chemical composition of both the plastic and non-plastic ingredients of the pottery fabric. This analysis enabled the quantity of major and trace elements in the body to be established, revealing the geochemical characteristics of the raw materials used, although the phases in which individual elements occur could not be determined[5] (giving the major elements as oxides[6] is standard procedure in geochemistry when presenting the results of chemical analysis).

The main aim of thin-section studies was to identify the mineralogical-petrographic content and grain size distribution of the non-plastic (clastic) components of the body. Thin-section analysis can provide only very general information about the matrix owing to the resolution of the microscope, the size of the clay minerals making up the plastic part of the body and the fact that they undergo transformation when fired.

When using three analytical methods in provenance studies, pottery groups are determined independently using: MGR analysis, chemical analysis and thin-section studies. Each of these methods yields a different type of classification (matrix groups, geochemical groups and clastic material groups). Collectively, these three types of classification allow provenance groups to be established, which not only highlight differences in chemical composition but can also demonstrate what these differences are associated with (e.g. ceramic vessels belonging to two different groups, such as tableware and kitchenware, may be locally produced using the same clay with the addition of different tempers depending on the intended function of the vessel).

The physical ceramic properties (apparent density, open porosity, water absorption) of the original pottery fragments were also evaluated. Physical ceramic properties depend on the type of raw material from which the vessel was made, the temperature at which it was fired, how it was formed, and in particular on the method used to de-air the ceramic body, which is very individual to each potter (de-airing is a very time-consuming process and as such is less susceptible to random problems). If we have products made of the same ceramic body, formed using the same technique, thoroughly dried and fired at the same temperature, their porosity will be entirely dependent on how well the

---

5 For example Ca 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.

6 Si = silicon, calculated as SiO_2; Al = aluminium, calculated as Al_2O_3; Ti = titanium, calculated as TiO_2; Fe = iron, total iron calculated as Fe_2O_3; Mn = manganese, calculated as MnO; Mg = magnesium calculated as MgO; Ca = calcium calculated as CaO; Na = sodium calculated as Na_2O; K = potassium calculated as K_2O; P = phosphorus calculated as P_2O_5.

ceramic body was de-aired[7]. The more poorly de-aired the ceramic body the greater the pottery's porosity and commensurate degree of water absorption, and the lower its density.

A *step by step* strategy was adopted for provenance analysis, allowing for a reduction in the number of analyses carried out[8]. All samples underwent MGR-analysis, the results being used as the basis for raw material classification, after which samples were selected for chemical analysis. Following further classification, samples were subsequently selected for examination in thin-section. The apparent density, open porosity and water absorption of all sherds was evaluated.

The first procedure undertaken for all 34 sherds was abridged MGR-analysis (an example of an MGR-chart is shown in Fig. 15). The thermal behaviour of every sample refried at three temperatures (1100 °C, 1150 °C and 1200 °C) is taken into account when defining different MGR-groups. Fig. 16 shows five samples; the first four exhibit the same thermal behaviour after refiring at each of the three temperatures, whilst the fifth (sample no. 34) differs distinctly from the rest. Thus, there is no doubt that this sample belongs to a different MGR-group. Definitive, standardised attribution to an MGR-group is based on thermal behaviour at 1200 °C[9]. If samples display the same appearance, colour and shade after refiring at 1200 °C this indicates that they were made using the same plastic raw material. All ceramic samples attributed to the same MGR-group were made of the same clay, or of the same ceramic body where intentional temper was not added. The term 'group' is used even when each group is represented by only a single sample[10].

The following types of matrix were identified based on the appearance of samples when refired at 1200 °C (tab. 1):

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

---

7 If the products differ only in firing temperature, when they are refired at a temperature higher than the original firing temperature they will exhibit the same porosity and density. Therefore, it is best to assess physical ceramic properties on original samples and samples after refiring at 1200 °C.

8 This strategy draws out the length of time required for analyses, however it significantly reduces their cost.

9 Only very few sherds of archaeological pottery were originally fired at 1100–1150 °C; a firing temperature of 1200 °C or more has not (thus far) been noted.

10 It is unlikely that only a single vessel was made from one ceramic body, hence it is assumed that the sample submitted by archaeologists for analysis represents a group of vessels made from the same material. It is for this reason that the term 'group' is used even in relation to those groups which are represented solely by one sample.

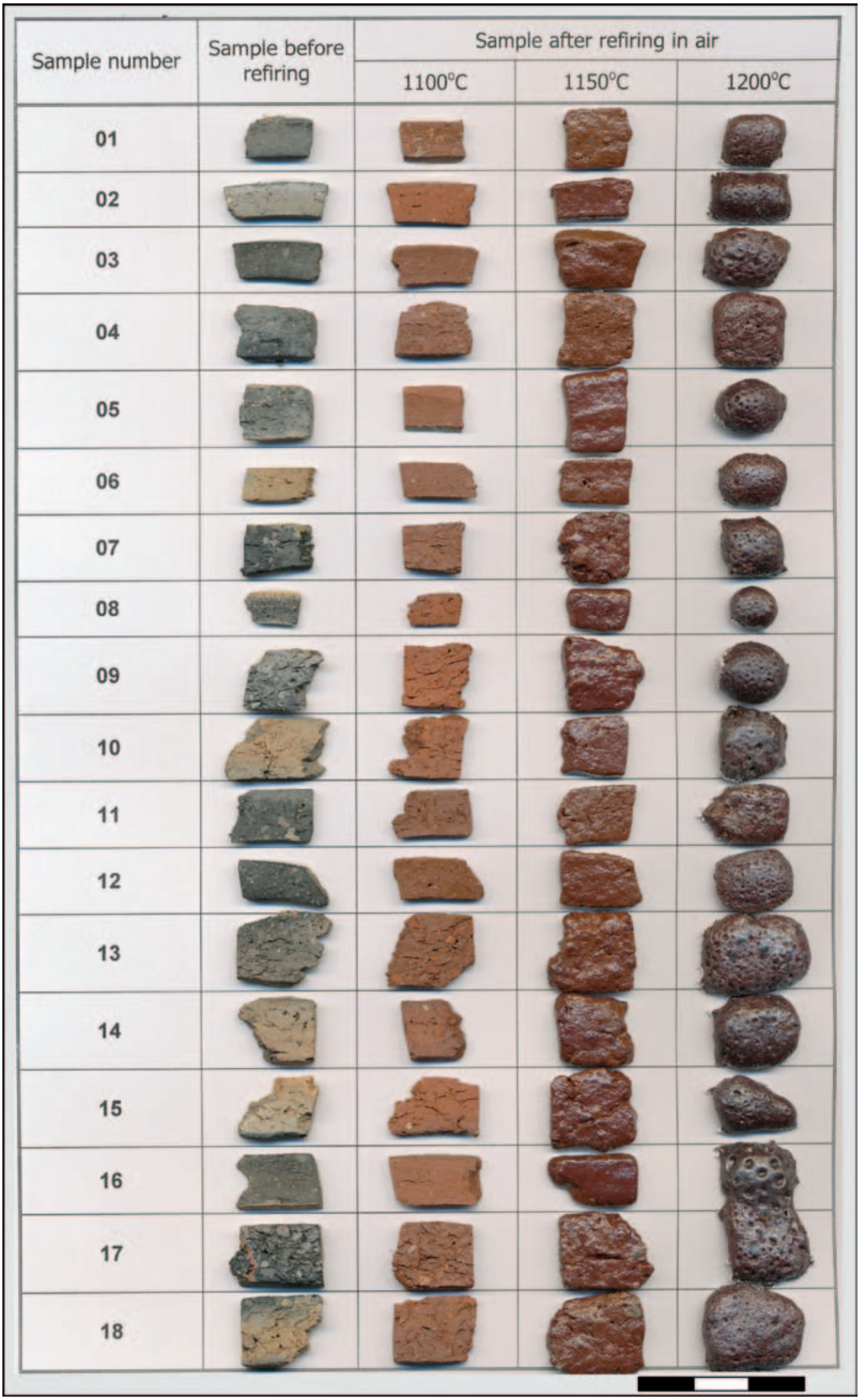

Fig. 15. MGR-chart. Samples before and after refiring at 1100, 1150 and 1200 °C.

Sample No.	Vessel type	Physical ceramic properties Po [%]	N [%]	dv [g/cm³]	Thermal behaviour after refiring at 1200°C apareance	carbonates	colour	MGR group	Lab. No. WD-XRF
Poiniesti-Lukasevka-culture; Ulmu, Rajon Ialoveni									
1	facceted vessels	30.7	16.5	1.86	sMLT BL few pit mat		silverisch brownish	**1**	MD5567
6	facceted vessels	33.3	19.1	1.75	sMLT BL few pit mat		silverisch brownish	**1**	-
3	facceted vessels	31.3	17.3	1.81	sMLT BL pit s-mat		silverisch brownish	**2**	MD5569
14	coarse ware	31.9	18.4	1.74	sMLT BL pit s-mat		silverisch brownish	**2**	-
15	coarse ware	30.8	18.3	1.68	sMLT BL pit s-mat		silverisch brownish	**2**	-
11	facceted vessels	36.3	21.5	1.69	ovM BL		brownish red	**3**	MD5574
2	fine ware	30.7	17.7	1.73	sMLT BL pit mat		silverisch brown	**4**	MD5568
5	facceted vessels	31.5	18.2	1.73	sMLT BL pit mat		silverisch brown	**4**	-
7	fine ware	33.6	19.4	1.74	sMLT BL pit mat	fn cc-cl	silverisch brown	**4**	MD5571
8	fine ware	34.2	20.6	1.66	sMLT BL pit mat		silverisch brown	**4**	MD5572
9	coarse ware	31.7	19.5	1.63	sMLT BL pit mat		silverisch brown	**4**	MD5573
10	coarse ware	37.1	22.3	1.67	sMLT BL pit mat		silverisch brown	**4**	-
12	fine ware	33.9	19.3	1.76	sMLT BL pit mat		silverisch brown	**4**	-
13	coarse ware	37.2	22.5	1.65	sMLT BL pit mat		silverisch brown	**4**	MD5575
17	coarse ware	33.6	19.5	1.72	sMLT BL pit mat		silverisch brown	**4**	-
18	coarse ware	35.2	20.4	1.73	sMLT BL pit mat		silverisch brown	**4**	MD5577
19	coarse ware	35.2	20.7	1.70	sMLT BL pit mat	fn cc-cl	silverisch brown	**4**	MD5578
16	facceted vessels	34.5	20.3	1.70	sMLT BL pit mat		silver grayish brown	**5**	MD5576
4	facceted vessels	30.9	17.0	1.82	sovM BL/ (MLT)		reddish brown	**6**	MD5570
Getic culture; Horodca Mică, Rajon Ialoveni									
20	coarse ware	35.1	21.1	1.66	sovM\ (sBL)		brownish reddish	**7**	MD5579
21	coarse ware	34.7	20.1	1.72	sovM\ (sBL)		brownish reddish	**7**	-
25	coarse ware	33.9	19.3	1.76	sovM\ (sBL)		brownish reddish	**7**	MD5582
28	coarse ware	37.3	22.4	1.66	sovM\ (sBL)		brownish reddish	**7**	MD5584
22	coarse ware	34.3	19.7	1.74	sMLT BL pit	cc	silverisch brownish red	**8**	-
23	coarse ware	31.8	18.1	1.76	sMLT BL pit		silverisch brownish red	**8**	MD5580
29	coarse ware	34.3	19.9	1.72	sMLT BL pit	cc	silverisch brownish red	**8**	MD5585
32	coarse ware	34.5	19.9	1.74	sovM\ (sBL)		brownish red	**9**	MD5588
24	coarse ware	37.4	22.6	1.66	sMLT BL few pit	fn cc-cl	silverisch brownish redddish	**10**	MD5581
26	coarse ware	33.1	19.6	1.69	sMLT BL few pit mat		silverisch brownish red	**11**	MD5583
27	coarse ware	41.6	26.7	1.56	sMLT BL few pit mat		silverisch brownish red	**11**	-
30	coarse ware	37.7	23.0	1.64	sMLT BL few pit s-mat		silverisch brown red	**12**	MD5586
31	coarse ware	37.5	22.2	1.69	sMLT BL few pit s-mat	cr	silverisch brown red	**12**	MD5587
33	coarse ware	38.8	23.6	1.64	sMLT BL pit s-mat	cr	silverisch brownish red	**13**	MD5589
34	coarse ware	34.2	19.8	1.73	sMLT BL pit mat	cr	silverisch brownish red	**14**	MD5590

Tab. 1. List of analysed samples and the results of MGR-analysis. sMLT = semi melted; BL = bloated, ovm = over-melted; fn = fine; cr = coarse; cc = carbonates; cc-cl = calcareous clay.

- 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.

In addition, 28 samples also exhibited bloating (BL), meaning that the sample expanded in volume. In five samples slight bloating occurred which did not affect the entire sample, but only its irregularly arranged small parts[11]. A combination of two different matrix types was also observed in one sample with a slightly over-melted matrix type and some parts with a melted matrix type (sample no. 4). Other terms used in reference to characteristics noted after refiring include: matt or s-matt (the sample has a matt or semi-matt surface); pit (the surface of the sample is uneven with visible pitting) or few pits, when only

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

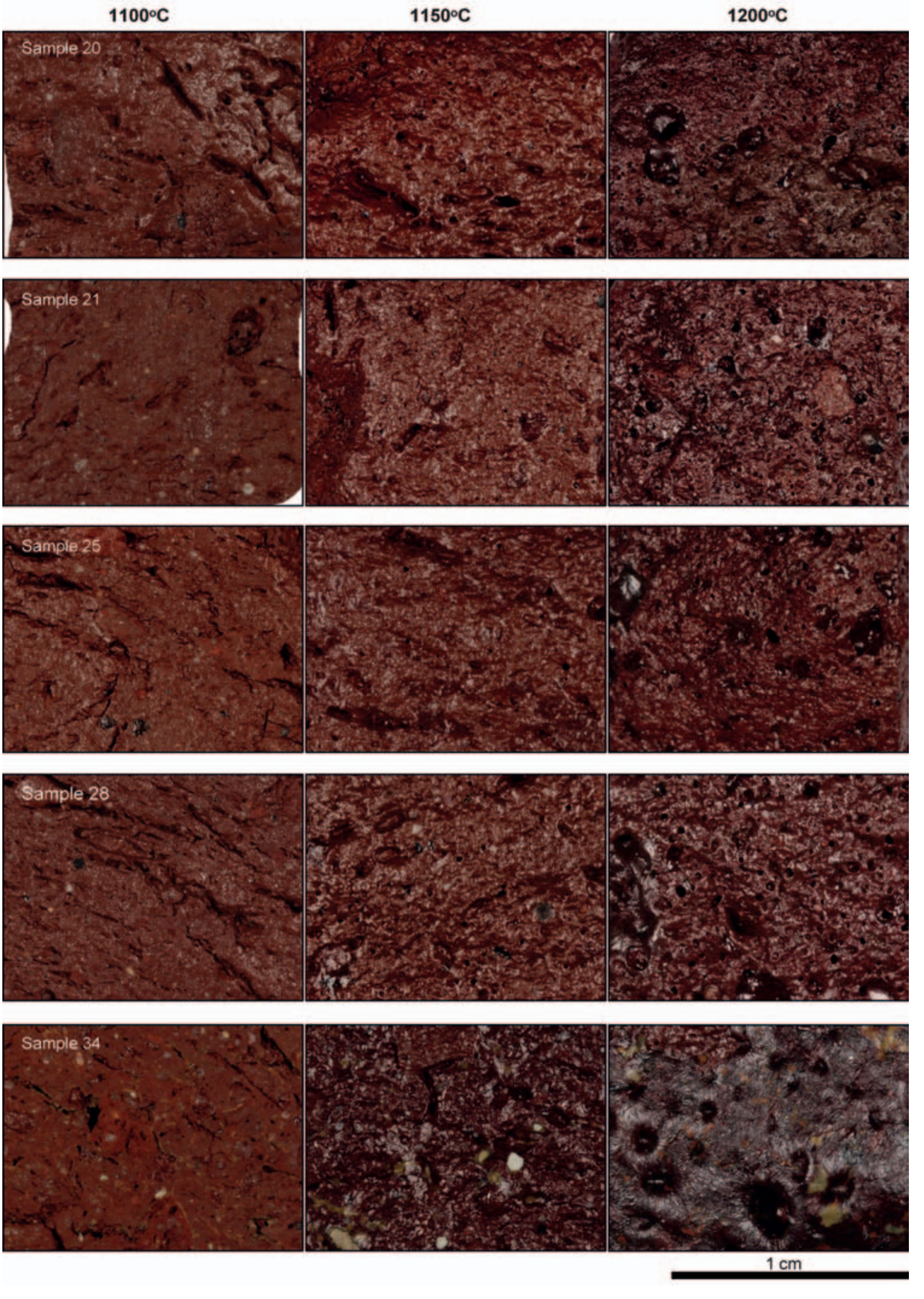

Fig. 16. Samples after refiring at 1100, 1150 and 1200 °C. The first four exhibit the same thermal behaviour after refiring at each of the three temperatures (they belong to the same MGR-group: this means that they are made from the same clay), the fifth sample differs distinctly from the rest (different MGR-group, different clay). (Graphic preparation: Hanna Baranowska).

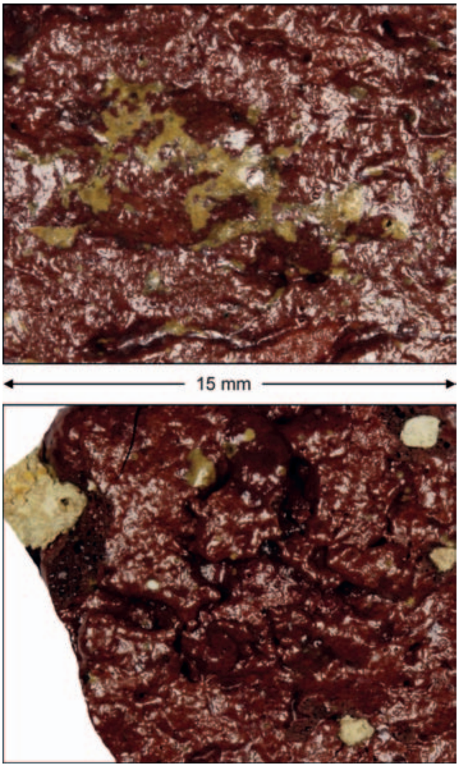

Fig. 17. Example of two samples made of non-calcareous clays. The top sample features an area with a sizeable portion of calcareous clay (the greenish-yellowish part in the middle). The bottom sample features a temper of sand-sized carbonates (white grains). Samples after refiring at 1200 °C. (Graphic preparation: Hanna Baranowska)

a small number of pits are visible. One sample (Ulmu, sample no. 11) differs slightly due to its surface appearance after refiring at 1100 °C and its partial bloating after refiring at 1200 °C.

Based on the colour of samples after refiring at 1200 °C, generally only one fundamental category of matrix can be identified: non-calcareous (NC = non-calcareous clay coloured by iron compounds)[12]. Different colours and shades can be distinguished within this category of matrix. Additionally, several samples featured very small, irregularly distributed portions of matrix of the same colour as a calcareous (CC = calcareous clay)[13] matrix, which points to the distribution of very fine carbonates in the matrix. These samples were classified as being made of an NC cc raw material (i.e. a non-calcareous clay coloured by iron compounds enriched with carbonates in clay fraction). Only one sample (sample no. 19) featured an area with a sizeable portion of CC matrix, but this did not result in the sample being reclassified to the MX (mixed) matrix category. Some NC cc samples feature a temper of carbonates in sand fraction or even single gravel-sized grains which causes the matrix to splinter after refiring[14] (Fig. 17, tab. 1). In contrast to the NC cc samples, in the NC samples carbonates are not visible macroscopically.

Based on similarities in the thermal behaviour of samples (appearance and colour), the results of MGR-analysis conclusively demonstrate that 34 of the

---

[12] Samples were deemed to have a non-calcareous matrix if no calcium silicate or calcium aluminium silicate phases formed during laboratory refiring in air at a temperature of 1200 °C, which was indicated by the fact that the samples did not adopt a greenish tint.

[13] Samples were said to have a calcareous matrix if calcium silicate or calcium aluminium silicate phases formed during laboratory refiring in air at a temperature of 1200 °C, indicated by the fact that the samples became green in colour (or had a greenish tint).

[14] Denoted 'cr' in table 1.

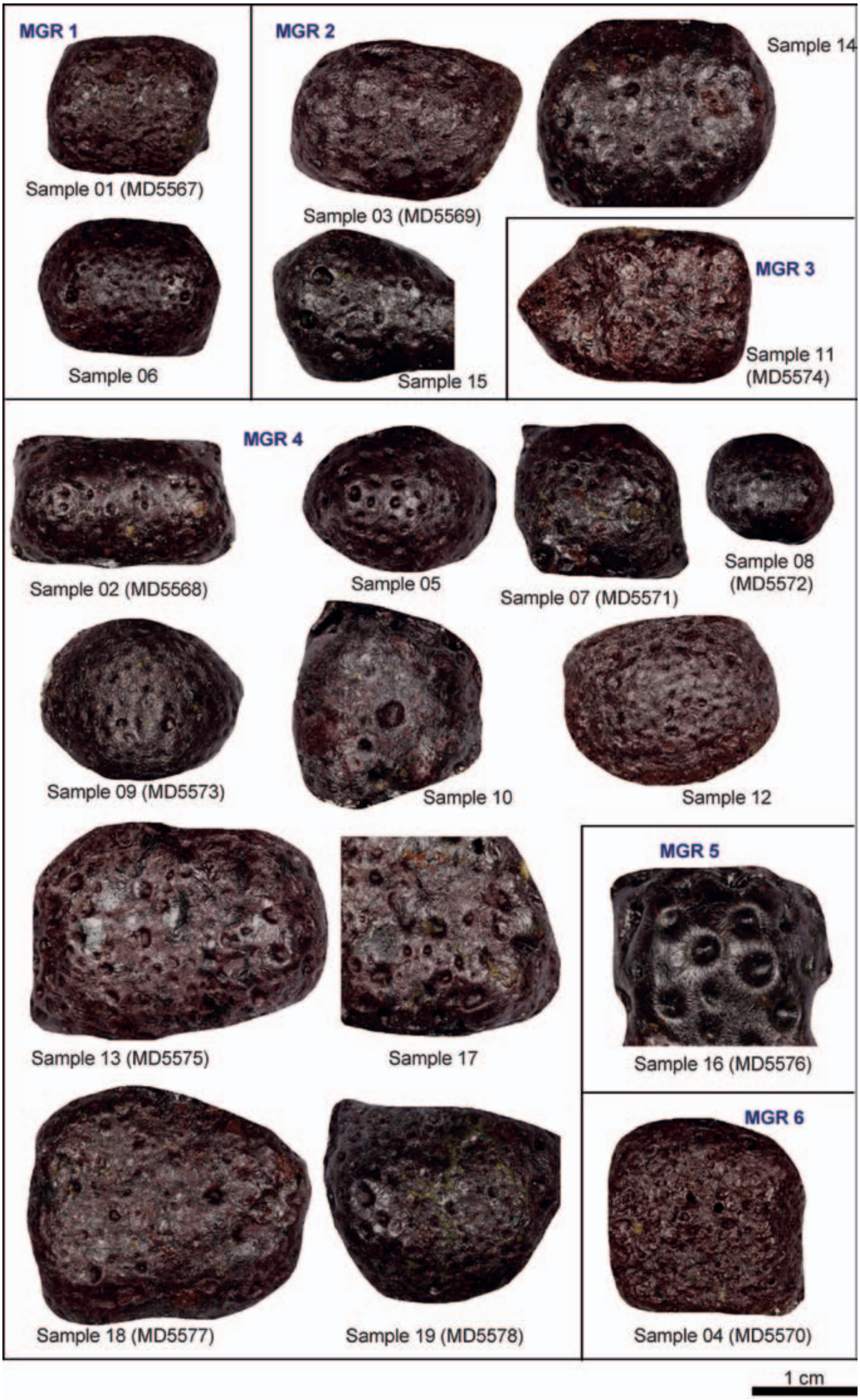

Fig. 18. Pottery fragments found in Ulmu representing MGR-groups 1–6. Samples after refiring at 1200 °C. (Graphic preparation: Hanna Baranowska).

ceramic fragments were made from 14 various clays (MGR-group 1–14). Fig. 18 and 19 show all of the samples after refiring at 1200 °C divided into MGR-groups. None of the MGR-groups are represented at both sites. Pottery fragments found in Ulmu represent MGR-groups 1–6 (Fig. 18). Eleven of these 19 samples represent MGR-group 4. The thermal behaviour of samples representing MGR-groups 1, 2 and 5 is comparable and similar to that of MGR-group 4 (all these samples fire a silverish-brownish/brown or silver grayish brown colour at 1200 °C and have an sMLT BL matrix type, they are more or less matt and have varying numbers of pits). Distinctive samples from Ulmu include sample no. 11, attributed to MGR-group 3, and sample no. 4, attributed to MGR-group 6. Pottery fragments recovered from Horodca Mică (Fig. 19) were attributed to MGR-groups 7–14. The most numerously represented is MGR-group 7 (four samples). These samples exhibit distinctly different thermal behaviour to all other samples found at this site. The samples attributed to this group fire a brownish-reddish colour at 1200 °C and have an sovM\(sBL) matrix type. Sample no. 32 (MGR-group 9) fires brownish-red. Samples attributed to MGR-groups 8 and 10–14 exhibit similar thermal behaviour: they fire a silverish-brownish colour with a red/reddish shade and have an sMLT matrix type with pits, those attributed to MGR-groups 11–14 having a more or less matt surface.

The results of MGR-analysis demonstrate that, based on shade and surface sheen, the prevalent samples among those found in Ulmu (17 of 19 samples belonging to MGR-groups 1, 2, 4 and 5) can be distinguished from most of the samples found at Horodca Mică (10 of 15 samples, MGR-groups 8, 10–14). Red is absent in samples from Ulmu after refiring, while samples from Horodca Mică have a shinier surface (tab. 1).

Figures 20 and 21 show samples before refiring (original samples) in the same order as in figures 18 and 19. Various clay lumps and/or grog are visible macroscopically in each sample. It is often difficult to distinguish between clay lumps (associated with poorly homogenised clay bodies) and grog in sherds made of the same raw material. Pottery fragments found at both sites feature various quantities of clay lumps and grog of various sizes, even among sherds belonging to the same MGR-group (see, for example, fig. 6, MGR 4, sample no. 02 and 17). MGR-analysis indicates that grog consisted both of crushed sherds made from the same raw material as the ceramic body to which it was added as well as crushed pottery made from different raw materials. Before refiring, the source of the grog cannot be definitively identified; however, after refiring differences become manifest in different thermal behaviour. For example, in figure 19 25 grog made from crushed sherds attributable to MGR-groups 4 and 9 is clearly visible in sample no. 31.

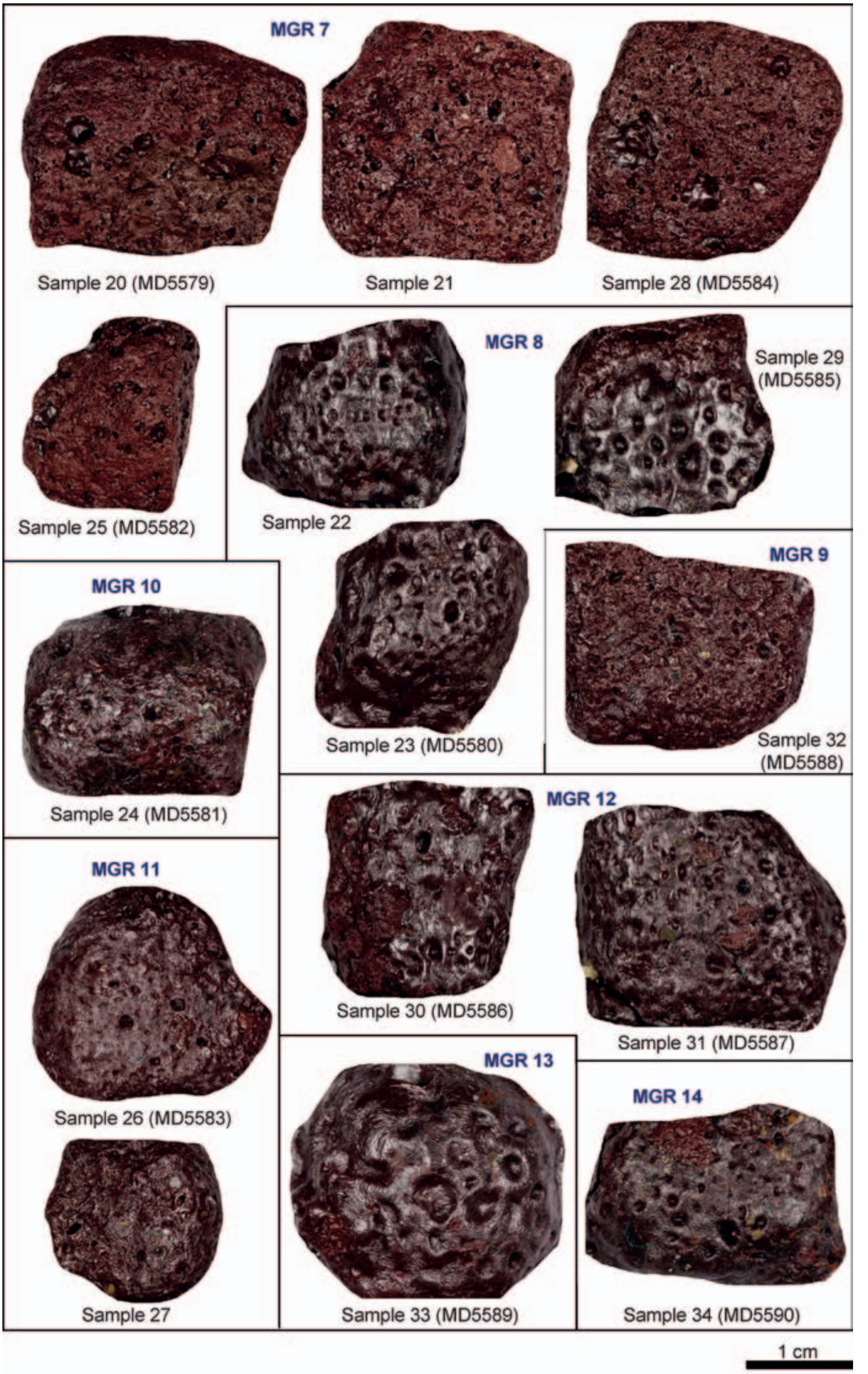

Fig. 19. Pottery fragments found in Horodca Mică representing MGR-groups 714. Samples after refiring at 1200 °C. (Graphic preparation: Hanna Baranowska).

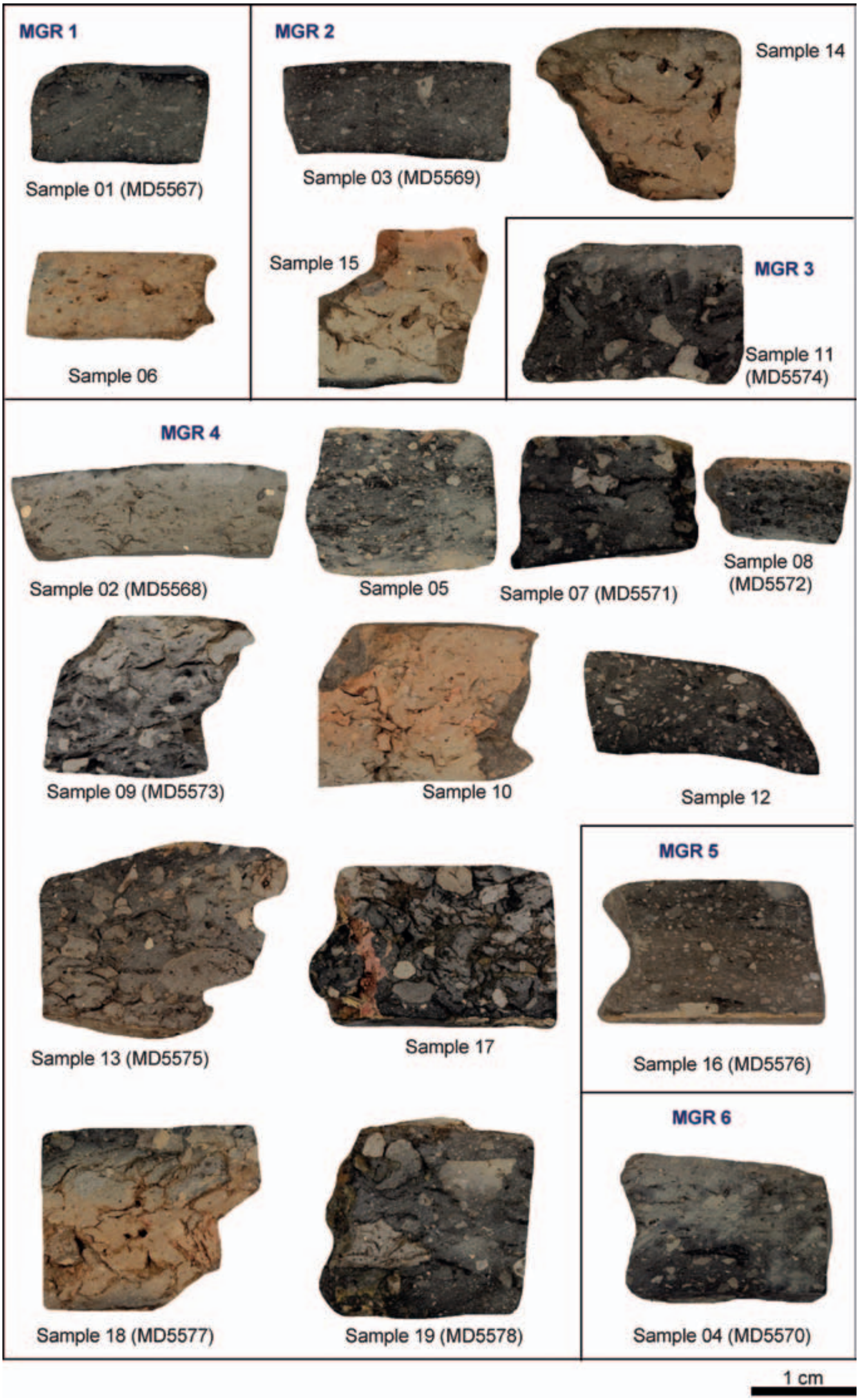

Fig. 20. Samples before refiring (original samples) displayed in the same order as in figure 4 (Graphic preparation: Hanna Baranowska).

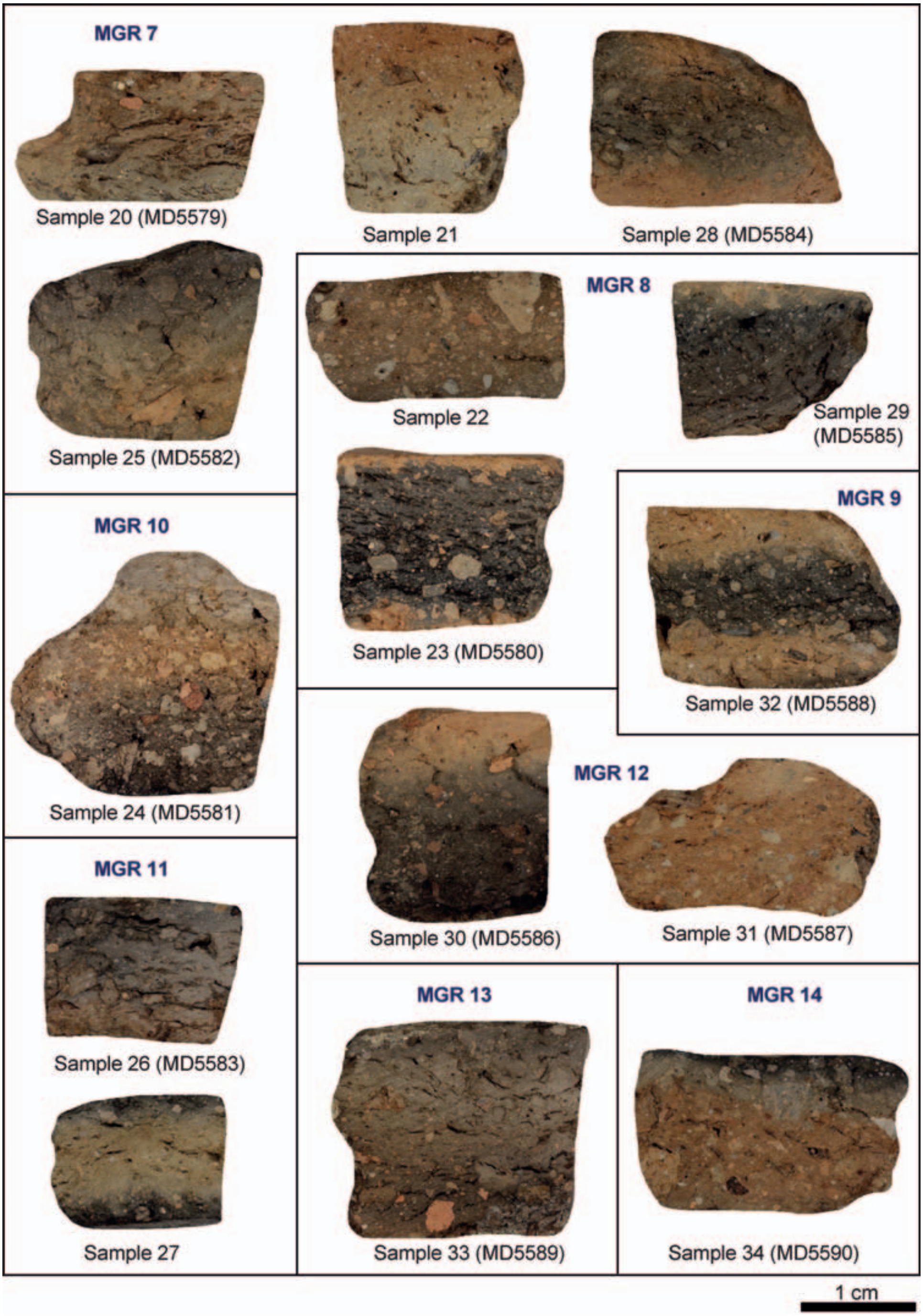

Fig. 21. Samples before refiring (original samples) displayed in the same order as in figure 5 (Graphic preparation: Hanna Baranowska).

Figures 20 and 21 clearly show that it is difficult to determine diagnostic parameters that would allow for a correlation between MGR-groups and a macroscopic assessment of wares based on analysis of the original samples.

Once MGR classification had been completed, samples were selected for chemical analyses. An important point to remember is that samples which exhibit the same thermal behaviour (appearance and shade of colour) after refiring at 1200 °C (the same MGR-group) were made using the same plastic raw material; however, the chemical composition of these samples might well be different because the results of chemical analysis carried out on potsherds also encompass the chemical composition of the ceramic body's non-plastic ingredients. Only samples attributed to one MGR-group and belonging to the same non-plastic material group were made from the same body (the same plastic and non-plastic material) and have the same chemical composition. This means that two sherds made of the same clay will only appear in two different chemical clusters if an intentionally added temper is present in one of the samples. For this reason, when selecting samples for chemical composition analysis, both the matrix group and the macroscopically visible non-plastic particles of the sherds were taken into account.

When both the results of MGR-analysis and chemical analysis are known this allows for the correct interpretation of chemical clusters deriving from multivariate statistics, as a multivariate cluster analysis is based on the content of elements within a given sample regardless of what phase they occur in. Furthermore, thanks to the results of chemical analysis[15] MGR-groups can be sorted into groups distinguished by similar geochemical parameters, hence into provenance groups.

Based on MGR-analysis results, 24 samples were selected for chemical composition analysis, the results of which are presented in table 2, divided into sites and MGR-groups. Looking at the content of key elements in determining provenance, samples from both sites are very similar in their chemical composition, with one exception (Ulmu, sample no. 11, MGR-group 3). In 23 of the sherds chromium (Cr) levels range from 101 to 129 ppm, nickel (Ni) content ranging from 52 to 82 ppm (Fig. 22). Magnesium (Mg) content calculated as MgO ranges from 2.05 to 3.12%.

[15] It must be stressed that it is only feasible if chemical analysis is conducted with good precision and accuracy (measurement accuracy is tested through measurement of international reference materials, precision by repeating a measurement. For a detailed description of the problems concerning chemical analysis of ancient ceramics see Daszkiewicz and Schneider 2014). This type of chemical analysis should be carried out using techniques such as WD-XRF, ICP-OS with ICP-MS, or NAA. Chemical analysis by pXRF is a good classification tool, but cannot be used for precisely determining chemical composition and establishing reference groups, particularly when the differences in chemical composition are small (as is the case, for example, with pottery from Ulmu and Horodca Mică.

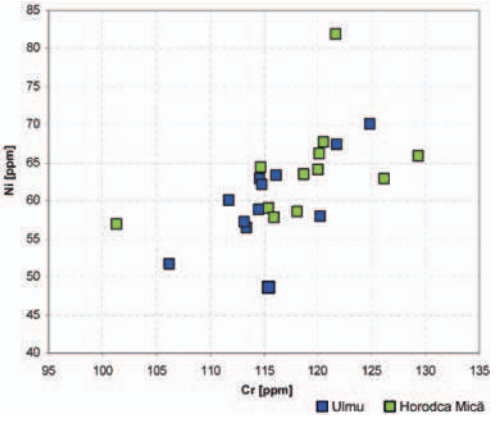

Fig. 22. Chromium content (Cr, in ppm) versus nickel content (Ni, in ppm) (Graphic preparation: Hanna Baranowska).

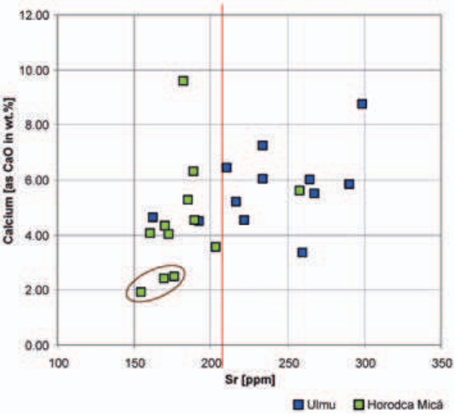

Fig. 23. Strontium content (Sr, in ppm) versus calcium content (CaO, in wt.%). (Graphic preparation: Hanna Baranowska).

Titanium (Ti) calculated as TiO_2 ranges from 0.73 to 0.79%. The greatest differences were noted in the concentrations of calcium (Ca) and strontium (Sr), which is geochemically correlated with calcium. Only one sample from Horodca Mică has an Sr content of over 210 ppm, and only two samples from Ulmu have a lower one (Fig. 23). Three samples classified to MGR-group 7 are characterised by low levels of CaO (< 2.5%). Among the sherds found in Ulmu, one sample is distinctive in having a low concentration of Ca and a high Sr/Ca ratio (Sr/Ca = 78, in other samples this ratio varied from 32 to 50). The sample in question is the aforementioned no. 11, which also differs from other samples in MGR-analysis. It is has the lowest Ni content (49 ppm) and the lowest levels of magnesium (MgO = 1.83%) of all 24 samples subjected to chemical analysis. In the dendrogram presenting the results of multivariate cluster analysis[16] this sample forms a separate cluster (cluster no. 5).

Separate clusters (clusters 1 and 2) are also formed by two other samples (nos. 16 and 34) with a high CaO content and by sample no. 24, which has the lowest Rb content of any sample (as well as the lowest Rb/K_2O ratio) and the highest Zr/SiO_2 ratio (each of these samples represents a different MGR-group). Cluster 3, with one exception, is made up of samples from Ulmu attributed to MGR-group 4 (six of the seven samples comprising this MGR-group). Cluster 4 consists of samples from Ulmu as well as Horodca Mică, though the samples from these sites exhibit a slight tendency to divide into sub-clusters. Cluster 6 is represented by the only sample attributed to MGR-group 10 (sample no. 24), which is distinguished from all other samples by having the lowest rubidium (Rb) content and lowest ratio of Rb to po-

[16] All statistical analyses, multivariate clusters analysis and principal components analysis were carried out using the SYSTEM Package ClusCorr 98 on licence from the Weierstrass Institute for Applied Analysis and Stochastics, Leibniz Institute in Forschungsverbund Berlin e.V.

tassium (K), with which it is geochemically correlated. Finally, cluster 7 consists solely of samples from Horodca Mică attributed to MGR-group 7. The results of cluster analysis do not fully coincide with those of MGR-analysis. In the dendrogram, sample no. 33 from Horodca Mică appears among samples from Ulmu in cluster 3, and one sample belonging to MGR-group 4 (sample no. 13) appears in cluster 4 (Fig. 24). In contrast, the results of principal components analysis (PCA) are consistent with those of MGR-analysis (Fig. 25). The loading plot (Fig. 26) shows that MGR-group 4 is distinctive primarily because of its Sr and Na levels.

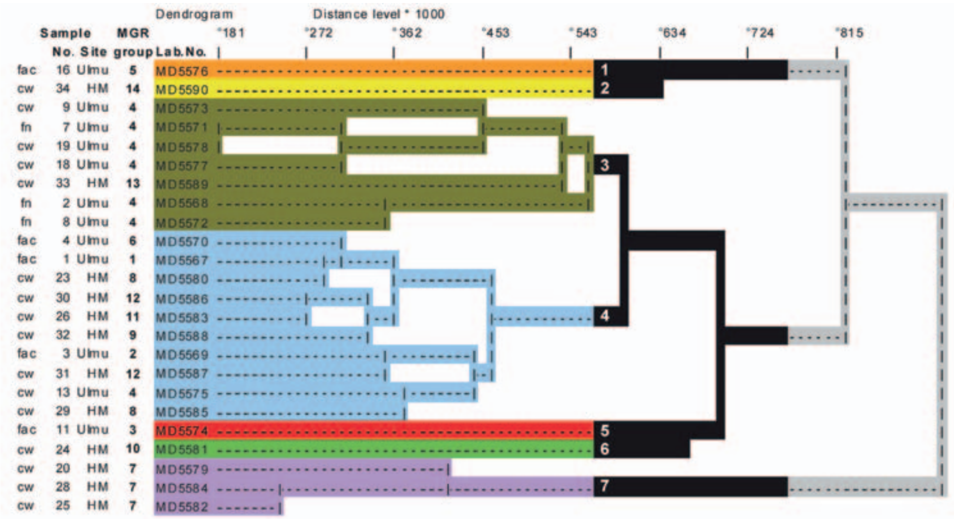

Fig. 24. Dendrogram presenting the results of multivariate cluster analysis. Analysis using Euclidean distance and average linkage aggregative clustering of a distance, data logged, elements used: Si, Ti, Al, Fe, Mn, Mg, Ca, Na, K, V, Cr, Ni, Zn, Rb, Sr, Y, Zr, Nb, La and Ce.

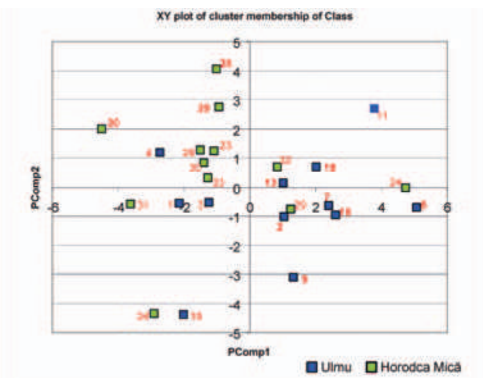

Fig. 25. Results of principal components analysis (PCA), elements used: Si, Ti, Al, Fe, Mn, Mg, Ca, Na, K, V, Cr, Ni, Zn, Rb, Sr, Y, Zr, Nb, La and Ce; sample numbers are shown in red.

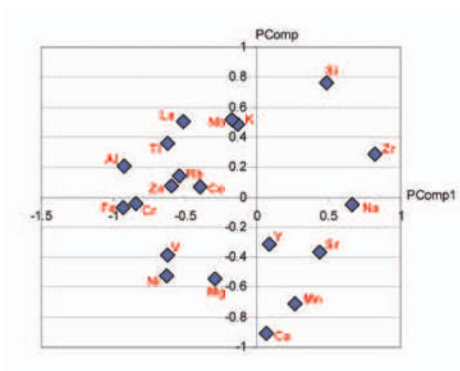

Fig. 26. Loading plot for PCA shown in figure 25.

Most of the samples found in Horodca Mică have higher concentrations of phosphorous (P_2O_5) than those found in Ulmu – this points to different depositional conditions.

Thin-sections were made from seven sherds, four of them found at the Ulmu site and three at the site in Horodca Mică. Studies of the thin-sections under a polarising microscope revealed that in general all of the samples are fairly similar in terms of the type, number and size of non-plastic particles. Grains of quartz representing natural inclusions are the predominate non-plastic material in all of the samples. Clay lumps and grog are also observed in all of the samples (Fig. 27-33). CaO levels identified by chemical analysis are associated with the presence of carbonates in the matrix (Fig. 27-30), secondary cryptocrystalline carbonates partially filling open pores (Fig. 30, Ulmu, sample no. 19) and with aggregates of crypto- or coarse crystalline carbonates (Fig. 33, Horodca Mică, sample no. 33). Single grains of chert are visible in two samples (Fig. 31 and 32, Horodca Mică, samples no. 20 and 28, both from MGR-group

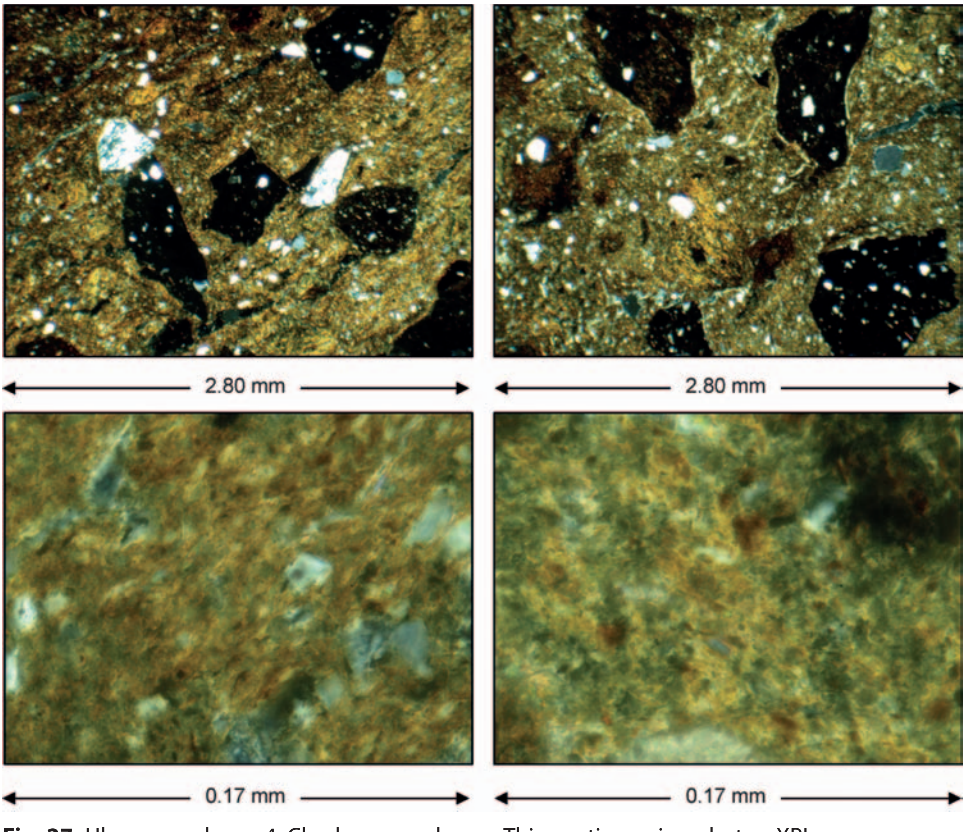

Fig. 27. Ulmu, sample no. 4. Clay lumps and grog. Thin-section, microphotos, XPL.

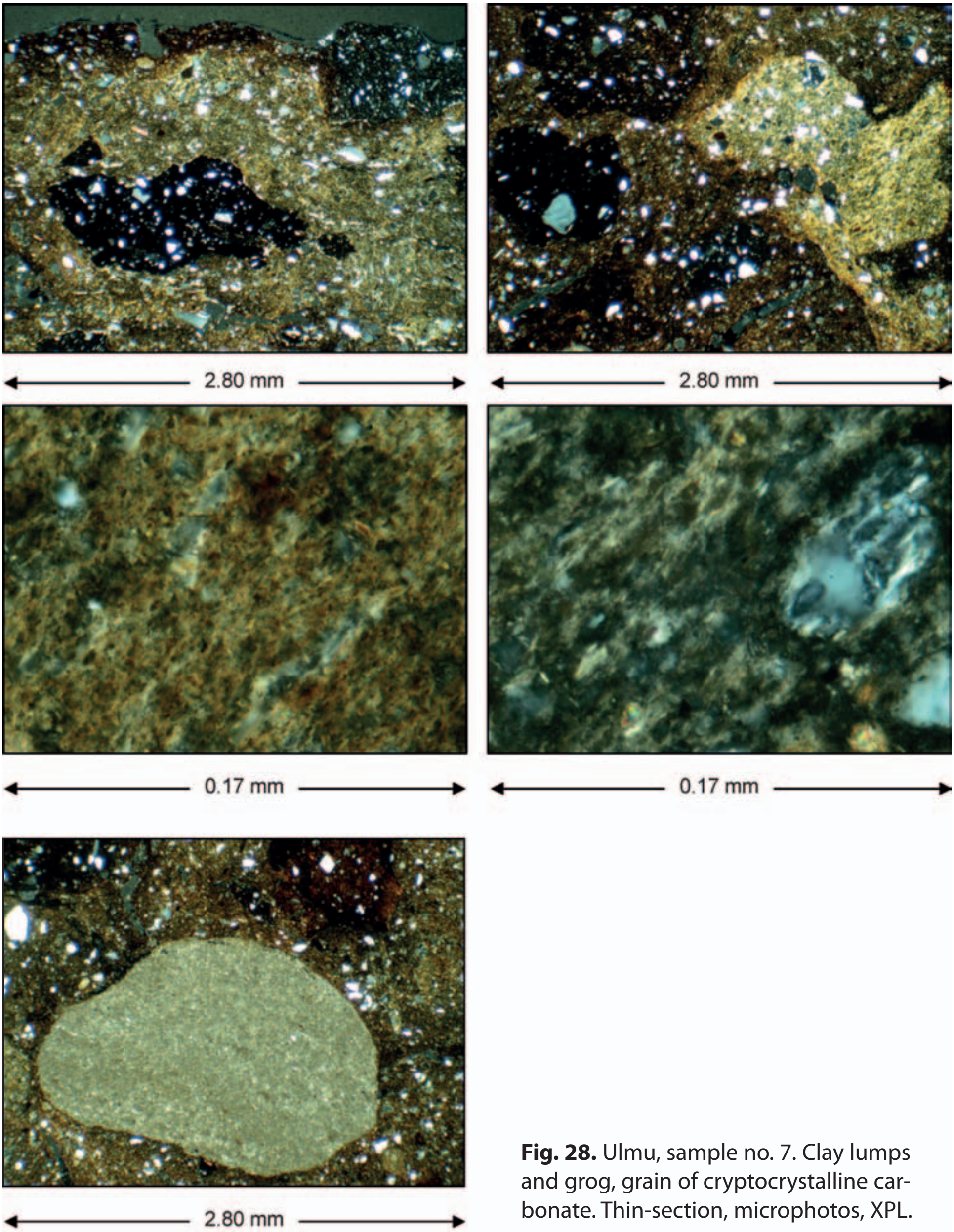

Fig. 28. Ulmu, sample no. 7. Clay lumps and grog, grain of cryptocrystalline carbonate. Thin-section, microphotos, XPL.

7) and two samples feature single grains of a microcline (Fig. 28 Ulmu sample no. 7; Fig. 33 Horodca Mică, sample no. 33).

The main difference observed among pottery samples from Ulmu is the variable content of quartz grains in fine sand fraction (Fig. 27-30), which is reflected in the SiO_2 content revealed by chemical analysis results. Two samples

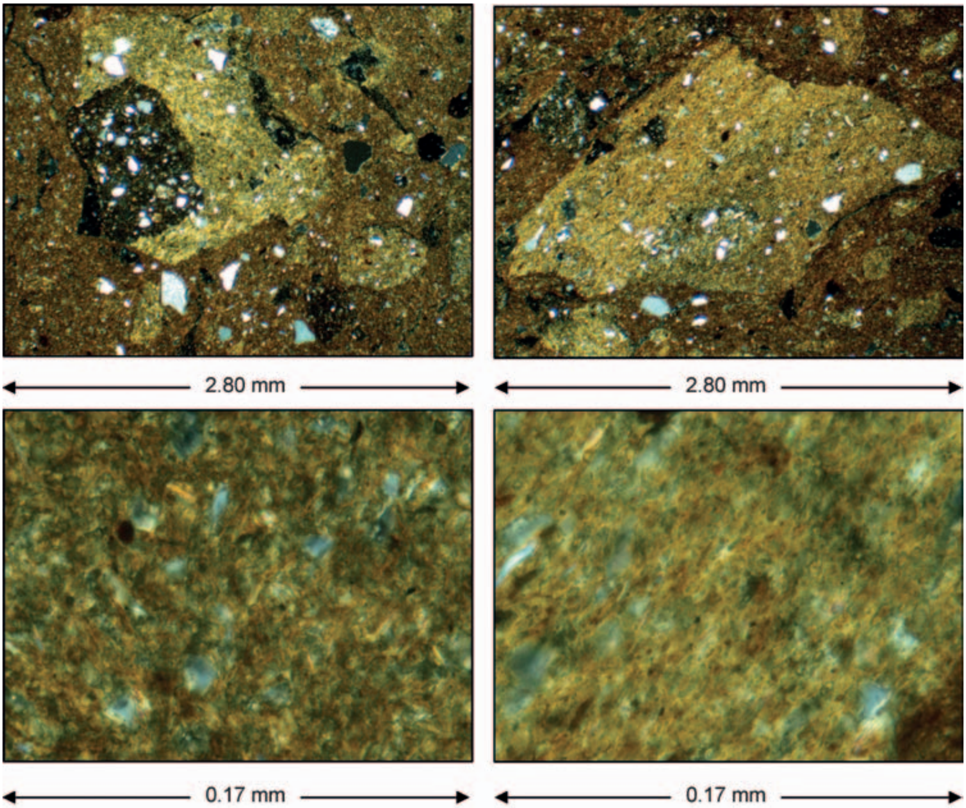

Fig. 29. Ulmu, sample no. 16. Clay lumps and grog. Thin-section, microphotos, XPL.

from MGR-group 4 have the same SiO_2 content; microscopic analysis also showed that their non-plastic particles differ little from one another. As well as variable quantities of quartz grains, samples from Horodca Mică also feature some grains of quartz in medium sand fraction (Fig. 27-30).

The physical ceramic properties of all 34 sherds were assessed. This means that an estimation was made of their open porosity (percentage of amount of water absorbed by a given volume of sample), water absorption (percentage mass gain of sample soaked in water in relation to mass of dry sample) and apparent density (mass of sample in relation to volume of sample).

When choosing locations from which to remove samples for analysis, handles and those parts of the vessel wall to which they were attached were disregarded because of their increased porosity, which bears no relation to the way in which the ceramic body was prepared (Fig. 36).

Large variations were observed in each of these three parameters (tab. 1). Fig. 35 shows a biplot of open porosity versus apparent density. Open porosity values range from 30.7 to 41.6%, with sherds recovered from the site at Ulmu displaying

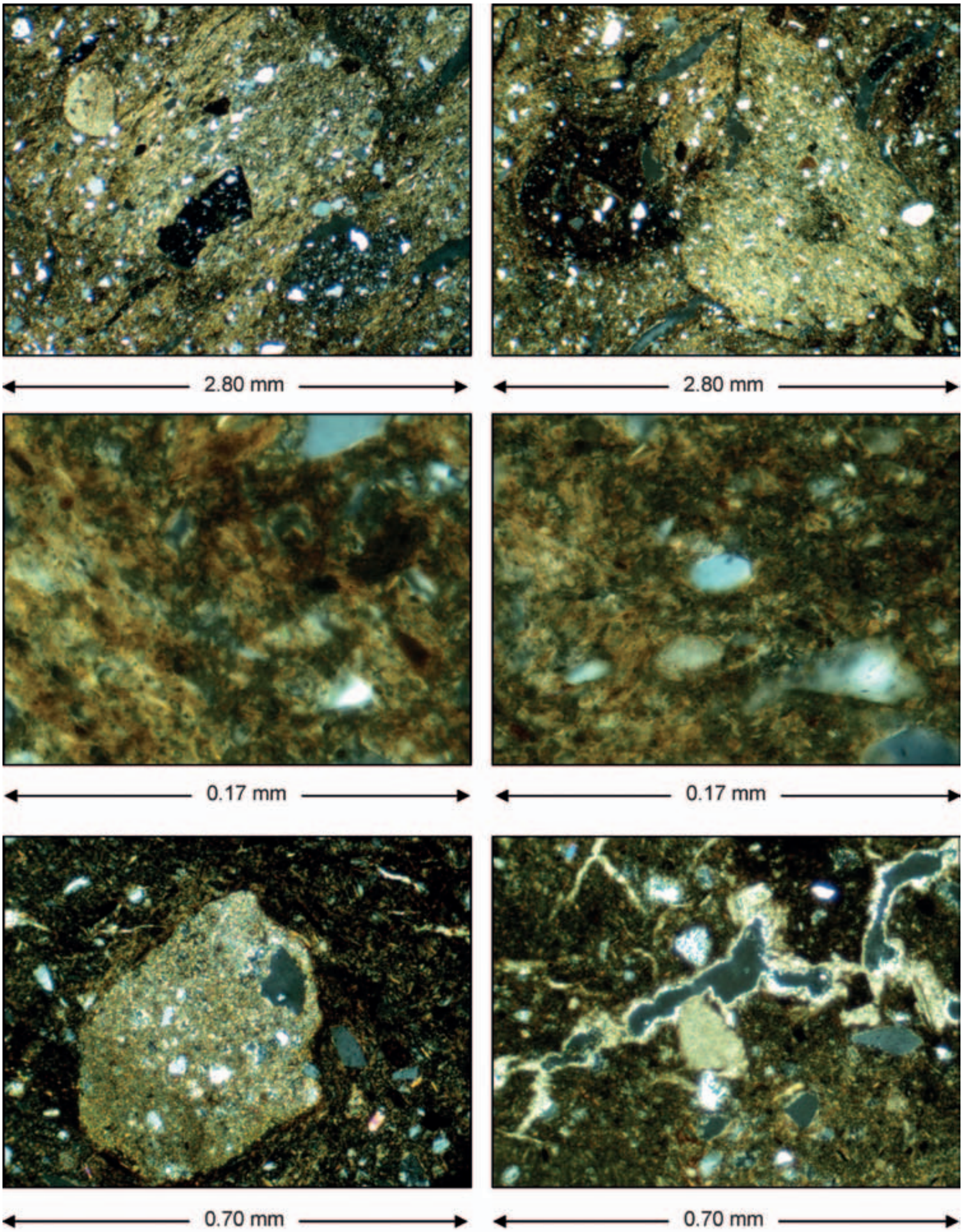

Fig. 30. Ulmu, sample no. 19. Clay lumps and grog; secondary cryptocrystalline carbonates partially filling open pores . Thin-section, microphotos, XPL.

a marked tendency towards lower values (less than 32 %) in comparison to sherds from Horodca Mică (over 37 %). Samples from both sites fall within an open porosity range of 33–35 %. The highest apparent density values were noted in three samples of Poienești-Lukașevka culture facetted vessels from Ulmu. The remain-

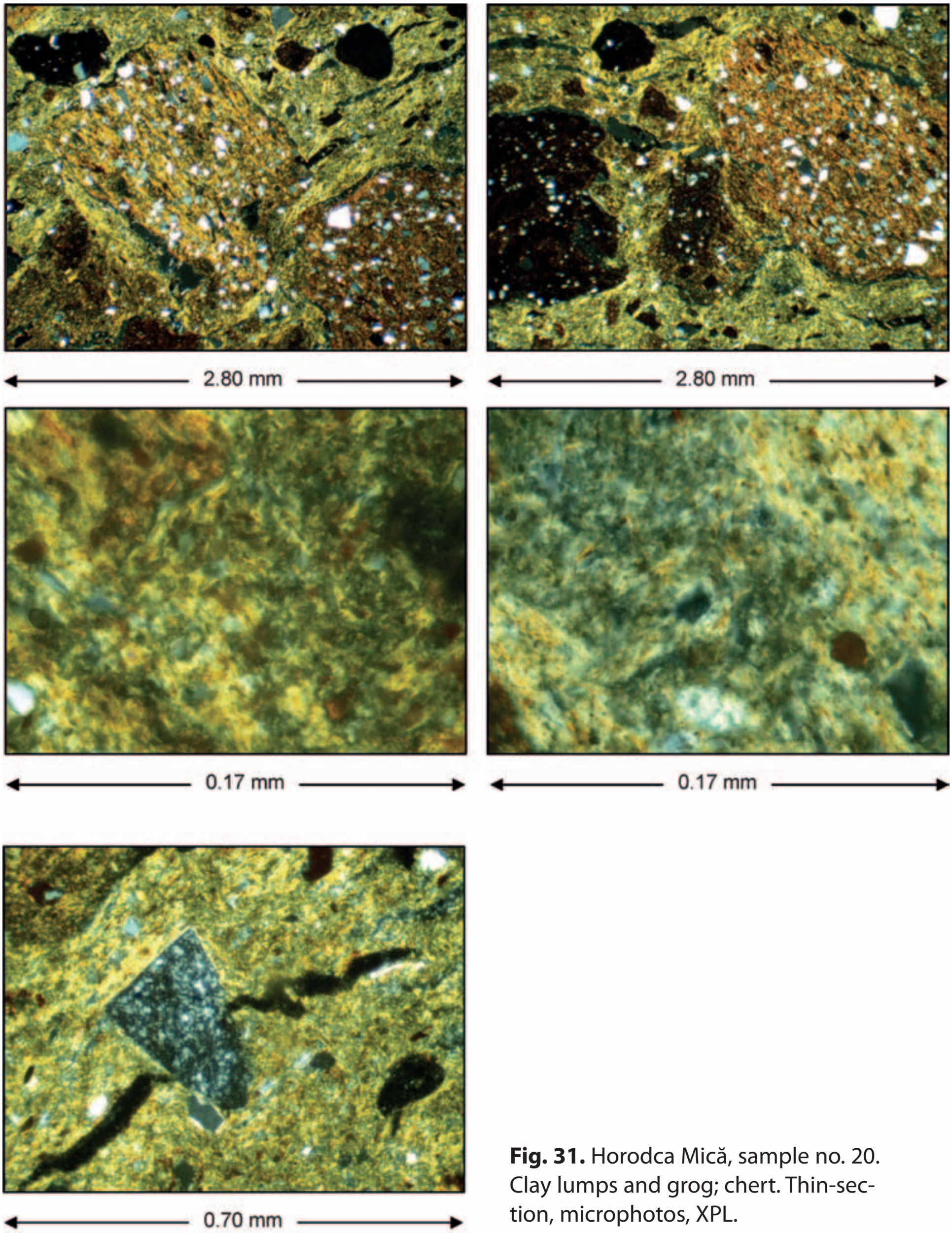

Fig. 31. Horodca Mică, sample no. 20. Clay lumps and grog; chert. Thin-section, microphotos, XPL.

ing facetted vessels from Ulmu as well as the coarse wares from this site do not differ significantly, in contrast to fine wares, whose open porosity does not exceed 34 %. Fig. 34 shows histograms together with normal distribution curves for open porosity values. The open porosity distribution for pottery from Ulmu is distinctly asymmetrical. Values within a range of 30–32 % predominate. This bears no relation to the raw material from which the pottery was made; samples attributed

Sample No.	MGR group	Lab. No.	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	V	Cr	Ni	Cu	Zn	Rb	Sr	Y	Zr	Nb	Ba	La	Ce	Pb	Th	l.o.i.	TOTAL
			per cent by weight										ppm															%	%
Poiniesti-Lukasevka-culture; Ulmu, Rajon Ialoveni																													
1	**1**	MD5567	64.61	0.78	16.49	6.55	0.091	2.98	4.63	0.25	3.31	0.33	144	115	63	41	122	141	163	30	153	14	601	36	71	19	11	6.79	100.07
3	**2**	MD5569	64.77	0.77	16.22	6.26	0.078	2.76	4.52	0.26	3.03	1.33	145	122	67	32	134	133	222	32	175	16	1697	37	56	24	5	6.85	100.74
11	**3**	MD5574	68.13	0.76	15.34	5.71	0.068	1.83	3.34	0.54	3.50	0.77	132	116	49	41	112	124	260	34	208	17	1104	32	67	21	7	4.94	99.68
2	**4**	MD5568	64.28	0.74	15.66	6.08	0.085	2.86	6.44	0.42	2.89	0.54	142	113	57	34	100	137	211	31	177	16	752	39	76	20	6	1.37	100.11
7	**4**	MD5571	65.65	0.75	15.14	5.89	0.101	2.30	6.01	0.26	3.42	0.50	127	115	59	27	113	135	264	31	180	15	747	28	56	21	5	5.96	100.41
8	**4**	MD5572	65.94	0.74	14.75	5.62	0.101	2.65	6.03	0.56	2.93	0.68	124	106	52	28	91	121	234	31	200	16	829	33	74	20	<5	1.30	100.15
9	**4**	MD5573	63.49	0.73	15.44	6.22	0.108	2.92	7.24	0.41	2.91	0.54	142	116	63	35	99	136	234	29	165	15	787	28	58	18	8	1.41	100.69
13	**4**	MD5575	64.81	0.74	15.89	6.14	0.081	2.58	5.19	0.41	3.47	0.70	136	112	60	45	112	130	216	28	164	17	1166	33	66	19	10	3.73	100.57
18	**4**	MD5577	65.76	0.75	15.19	6.19	0.100	2.34	5.49	0.25	3.44	0.48	113	113	57	39	122	134	268	29	177	18	811	34	53	21	6	5.89	100.69
19	**4**	MD5578	65.76	0.74	15.06	5.92	0.093	2.42	5.84	0.28	3.36	0.52	123	115	62	31	111	131	291	34	175	16	806	28	56	22	<5	7.48	100.51
16	**5**	MD5576	60.07	0.74	16.07	6.60	0.106	3.12	8.75	0.32	3.13	1.08	149	125	70	49	127	131	299	30	147	16	1439	34	72	19	8	8.92	100.51
4	**6**	MD5570	64.16	0.79	16.88	6.60	0.058	2.63	4.48	0.27	3.42	0.73	145	120	58	40	129	127	193	33	154	17	1216	38	72	18	5	6.76	100.07
Getic culture; Horodca Mică, Rajon Ialoveni																													
20	**7**	MD5579	65.36	0.79	17.48	6.93	0.078	2.66	1.90	0.27	3.52	1.02	143	129	66	30	123	148	154	30	161	16	1168	43	72	23	14	2.37	100.55
25	**7**	MD5582	68.13	0.75	16.18	6.22	0.053	2.05	2.41	0.18	3.32	0.71	129	116	58	29	127	131	170	26	159	18	1072	50	78	29	8	3.63	100.10
28	**7**	MD5584	66.83	0.76	16.18	6.39	0.096	2.18	2.47	0.24	3.48	1.37	133	119	64	42	114	132	177	28	169	19	1207	46	70	26	10	3.52	101.08
23	**8**	MD5580	63.95	0.75	16.67	6.51	0.064	2.68	4.51	0.30	3.90	0.66	131	116	59	34	115	148	190	30	175	15	821	37	70	18	5	1.95	100.34
29	**8**	MD5585	64.97	0.74	15.27	5.88	0.078	2.50	6.32	0.24	3.39	0.62	128	115	64	37	126	124	189	31	165	14	625	34	58	20	6	6.23	100.36
32	**9**	MD5588	67.14	0.74	15.72	6.20	0.087	2.17	3.55	0.23	3.35	0.81	136	118	59	33	110	128	203	31	164	16	910	32	69	22	7	4.13	100.91
24	**10**	MD5581	67.14	0.74	14.92	5.86	0.112	2.37	4.02	0.42	3.58	0.83	129	101	57	32	116	114	173	32	202	14	715	24	53	20	<5	3.91	101.20
26	**11**	MD5583	65.11	0.78	16.58	6.48	0.068	2.24	4.05	0.30	3.39	1.00	135	120	66	27	109	140	161	32	164	17	792	32	67	20	10	2.58	100.63
30	**12**	MD5586	65.09	0.77	16.41	6.45	0.077	2.58	4.33	0.20	3.38	0.73	125	120	64	33	121	130	171	31	163	17	948	31	79	24	11	4.19	100.97
31	**12**	MD5587	63.78	0.77	16.63	6.64	0.081	2.73	5.25	0.19	3.32	0.61	152	126	63	45	158	142	186	33	151	16	797	34	57	18	8	5.77	100.24
33	**13**	MD5589	62.49	0.76	16.31	6.45	0.083	2.50	5.59	0.20	3.51	2.10	127	121	68	54	115	124	258	27	165	17	1358	44	64	21	12	6.19	100.64
34	**14**	MD5590	59.53	0.75	16.38	6.75	0.127	2.23	9.58	0.18	3.32	1.16	149	122	82	56	118	123	182	35	143	16	1036	32	83	23	9	9.34	100.93

Tab. 2. 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.

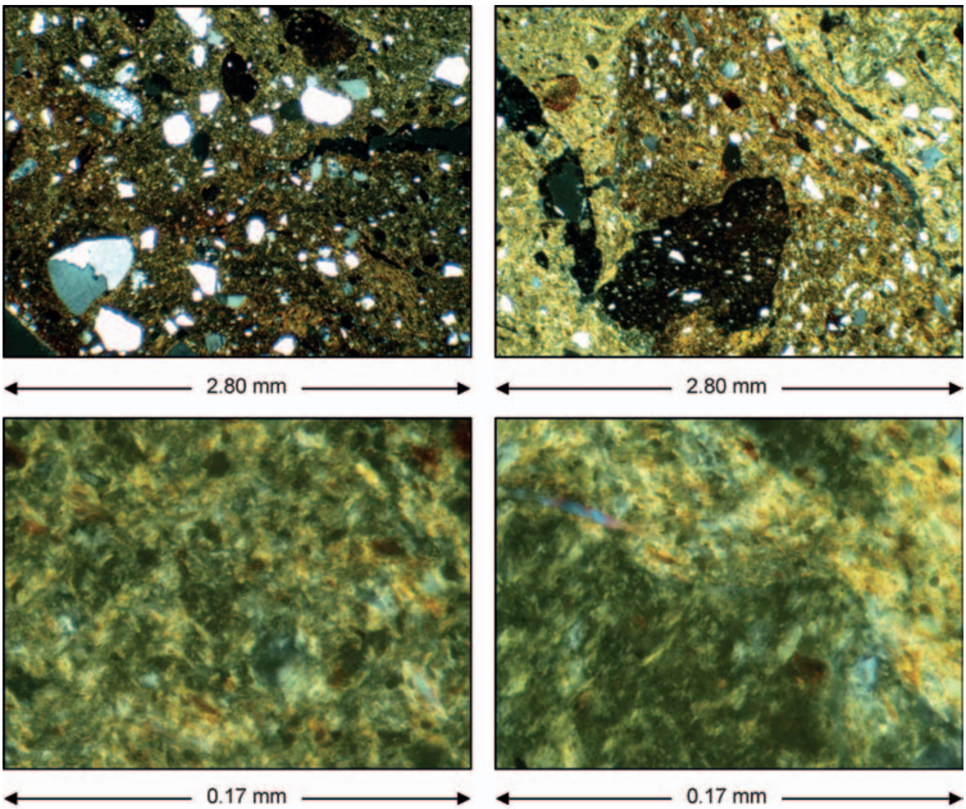

Fig. 32. Horodca Mică, sample no. 28. Grains of quartz, clay lumps and grog Thin-section, microphotos, XPL.

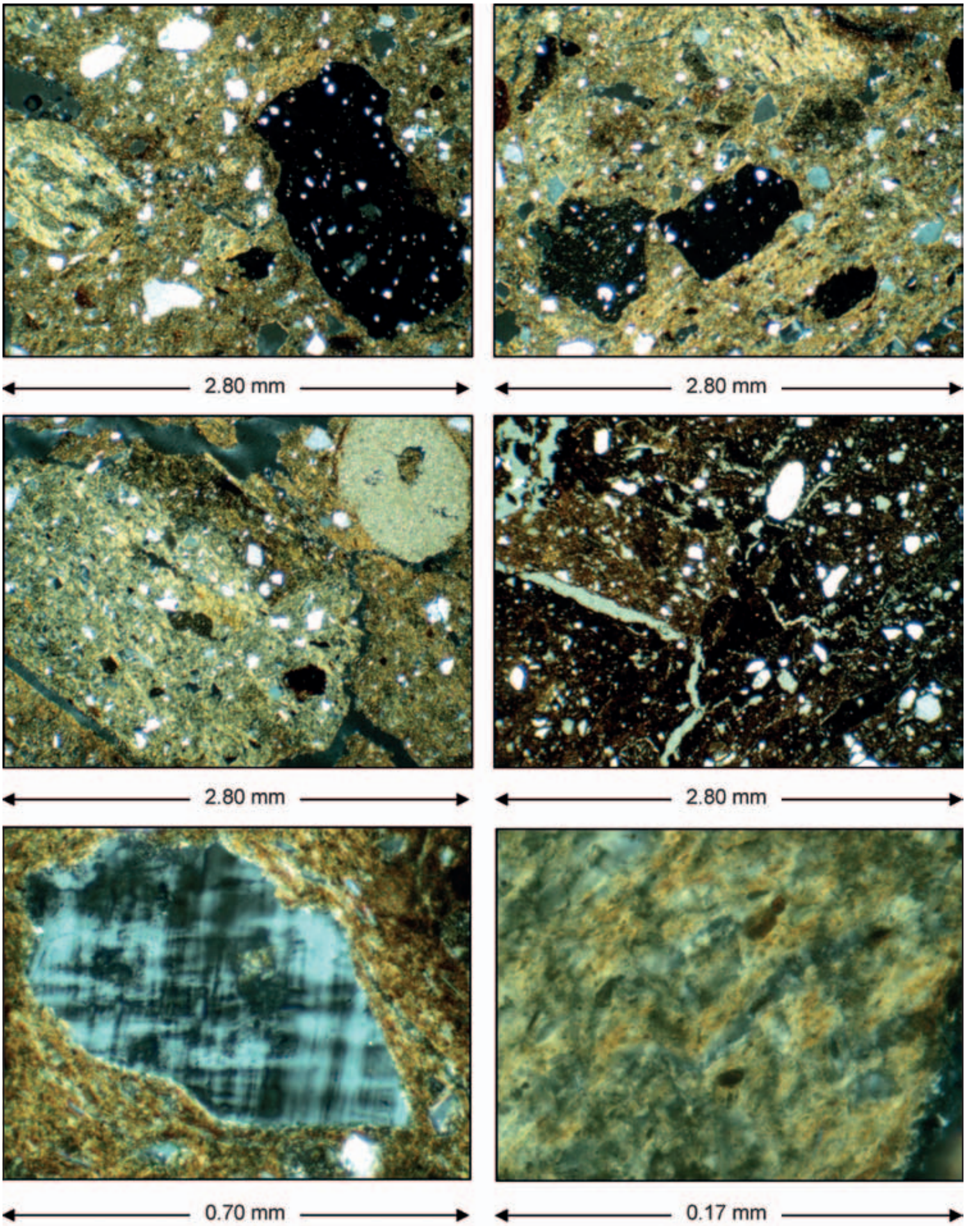

Fig. 33. Horodca Mică, sample no. 33. Clay lumps and grog, cryptocrystalline carbonate, microcline. Thin-section, microphotos, XPL.

to the most abundant MGR-group at this site (MGR-group 4) are represented in every range. Pottery recovered from Horodca Mică is more or less symmetrically distributed around the average value, with a tendency towards orthogonal asymmetry, i.e. with a greater number of samples with higher open porosity values. In

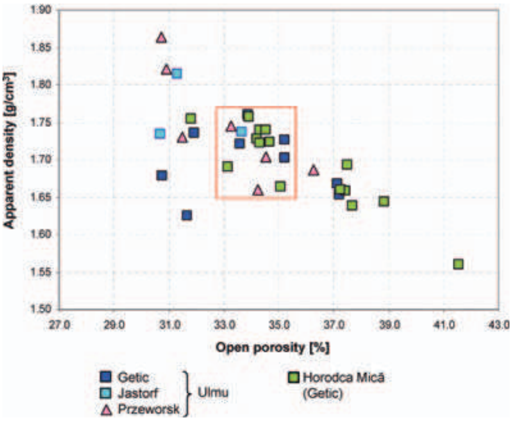

Fig. 34. Histograms (number of samples representing a specific open porosity values) together with normal distribution curves for open porosity values.

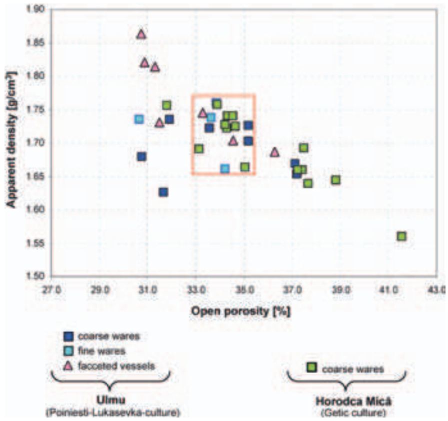

Fig. 35. Biplot of open porosity versus apparent density.

this instance there is also no correlation with the raw material used.

The original firing temperature of sherds was not estimated by analysis; however, it undoubtedly varied considerably, as indicated by loss on ignition values (tab. 2) ranging from 1.30 to 9.34 %, which in many instances were not correlated with the content of carbonate, phosphorous or unburned organic matter. It is interesting that the highest temperature (much higher than that evinced by all other samples) was observed for three sherds attributed to MGR-group 4 (Ulmu, samples no. 2, 8, 9), each one representing a different typological attribution: facetted bowls, fine ware and coarse ware respectively.

Fig. 36. Handles and those parts of the vessel wall to which they were attached exhibit increased porosity, which bears no relation to the way in which the ceramic body was prepared.

Conclusions

All sherds found at the Ulmu and Horodca Mică sites were made either of various non-calcareous clays coloured by iron compounds (MGR-groups 3, 6, 7 and 9) or of various non-calcareous clays coloured by iron compounds and enriched with carbonates. Sherds classified to MGR-groups 1, 2, 4 and 5 (Ulmu) have a matrix enriched with carbonates to a greater degree than sherds representing MGR-groups 8 and 10–14 (Horodca Mică), in which carbonates are mainly associated with the non-plastic part of the body.

Ceramic wares found at both sites were made using a body intentionally tempered with crushed potsherds (grog). At both sites pottery was made using similar, non-standardised technology: various amounts of grog temper were used and firing was carried out at various temperatures in an incompletely oxidizing atmosphere.

None of the analysed sherds found in Ulmu were made of the same raw material as those used for pottery manufacturing at the neighbouring site in Horodca Mică. As the sites differ chronologically this demonstrates a discontinuity in raw material use.

Taking into consideration the results of MGR-analysis, chemical analysis and thin-section studies it can be concluded that the analysed samples represent wares made at local pottery workshops, except for facetted pot sample no. 11 found at the site in Ulmu. This sample most probably represents a non-regional import. The same might be true of another facetted pot sample (sample no. 16), which was notable for having the highest Al/Si ratio. Interestingly, both sample no. 16 and sample no. 11 have an unusually high open porosity value for facetted pots.

One of the samples found in Horodca Mică (sample no. 24) has a slightly different chemical composition and phase composition than all of the remaining samples. At this stage of research it is difficult to determine whether it represents a regional or a local ware. There are no formal differences between this sample and other samples from the site (samples no. 21 and 30).

Most of the pottery found in Ulmu (11 of the 19 analysed samples) was made from the same raw material (MGR-4). This raw material was used to produce coarse (GK) and fine ware (FK) as well as facetted pots. This clearly points towards a local production of pottery of all types. Matrix groups that were restricted to the production of facetted bowls (MGR-groups 1, 2 and 6) might additionally show a specific selection of raw materials for these particular forms (samples no. 1, 4 and 6), but there is no evidence that these MGR-groups represent imports.

Open porosity values are generally high (30–42 %) These values differ significantly between the two sites analysed (Fig. 36). This is clearly connected to the presence of facetted bowls. In general, facetted bowls and cups show a lower open porosity and a higher apparent density (Fig. 35). The two facetted pots with a higher porosity (samples no. 11 and 16) differ in chemical composition and matrix group (Fig. 24) and might have been produced at other sites.

At both sites and in both phases there is a high emphasis on local production of ceramics using raw materials from the direct vicinity of the sites only one evident import could be detected. Technology was not standardised at both sites, the same temper strategy (type, size to a new type of vessel noted at the Poienești-Lukaşevka culture settlement: facetted bowls were generally produced using a technology that yielded vessels with a higher apparent density and lower open porosity. This certainly has to do with the character of these bowls as fine ware.

In summary, the similarities in production between ceramics from the Getic site and the Poienești-Lukaşevka-site are clearly visible. The only change is connected to a new group of vessel types. From the archaeometric point of view, there is nothing to suggest a lack of continuity in ceramic production traditions. This continuity in technology can be understood as a continuous transmission of knowledge between individuals. We assume that a complete change of population involving a deserted landscape after the end of the Getic settlements and the arrival of new settlers would yield very different results. As the results presented herein are only based on a small number of samples it is clear that the interpretation is only of a preliminary nature.

APPENDIX

Description of methods used

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 500 °C, 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 precision for major elements is below 1 %, for trace elements this rises to a maximum of 20 % depending on the concentrations. Accuracy was tested by analysing international reference samples and by exchange of samples with other laboratories. For major elements and the most important trace elements it is between 5 and 10 %.

Preparation of samples for analysis was carried out by M. Daszkiewicz in ARCHEA, measurement using a PANnalytical AXIOS XRF-spectrometer and the calibration of Arbeitsgruppe Archaeometrie by G. Schneider and A. Schleicher in GFZ Potsdam (GFZ = Helmholtz-Zentrum Potsdam, Deutsches GeoForschungsZentrum GFZ, Sektion 4.2, Anorganische und Isotopengeochemie).

Thin-sections

Thin-sections were studied under a polarising microscope to provide some information on the matrix (the amount of information gleaned being dictated by the resolution of the microscope), primarily to estimate the composition and distribution of non-plastic inclusions.

Physical ceramic properties

Physical ceramic properties (apparent density, open porosity, water absorption) estimated by hydrostatic weighing can be carried out on original pottery fragments. Individual values were calculated using one of three measurements: mass of sample immersed in water, mass of moist sample weighed in air, mass of dry sample.

Bibliography

Arnăut, Tudor. 2003. *Vestigii ale sec. VII–III a. Chr. în spațiul de la răsărit de Carpați*. Chișinău: Universitatea de Stat.

Daszkiewicz, Małgorzata, and Gerwulf Schneider. 2001. "Klassifizierung von Keramik durch Nachbrennen von Scherben", *Zeitschrift für Schweizerische Archäologie und Kunstgeschichte,* 58, 1: 25-32.

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

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

Dergachev, Valentin. 1973. "Pamjatniki jepohi bronzy." Arheologicheskaja karta MSSR, 3. Kishinev: Stiinta.

Fedorov, Georgij. 1960. "Naselenie Pruto-Dnevstrovskogo mezhdurech'ja v I t. n.je.", *Materialy i Иssledovanija po Arheologii SSSR,* 89: 1-378.

Hâncu, Ion. 1993. Cetăţi antice şi medievale timpurii din Republica Moldova. Chişinău: Universitas.

Iarmulschi, Vasile. 2013. "Unele consideraţii privind cronologia culturii Poieneşti-Lucaşeuca." *Tyragetia s. n.,* vol. VII [XXII], nr. 1: 29-52.

Iarmulschi, Vasile. 2016. "A few consideration regarding the chronology of the Poienești-Lucașeuca culture." *Prähistorische Zeitschrift* 91, 2: 471-494.

Iarmulschi, Vasile. 2017. "Reflections on the Setllements attribuited to the Poienești-Lucașeuca Culture." *Journal of Ancient History and Archeology* 4, 1: 29-46.

Lapushnjan, Valerij, Ion Nikulicje, and Marina Romanovskaja. 1974. "Pamjatniki rannego zheleznogo veka." Arheologicheskaja karta MSSR, 4, Kishinev: Stiinta.

Meyer, Michael, and Malgorzata Daszkiewicz. 2003. "New pots or new people? – Archaeoceramological study of La Tène and "Przeworsk"-like Pottery in the Celtic German highland zone." In *Prehistoric Pottery: People, Pattern and Purpos.* edited be A. Gibson, Proceedings of the Prehistoric Ceramics Research Group and the Ceramic Petrology Group Joint conference in Bradford 12th-13th October 2002, 114-133. Oxford: Archaeopress.

Munteanu, Octavian, and Vasile Iarmulschi. 2007. „Preliminarii privind fortificația de la Horodca-Mică." *Tyaragetia s. n.,* vol. I [XVI], nr. 1, 2007: 279-286.

Munteanu, Octavian, Vasile Iarmulschi, Veronica Perju, and Livia Ermurachi 2009. „Prima fază de edificare a fortificației de la Horodca Mică." *Tyragetia s.n.,* vol. 1, IV (XIX): 179-198.

Munteanu, Octavian, and Vasile Iarmulschi. 2013. "La Fortification Gète de Horodca Mica, R. de Moldavie: techniques de construction et phases de l'édification." In *The Thracians and their Neighbours in the Bronze and Iron Ages. Settlements, Fortresses, Artifacts,* vol. I, Proceedings of The 12th International Congress of Thracology. Târgovişte 10-14 september 2013, 2. edited by Christian Shuster, O. Cîrstina, Marian Cozac and George Murătoreanu, 269-295. Târgovişte: Cetatea de Scaun.

Munteanu, Octavian. 2009. „Raport ştiinţific privind rezultatele investigaţiilor arheologice din anul 2008 în microzona fortificaţiilor de la Horodca, raionul Ialoveni." Chişinău. Arhiva MNIM. Ms.

Munteanu, Octavian. 2010. „Raport ştiinţific privind rezultatele investigaţiilor arheologice din anul 2009 în microzona fortificaţiilor de la Horodca, raionul Ialoveni." Chişinău: Arhiva MNIM. Ms.

Munteanu, Octavian. 2011. „Raport ştiinţific privind rezultatele investigaţiilor arheologice din anul 2010 în microzona fortificaţiilor de la Horodca, raionul Ialoveni." Chişinău: Arhiva MNIM. Ms.

Munteanu, Octavian. 2012. „Raport ştiinţific privind rezultatele investigaţiilor arheologice din anul 2011 în microzona fortificaţiilor de la Horodca, raionul Ialoveni." Chişinău: Arhiva MNIM. Ms.

Munteanu, Octavian. 2013. „Etapele de edificare ale fortificaţiei de la Horodca-Mică." Tyragetia s. n., vol. VII [XXII], nr. 1: 311-328.

Nikulice, Ion. 1981. „Issledovanie getskih pamjatnikov u s. Hanska." Arheologicheskie otkrytija 1980 g., Moskva:493-494.

Nikulice, Ion. 1987. *Severnye frakijcy VI-I vekov do nashej jery*. Kishinjov: Stiinca

Passek, Tatiana. 1949. „Arheologicheskie razvedki v Moldavii." Kratkie Soobshhenija Instituta Istorii Material'noj Kul'tury, 26: 57-68.

Polevoj, Lazar', and Pavel Byrnja. 1974. „Srednevekovye pamjatniki XIV-XVII vv." *Arheologicheskaja karta MSSR*, 7. Kishinev: Stiinta.

Polevoj, Lazar'. 1969. „Arheologicheskie pamjatniki verhnego techenija r. Botna." *Dalekoe proshloe Moldavii* (Kishinev), 185-210.

Popa, Alexandru, Sergiu Musteaţă, Veaceslav Bicbaev, Knut Rassmann, Octavian Munteanu, Gheorghe Postică, and Ghenadie Sîrbu. 2010. „Rezultatele preliminare privind sondajele geofizice din anul 2009 și perspectivele folosirii magnetometriei în Republica Moldova." In: *Arheologia între ştiinţă, politică şi economia de piaţă*, edited by Musteaţă Sergiu, Alexandru Popa and J.-P. Abraham, 145-157. Chişinău: Pontos.

Romanovskaja, Marina. 1969. „Ob jetnicheskoj prinadlezhnosti naselenija ostavivshego pamjatniki tipa Lukashevka." *Materialy i Иssledovanija po Arheologii SSSR*, 150: 81-95.

Romanovskaja, Marina. 1987. „Aşezarea de la Ulmu. Săpăturile din anul 1960." *Arheologia Moldovei* XI: 207-226.

Smirnov, Georgij. 1949. „Itogi arheologicheskih issledovanij V Moldavii v 1946 godu." *Uchennye zapiski Instituta Istorii, jazyka i literatury*, tom II, Kishinev: 197-198

Tentiuc, Ion. 2012. *Contribuții la istoria și arheologia spațiului pruto-nistrean*. Chișinău: Muzeul Național de Istorie a Moldovei.

Zlatkovskaja, Tatiana, and Leonid Polevoj. 1969. „Gorodishha pruto-dnestrovskogo mezhdurech'ja IV-III vv. do n. je i voprosy politicheskoj istorii getov." *Materialy i Иssledovanija po Arheologii SSSR*, 150: 35-60.

Ceramica din așezările epocii fierului de la Ulmu și Horodca Mică – rezultatele analizei arheoceramologice

Rezumat

Una dintre problemele majore ale așezărilor ce caracterizează epoca pre-romană din spațiul est-carpatic este determinată de interdependența dintre cultura Getică și cultura Poienești-Lukașevka. În contextul posibilelor conexiuni dintre culturile Getică și Poienești-Lukașevka, este important de înțeles dacă există legături între purtătorii celor două culturi sau avem de-a face cu o distrugere totală a așezărilor și o reașezare completă a „imigranților" veniți din partea de nord a Europei? Observațiile făcute de-a lungul timpului ne determină să constatăm că ceramica „getică" din așezările culturii Poienești-Lukașevka nu ar favoriza ideea unei discontinuități radicale. Totodată, importantele restructurări ale sistemului de organizare ale locuirii, noile manifestări ale ritului funerar și matrițele ceramice ar pleda pentru o reorganizare de amploare ale comunităților.

În textul articolului se admite ideea că distrugerea așezărilor și imigrația pot fi văzute printr-o schimbare evidentă a tehnologiei de producere a ceramicii și a furnizării asociate de materii prime. Se presupune că continuitatea extinsă a producției de ceramică necesită un transfer de cunoștințe între actori, ceea ce nu se poate întâmpla într-o așezare complet nouă. În special, acest lucru poate fi urmărit în baza analizelor arheometrice ale ceramicii, prin care pot fi înțelese aprovizionările cu materie primă din surse locale sau non-locale, procesele de prelucrare ale lutului și tehnicile de ardere. Din aceste considerente, ceramica celor două culturi din două așezări vecine – Ulmu (raionul Ialoveni, Republica Moldova, cultura Poienești-Lukașevka) și Horodca Mică (raionul Hâncești, Republica Moldova, cultura Getică) – a fost examinată prin prisma acestor parametri.

Toate probele au fost supuse analizei MGR, rezultatele fiind utilizate ca bază pentru clasificarea materiilor prime, după care au fost selectate probe pentru analiza chimică. După clasificarea ulterioară, probele au fost selectate pentru examinare în secțiune subțire. S-a evaluat densitatea aparentă, porozitatea deschisă și absorbția apei din toate exemplarele. Ca urmare a metodelor aplicate, au fost atinse o serie de constatări.

Ceramica din ambele situri ce a fost supusă analizei a fost produsă utilizând în calitate de degresant fragmente de cioburi pisate. În ambele situri, pentru producerea ceramicii, s-a folosit o tehnologie similară, ne standardizată prin utilizarea cantităților diferite de degresanți în pastă, iar arderea era incompletă și inoxidantă. Astfel, niciunul din exemplarele analizate din descoperirile de la Ulmu nu a fost fabricat din aceeași materie primă ca cele din situl vecin de la Horodca Mică. În cazul de față, discontinuitatea utilizării materiilor prime poate fi explicată prin discrepanța cronologică.

Având în vedere rezultatele analizei MGR, a analizelor chimice și a studiilor secțiunilor subțiri, se poate concluziona că probele analizate reprezintă mărfuri realizate în atelierele locale de producție a ceramicii, cu excepția unui exemplar de ceramică cu buza fațetată descoperit în situl de la Ulmu (nr. 11). Acest exemplar reprezintă, cel mai probabil, un import non-regional. Același lucru ar putea fi valabil și pentru o altă mostră de ceramică cu buza fațetată descoperită la Ulmu (nr. 16). Interesant de remarcat că ambele exemplare au o valoare de porozitate deschisă neobișnuit de ridicată pentru vasele fațetate. În general, cea mai mare parte a ceramicii găsite în situl de la Ulmu (11 dintre cele 19 probe analizate) a fost făcută din aceeași materie primă (MGR-4). Această materie primă a fost utilizată pentru a produce atât articole grosiere, cât și exemplare fine (inclusiv vase fațetate). Acest lucru indică în mod clar o producție locală de ceramică de toate tipurile. Totodată, grupurile de matrice care s-au limitat la producerea vaselor fațetate ar putea să prezinte suplimentar o selecție specifică de materii prime pentru aceste forme particulare, dar nu există dovezi că aceste grupuri MGR reprezintă importuri.

În concluzie, similitudinile producției ceramice din situl getic și din situl de tip Poienești-Lukașevka sunt mai mult decât vizibile. Singura deosebire este legată de un nou grup de tipuri de vase. Din punct de vedere arheometric, nu există nimic care să sugereze o lipsă de continuitate în tradițiile de producție a ceramicii. Această continuitate în tehnologie poate fi înțeleasă ca o transmitere continuă a cunoștințelor între indivizi. Presupunem că o schimbare completă a populației care implică pustiirea peisajului în perioada de după încetarea funcționării așezărilor getice și pînă la sosirea de noi coloniști, ar produce rezultate foarte diferite de cele constate. Întrucât rezultatele prezentate aici se bazează doar pe un număr mic de eșantioane, este clar că interpretarea are doar o natură preliminară.

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

Małgorzata Daszkiewicz, Freie Universität Berlin. E-Mail: m.dasz@wp.pl

Michael Meyer, Freie Universität Berlin. E-mail: michael.meyer@topoi.org

Octavian Munteanu, State Pedagogical University of Chisinau.
E-mail: ocmunteanu@gmail.com

Vasile Iarmulschi, Freie Universität Berlin. E-mail: vasile.iarmulschi@gmail.com