PASTE RECIPES AND RAW MATERIALS OF THE CUCUTENI C WARE FROM EASTERN ROMANIA

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Rezumat. Ceramica Cucuteni C a fost interpretată, în mod tradițional, ca o ceramică "străină și inferioară", în comparație cu ceramica pictată, fiind definită, în principal, pe baza particularităților stilistice. A avut o durată de cca. 800 de ani (4300–3500 cal BC) în cadrul ceramicii Cucuteni și este considerată ca reprezentativă pentru contactele comunităților Cucuteni-Trypillia cu cele din stepă.

Obiectivul acestui studiu îl reprezintă analiza caracteristicilor tehnologice ale ceramicii Cucuteni C identificate în siturile de la Văleni-*Cetățuia* și Piatra Șoimului-*Horodiștea*, utilizând o abordare multidisciplinară bazată pe investigații petrografice, mineralogice și de compoziție chimică pentru a completa observațiile tipologice și stilistice. Ambele situri sunt amplasate în bazinul Bistriței și au fost atribuite pe baza artefactelor asociate fazei Cucuteni A-B (4100–3800 cal BC) și Cucuteni B (3800–3600/3500 cal BC). Investigațiile de microscopie optică (OM) și electronică (SEM) și de difracție de raze X (XRPD) au evidențiat utilizarea a diferite tipuri de degresant. Datele de compoziție chimică determinate prin fluorescență de raze X (XRF) au reliefat posibila utilizare a mai multor surse de argilă.

Pe baza informațiilor oferite de analizele petrografice, mineralogice și de compoziție chimică am putut determina abilitatea tehnologică a olarilor de a selecta materii prime adecvate și de a le combina în rețete diferite de pastă și de a le supune unor tratamente diferite în timpul arderii.

Cuvinte cheie: ceramică, tehnologie, petrografie, mineralogie, compoziție chimică.

1. Introduction

The Cucuteni C ware attracted scholars for more than eight decades due to its specific features when compared to the painted pottery. It appeared among the Cucuteni pottery assemblages during the Cucuteni A_3 phase (4350/4325–4050 cal BC) and lasted until the Cucuteni B_2 phase (3700/3650–3350 cal BC), being more common among the Cucuteni B sites[1].

Although initially noticed for its specific technological and stylistic characteristics among the Cucuteni painted ceramic assemblages[2], the successive research agenda was set towards identifying its origin[3]. Hubert SCHMIDT used for the first time the label Cucuteni C and advanced a Baltic origin for the potshards identified in the upper strata of the Cucuteni B layer from Cucuteni-*Cetățuia*[4]. Later on, it was considered as originating in the steppe region north of the Black Sea[5]. Ann DODD-OPRIȚESCU who conducted a systematic survey focused on identifying the first "steppic" elements present in the Romanian Chalcolithic refers for the first time to the great variety of the vessels morphology and decoration for the same chronological phase. Recently, a new approach focused on the actual use of the Cucuteni C pottery in order to understand vessels function related to specific human behaviours. The observations of use traces on ceramic vessels focused on surface modifications and/or features attributed to use activities, mainly *fire traces*[6].

The technological characteristics of pottery and, subsequently, its provenance are usually debatable when based solely on archaeological evidences. For complementing the archaeological information, we can add petrographic, mineralogical and geochemical analysis. The identification of petrographic and geochemical reference groups, the analysis of the clasts present within the pottery matrix and of the added temper and the comparison with the local clayey materials in the area surrounding the archaeological study site can all give additional information to the provenance problem[7]. Additionally, the analysis of mineralogical assemblages present within the pottery by physical-chemical methods allows the identification of specific technological parameters such as maximal temperature, redox conditions, and the duration of firing[8].

This study continues the systematic archaeometric analysis of the Cucuteni C ware initiated with Poduri-*Dealul Ghindaru*[9] and Gârcina-*Slatina Cozla II-III*[10] for evaluating the degree of similarity in terms of the paste composition combined with

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[1] Mantu, 1998, p. 111-133; Bem, 2001, p. 25-123.

[2] Asandei, 2010, p. 182, Fig. 15.

[3] Schmidt, 1932, p. 42-45; Nestor, Zaharia, 1968, p. 17-19; Dodd-Oprițescu, 1977, p. 50-75; Dodd-Oprițescu, 1980, p. 547-557; Dodd-Oprițescu, 1981, p. 511-528; Dodd-Oprițescu, 1982, p. 70-79; Cucoș, 1985, 63-92.

[4] Schmidt, 1932, p. 42-45.

[5] Nestor, Zaharia, 1968, p. 17-19; Dodd-Oprițescu, 1977, p. 50-75; Dodd-Oprițescu, 1980, p. 547-557; Dodd-Oprițescu, 1981, p. 511-528; Dodd-Oprițescu, 1982, p. 70-79; Cucoș, 1985, 63-92.

[6] Munteanu, 2015, p. 211-234.

[7] Maritan *et alii*, 2005, p. 31-44; Ionescu, Hoeck, 2012, p. 193-209;Waksman, 2017, p. 148-162; Brorsson *et alii*, 2018, p. 662-674.

[8] Rasmussen *et alii*, 2012, p. 1705-1716; Matau *et alii*, 2013, p. 914-925; Karacic *et alii*, 2016, p. 599-607.

[9] Mățău *et alii*, 2015.

[10] Mățău *et alii*, 2018.

the use-wear analysis for revealing its functional attributes[11]. In the present work, a multianalytical approach was applied to the study of the Cucuteni C ware identified at Văleni-*Cetăţuia* and Piatra Şoimului-*Horodiştea* for identifying its main technological characteristics.

2. The archaeological context

The two sites are located near Piatra Neamţ (Neamţ County), on the right bank of the Bistriţa River. While *Cetăţuia* at Văleni is placed on a low ground close to the river, Piatra Şoimului-*Horodiştea* habitation was settled on top of a high terrace, upstream of the mouth of a large creek (Calu) (**Fig. 1**).

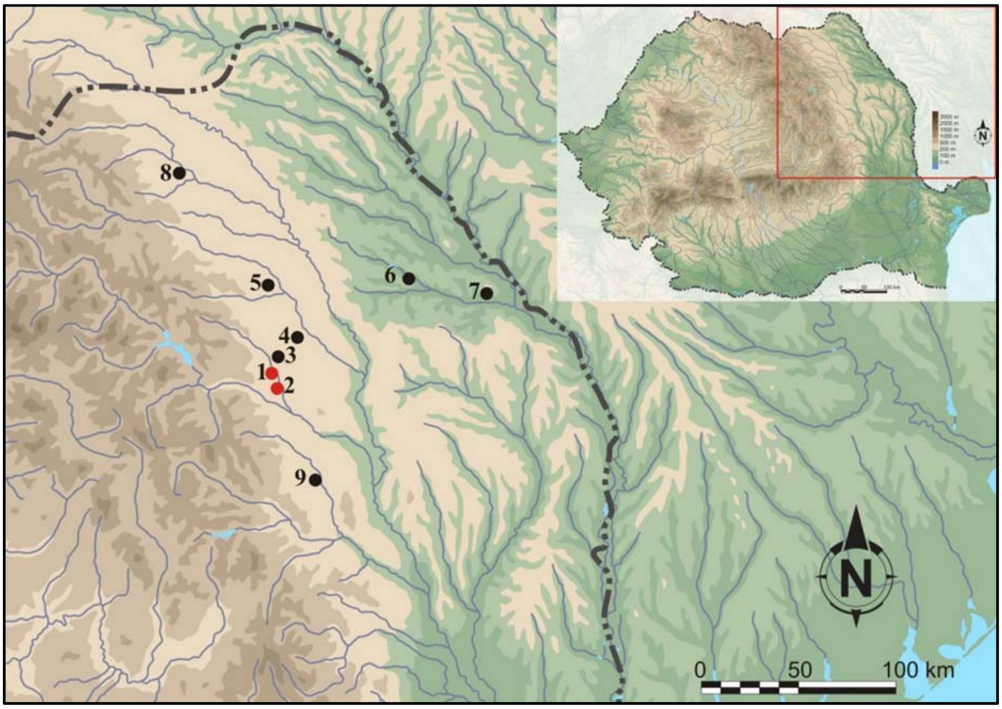

Fig. 1. The location of the Văleni (1) and Piatra Șoimului (2) sites and other sampling sites for Cucuteni C ware (3 - Gârcina, 4 - Bodești, 5 - Lunca, 6 - Cucuteni, 7 - Valea Lupului, 8 - Solca, 9 - Poduri).

Cetăţuia was discovered in 1939 and further investigated in 1942. Larger-scale archaeological researches were conducted during the 1970's, yet few data were processed and published regarding these excavations[12].

The archaeological strata contain Chalcolithic (Precucuteni, Cucuteni A and B), Bronze Age and Early Medieval artefacts. The Cucuteni B features are the most consistent – the remains of 13 wattle and daub structures[13] and several pits, a large amount of

[11] Munteanu, 2015.
[12] See Monah, Cucoş, 1985, p. 162; Cucoş, 1999, p. 36-37, 45-46 (with previous references).
[13] Dumitrescu, 1950, p. 1-27; Cucoş, 1999, p. 46.

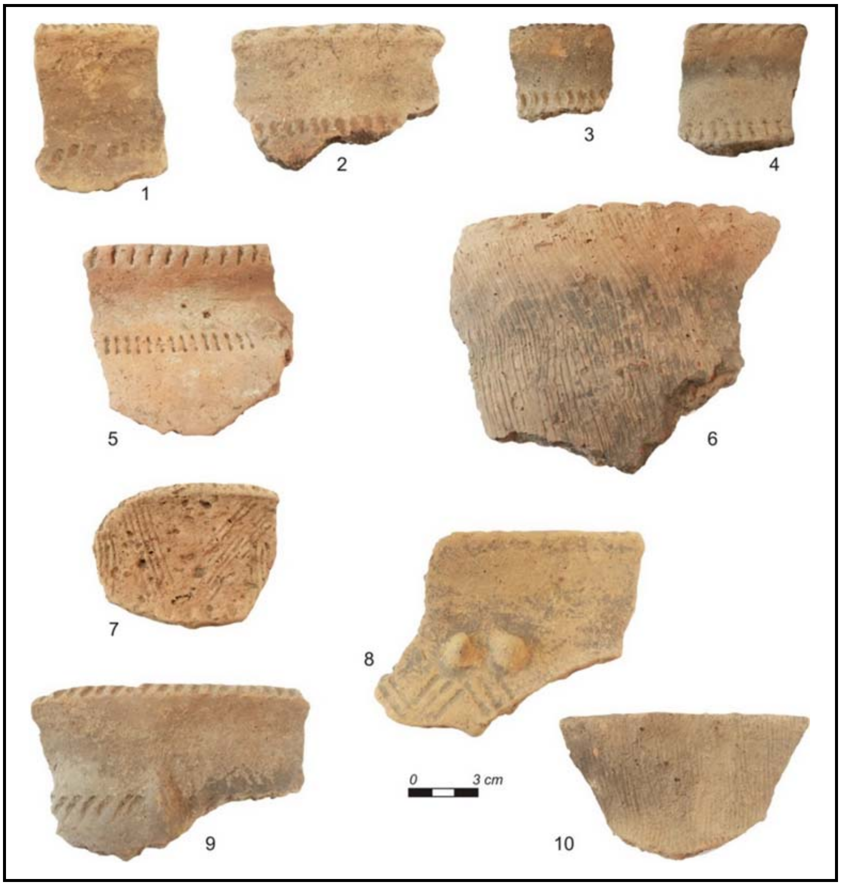

Fig. 2. Representative Cucuteni C ware identified at Văleni-*Cetățuia* (1–6, 8–10 - sandstone tempered pottery, and 7 - shell tempered pottery).

painted, common and shell-tempered pottery, bone and stone implements were retrieved from the 0.20/0.35 metre thick deposit. The author of the 1974 research remarked upon the amount of Cucuteni C wares retrieved from Houses 1 and 2[14].

The site from Piatra Şoimului (formerly Calu), located about 10 km downstream from Văleni, was subjected to systematic research in 1935 and between 1973–'75[15]. The large plateau situated on top of a hill extends oven 5 hectares and is segmented by several ditches. The Chalcolithic artefacts were scattered in all the trenches, along with Iron Age items and scarce Bronze Age artefacts. The prehistoric layers were heavily perturbed by the Iron Age occupation and no well-defined feature from this earlier age remained undisturbed.

It is generally considered that the settlement had distinct Cucuteni A, A-B, B_1 and B_2 phases. While the first report pointed out that the Cucuteni C pottery is to be

[14] Cucoş, 1999, p. 46.
[15] Vulpe, 1941; Cucoş, 1999, p. 27.

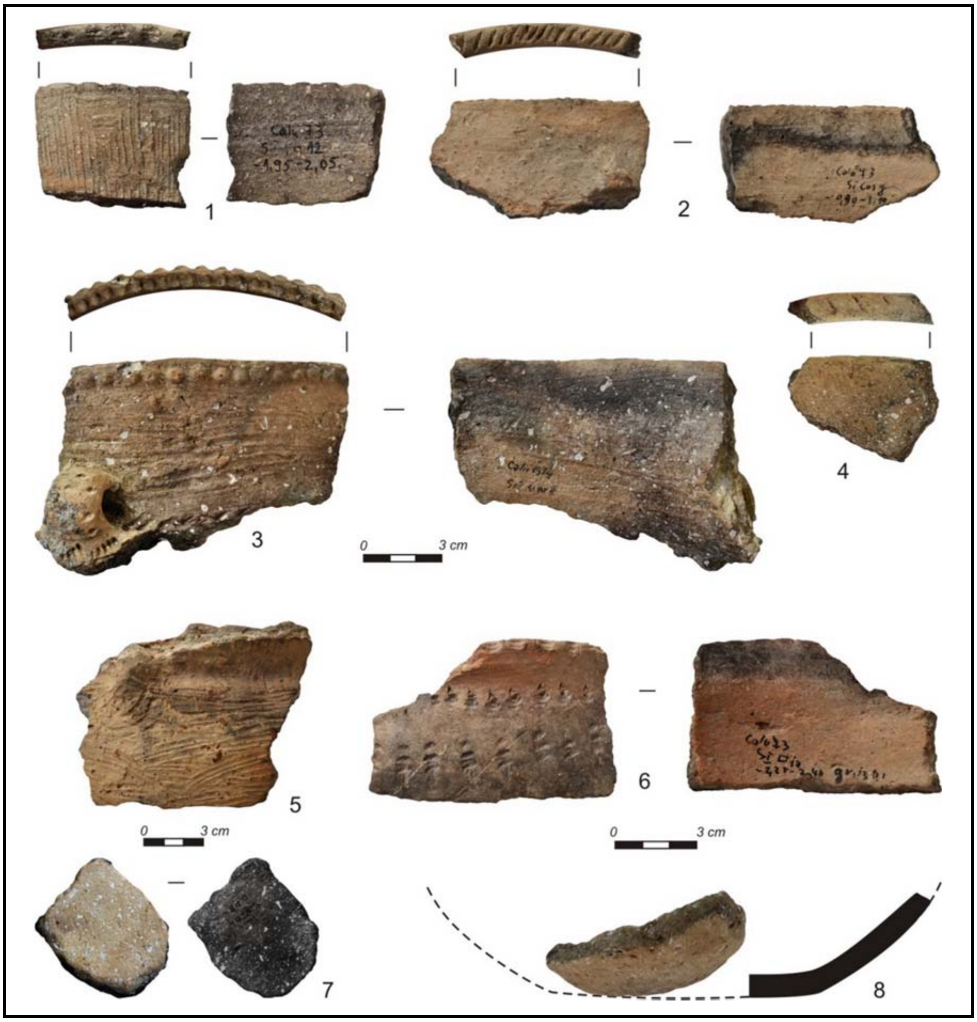

Fig. 3. Representative Cucuteni C ware identified at Piatra Șoimului-*Horodiștea* (1, 3, 4, 7, 8 - shell tempered pottery; 2, 5, 6 - grog tempered pottery).

found in the upper Chalcolithic layers, the 1973–’75 report contains several mentions of the mixed ceramic material.

The shell-tempered pottery seems to be associated both with Cucuteni A-B and B painted pottery[16]. The lack of stratigraphic precision hinders the interpretation of the ceramic inventory.

The Cucuteni C assemblages from both sites display the general features of this type of pottery - uneven coloured, brick-red, reddish-brown, gray or black-gray recipients. Văleni assemblage tends to be lighter in colour; the surface alteration is more pronounced (**Fig. 2**).

[16] Mihăilescu-Bîrliba, 1973-1975.

Some morphologic variation could be noted between the two inventories: at Piatra Şoimului just medium-sized open-mouthed vessels were identified, both with a shell-tempered or a grog-tempered paste (the first group is dominant) (**Fig. 3**); open- and restricted-mouthed pots of small to medium sizes appear al Văleni. The vast majority of potsherds from Văleni are not shell-tempered.

The decorations are also different: comb patterns are the predominant feature at Piatra Şoimului. Only three of the identified potsherds have cord imprints (**Fig. 3**). At Văleni, while textured ornaments appear on some vessels (comb decoration mainly on the neck, light grooves on the body), cord impressions are the most common element (short vertical segments are applied frequently of the shoulder) (**Fig. 2**). Also, plastic ornaments such as knobs appear on Văleni pottery (**Fig. 2/8**).

The same decorative patterns and the same morphology are used for the shell-tempered and the grog-tempered pottery.

Five of the sherds from Piatra Şoimului and two from Văleni display use-related traces – internal and external carbonization usually attributed to boiling / wet cooking usage of the vessels.

3. Materials and methods

For the present study, we have selected pottery samples (**Fig. 4**) which illustrates typologically and stylistically the Cucuteni C ware present within the two sites.

The first step in the analysis of the technological characteristics of the Cucuteni C pottery samples selected from Văleni-*Cetățuia* and Piatra Șoimului-*Horodiștea* was represented by the macroscopic examination of the inner and outer surfaces, as well as cross-sections. The colour of all the analysed sections of the pottery fragments was recorded using Munsell Soil Color Charts. Additionally, we have carried out textural and compositional analysis applying polarized light optical microscopy (OM) analysis of thin-sections, microstructutal investigations of small fresh cross-sections by scanning electon microscopy (SEM). Also, we have identified the mineralogical compounds by X-ray diffraction (XRPD) and the chemical composition by X-ray fluorescence (XRF) analysis.

The pottery samples were rinsed with distilled water in a ultrasonic bath prior cutting small slices across the cermic wall for preparing petrographic thin-section analysis using a Meiji ML9430 microscope.

Furthermore, we have performed SEM analysis on small sections fixed on copper supports and examined using and Environmental Scanning Electron Microscope (ESEM) type Quanta 200, operating at 20 kV with secondary electrons in low vacuum mode.

For the X-ray diffraction analysis we have used a Shimadzu XRD 6000 diffractometer using CuKα radiation (λ=1.54059 Å) in reflection mode. A small quantity of each pottery sample (2 g) was powdered using an agate mortar and then side-pressed into a top-loaded holder in order to minimize the preferred orientation and analysed in the range of 2θ=4°–80° with a scan rate of 0.02° and 4s/step. Phase compositions were automatically identified by comparison with the reference powder patterns included in ICDD Powder Diffraction Files (PDF-4).

In order to perform X-ray fluorescence analysis we have grounded 10 g of each sample into an agate mortar. Then, the samples were homogenized and mixed with a binding material (wax containing only C and H) in a 1:6 ratio (1 part wax and 6 parts pottery sample) using ball-milling technique (Fritsch Planetary Mill Pulverisette 5). The homogeneous samples were pressed using a Fluxana PR-25A automatic press at pressure of 20 t/cm^2. The pressed pellets were analysed using PANanlytical Epsilon 5 Energy dispersive X-ray spectrometer with certified reference materials as standards.

Fig. 4. Cucuteni C pottery samples selected from Văleni-*Cetățuia* and Piatra Șoimului-*Horodiștea*.

4. Results and discussion

Three of the pottery fragments from Văleni selected for archaeometric analysis (**Fig. 4**) show distinctive decorative patterns ranging from cord impressions (VLN_C1, VLN_C2) to lighter groove (VLN_C4), sample VLN_C1 has, also, a small plastic knob. The pottery samples from Piatra Șoimului (PSM_C1, PSM_C2, PSM_C3) and one of the samples from Văleni (VLN_C3) have no decoration. The colours of most of the pottery samples from Văleni (VLN_C2, VLN_C3, VLN_C4) range from light brown (7.5YR6/4) to reddish yellow (7.5YR6/6), while sample VLN_C1 shows uneven light brown colour (7.5YR6/4) with brown spots (7.5YR5/2). The samples from Piatra Șoimului have darker colours ranging from dark grey (7.5YR4/1) in sample PSM_C1 to brown hues (7.5YR4/3, 7.5YR4/4) for samples PSM_C2 and PSM_C3.

Although most of the pottery fragments selected from Văleni displays uniform lighter colours on the outer surface, in cross-section (Fig. 5) exhibit a diffused *sandwich* structure ranging from brown (7.5YR5/4) to light brown (7.5YR6/4) hues for samples VLN_C1, VLN_2 and VLN_C3. The inner surface of sample VLN_C4 presents a combination of reddish yellow (7.5YR6/6) to light brown (7.5YR6/3) hues.

Fig. 5. Representative cross-sections of the Cucuteni C pottery samples selected from Văleni-*Cetățuia* and Piatra Șoimului-*Horodiștea*.

The analysed potshards from Piatra Șoimului (**Fig. 5**) shows homogenous colours in cross-section with darker hues ranging from dark grey (7.5YR4/1) in sample PSM_C1 to brown (7.5YR4/3) for samples PSM_C2 and PSM_C3.

The change in colour from core to margin resembling a *sandwich* structure with black core as displayed in sample VLN_C4 from Văleni is due to firing in reducing conditions with an oxidizing cooling stage, or to firing pottery rich in organic matter in oxidizing conditions[17]. Another possible cause for the black core may be the shorter firing duration at low temperature, which was not sufficient for the complete oxidation within the ceramic body thus reducing the hematite formation[18]. The origin of the colour change from darker hues close to the outer surface to more reddish ones in the core, as seen in most of the potshards selected from Văleni resides, most probably, in the use of low reducing atmosphere at the end of the firing process[19]. The presence of darker colours in the pottery samples from Piatra Șoimului points to the occurrence of reducing conditions during the firing process[20].

The pottery samples selected from Văleni display two types of matrix with various quantities and types of clasts (Fig. 6). The first type of matrix is homogenous with a reddish colour (VLN_C3), while the second one displays more brownish hues (VLN_C1, VLN_C2, VLN_C4), as seen with parallel nicols. The optical activity is low for all the pottery samples. Samples VLN_C1 and VLN_C2 shows abundant rounded voids, mostly open-spaced distributed, without a preferred orientation, while samples VLN_C3 and VLN_C4 have scarce disordered rounded pores. All samples contains various amounts of small quartz grains (under 20 µm) as part of the matrix[21]. The non-plastic clasts present in various amounts in samples VLN_C1, VLN_C3 and VLN_C4 are quartz, K-feldspar, muscovite and plagioclase for samples, while sample VLN_C3 have sparse shell-temper fragments, which were highly affected by the thermal transformation.

Quartz of various sizes and ranging from angular to sub-rounded grains, often with undulatory extinction was identified in all the pottery fragments. Sample VLN_C3 (**Fig. 6/a**) shows small red grains, mostly anisotropic and unevenly distributed throughout the matrix, which represents hematite. Sample VLN_C2 (**Fig. 6/c**) contains abundant small mica-flakes, plagioclase with polysynthetic twinning and feldspar grains slightly seritised, while sample VLN_C4 (**Fig. 6/d**) contains microcline grains with

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[17] Nodari *et alii*, 2004, p. 120 with references therein.
[18] De Bonis *et alii*, 2017, p. 8072.
[19] Molera *et alii*, 1998, p. 201.
[20] Shepard, 1956, p. 106.
[21] Ionescu *et alii*, 2011, p. 469.

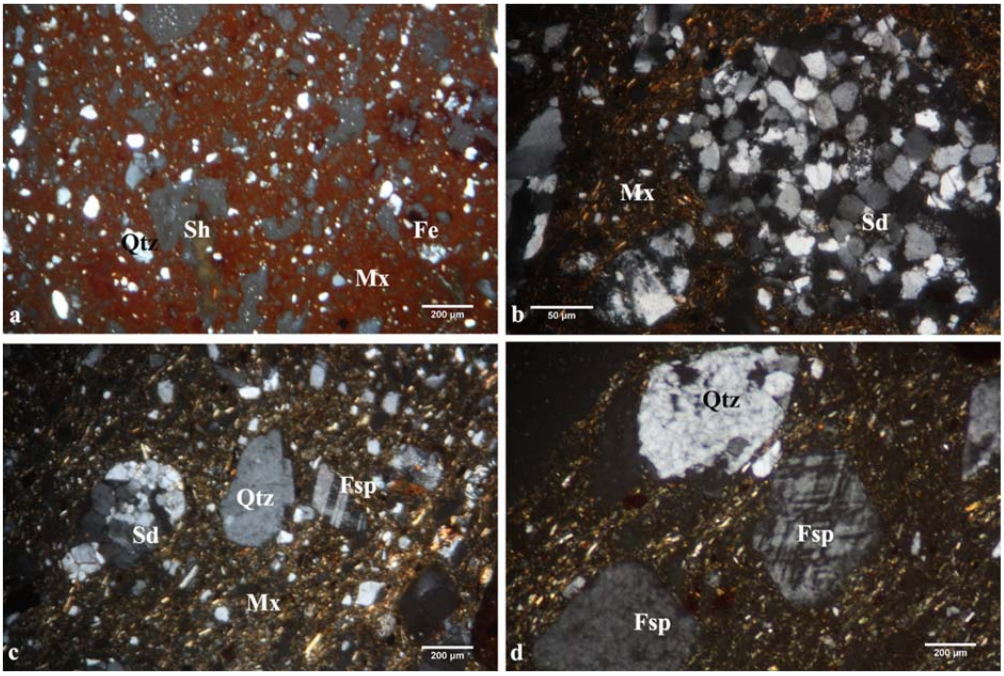

Fig. 6. Polarized light microphotos of pottery samples from Văleni: a. VLN_C3 matrix (*Mx*) with iron oxides (*Fe*), quartz (*Qtz*) grains and shell-temper (*Sh*); b. VLN_C2 matrix (*Mx*) and sandstone inclusion (*Sd*); c. VLN_C2 matrix (*Mx*), sandstone inclusion (*Sd*), quartz (*Qtz*) and feldspar (*Fs*) grains; d. VLN_C4 quartz (*Qtz*) and feldspar (*Fsp*) grains. All images are with crossed polarizers (a., c., d. at 4×; b. at 20×).

polysynthetic twinning in two directions. The lithoclasts are mostly sedimentary rocks represented by sandstones widely containing quartz and feldspar grains.

The clasts extends from poorly sorted in samples VLN_C1, VLN_C2 and VLN_C4 to well sort in VLN_C3 with sizes varying up to 500 µm. Most of the lithoclasts are in accordance with the silt to fine sand category (50–200 µm), based on the Wentworth scale[22].

The pottery samples selected from Piatra Șoimului show distinctive optical and textural features when compared to the ones from Văleni. There are no major differences between the samples from Piatra Șoimului in terms of matrix characteristics and type of clasts. The matrix is slightly homogenous with light brown colour range as seen with parallel nicols. All samples exhibit a low to medium optical activity and contains scarce rounded voids. The microstructure of sample PSM_C3 (**Fig. 7/a**) has small area which are slightly oriented.

Mainly small-sized angular quartz grains and small mica-flakes represent the non-plastic clasts. All the pottery fragments contains various amounts of shells. In sam-

[22] Wentworth, 1922, p. 389, 391.

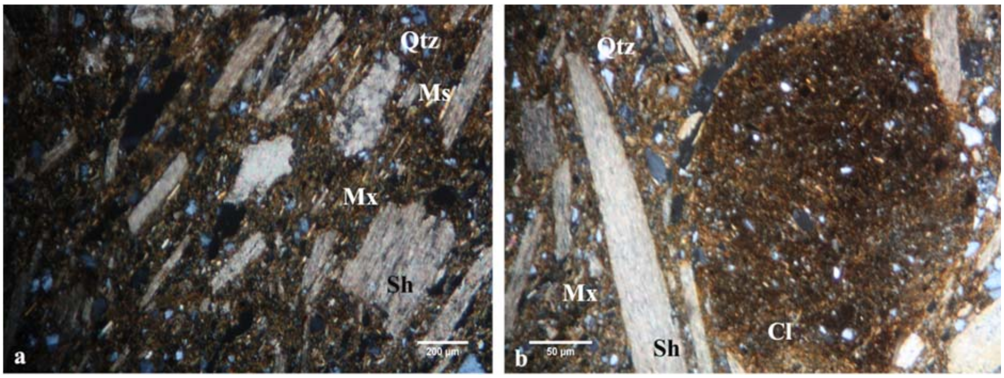

Fig. 7. Polarized light microphotos of pottery samples from Piatra Șoimului (a. PSM_C3 matrix (*Mx*), shell-temper (*Sh*), and quartz (*Qtz*) grains; b. PSM_C3 matrix (*Mx*), shell-temper (*Sh*), clay-pellet (*Cl*), and quartz (*Qtz*) grains). All images are with crossed polarizers (a. at 4×; b. at 20×).

ple PSM_C3 (**Fig. 7/a**) the shells forms parallel oriented zones, while in the other samples are more randomly distributed. The shell-temper shows rather limited firing transformation, still preserving its multi-layered internal microstructure. Besides various amounts of shells and lithoclasts, in sample PSM_C3 was identified, also, a clay pellet (**Fig. 7/b**). According to Whitbread's criteria[23], the clay pellet presents discrete textural features with clear boundaries around its circumference, a high degree of roundness and poor internal orientation. It displays a darker colour than the matrix, most probably, due to the high degree of iron oxides concentration. The clay pellet identified in the ceramic paste from Piatra Șoimului illustrates that the clay was not seasoned, or at east not for long.

SEM microphotographs listed in **Fig. 8** reveals the microstructural transformations due to the firing process of representative pottery samples from Văleni (**Fig. 8/a**) and Piatra Șoimului (**Fig. 8/b**). The microstructure of the sample present in **Fig. 8/a** is characterized by *extensive vitrification* with "islands" of medium bloating pores due to *continuous vitrification* indicating a firing temperature between 850–950°C[24]. The matrix of the pottery sample selected from Piatra Șoimului shows *no vitrification*, which reveals that the firing temperature was lower than 750°C[25], while the appearance of the pores within the growth layers argues for higher temperature ranging from 750–800°C[26].

The mineralogical composition of the pottery samples selected from Văleni (VLN) and Piatra Șoimului (PSM) determined by X-ray diffraction is shown in **Fig. 9**. Due to the various amounts of shell-temper present in the Piatra Șoimului ware, the samples present significant differences in their mineralogical assemblages when com-

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[23] Whitbread, 1986, p. 84.
[24] Maniatis, Tite, 1981, p. 61-64.
[25] Maniatis, Tite, 1981, p. 68.
[26] Maritan *et alii*, 2007, p. 535-536.

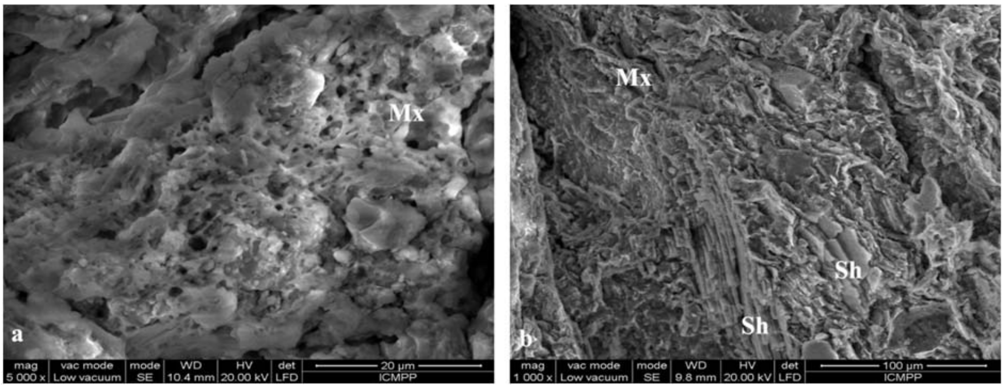

Fig. 8. SEM images of pottery microstructure from Văleni (a) and Piatra Șoimului (b) showing the pottery matrix (*Mx*) and shell-temper (*Sh*).

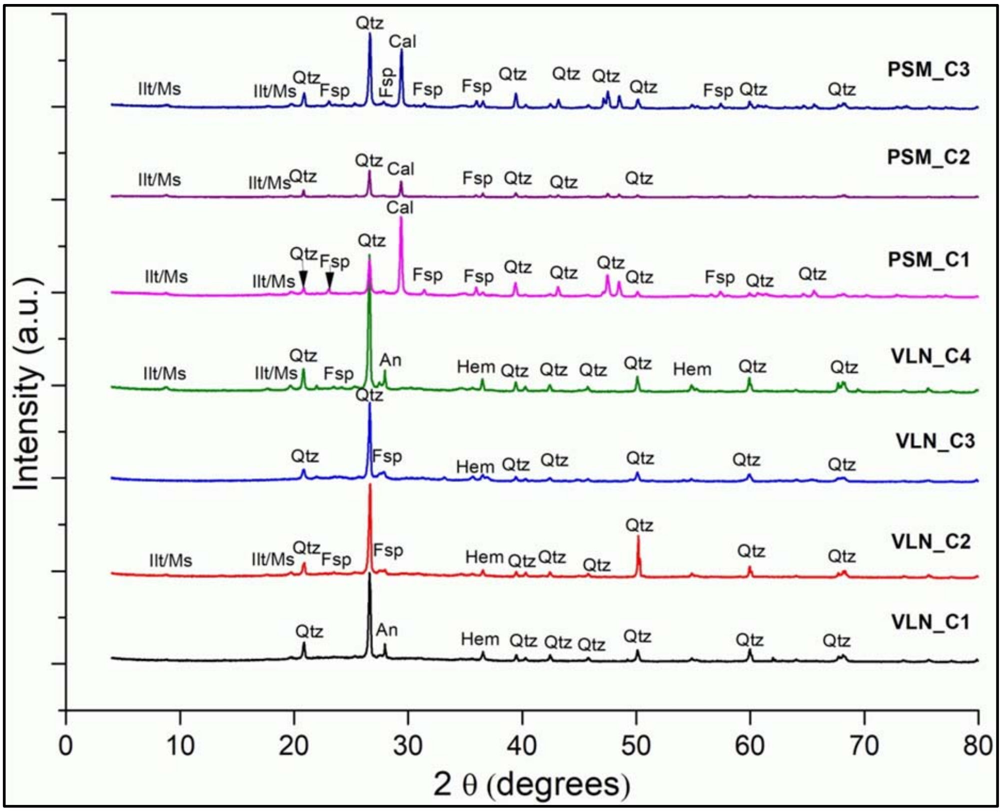

Fig. 9. X-ray diffractograms of the pottery samples from Văleni and Piatra Șoimului[27].

[27] Abbreviations: Ilt/Ms-illite-muscovite, Qtz-quartz, Cal-calcite, Fsp-feldspar, An-Anorthite, Hem-Hematite.

pared with the ones from Văleni. The main diffraction peaks identified in the Cucuteni C samples from Văleni are those of quartz, feldspars, illite/muscovite, anorthite and hematite. The dominant mineral component identified in all the potshards from Văleni is quartz, while illite/muscovite, feldspars, hematite and anorthite have variable intensity caused by the thermal transformations. The identified mineral assemblage is a result of the firing process in which the crystalline phases, once they transcend their stability limits, partially collapse (e.g. illite/muscovite), and newly formed minerals (e.g. hematite, anorthite) appears[28].

Technological characteristics such as the type of the raw clays and of the added temper as well as the firing temperature and atmosphere are revealed by the mineralogical composition. The clayey material used for producing the potshards from Văleni is of illitic type as revealed by the persistence of illite/muscovite peaks with diminished intensity in samples VLN_C2 and VLN_C4. The illite/muscovite phase disappears at 900°C[29] and, depending on the other phases present in the ceramic body, participates in the increment of newly formed compounds such as anorthite and hematite. Hematite nucleates at 750°C due to the breakdown of chlorite[30], while anorthite starts to form at 900°C at the expenses of calcite and illite (plus quartz)[31].

Based on the disappearance of the illite/muscovite diffraction peak in samples VLN_C1 and VLN_C3 combined with the presence of newly formed phases we estimate a firing temperature ranging from 900°C to 950°C. The XRPD results are in agreement with the microstructural transformations leading to the appearance of *vitrification* (**Fig. 8/a**) and with the presence of presence of red small grains observed in thin-sections (**Fig. 6/a**) corresponding to hematite and the high-structural transformations of the shells.

The XRPD results for the pottery selected from Piatra Șoimului have identified calcite as the main peak in one of the analysed samples (PSM_1), while in the other samples quartz represents the main peak. The high intensity of the calcite peak is caused by the presence of large amounts of added shells in sample PSM_1, while in the other two samples there is a diminish in the used temper. Except calcite and quartz, the other mineral phases identified in the Piatra Șoimului potshards are illite/muscovite and feldspar, which show variable intensity caused by the thermal transformations.

For producing the Cucuteni C ware from Piatra Șoimului an illitic clayey material was used, also. The presence of the main diffraction peak of illite/muscovite combined with the absence of newly formed phases in all the samples from Piatra Șoimului indicates that the firing temperature did not attained 900°C. The XRPD results confirms the microstructural observations where no vitrification was detected, only the presence of inter-layer pores allowing to advance a firing range between 750–800°C.

In order to understand the degree of similarity in terms of clayey material used, we have represented the HCA dendrogram based on the chemical composition obtained

[28] Jordan *et alii*, 2008, p. 268-269.
[29] Cultrone *et alii*, 2001, p. 633.
[30] Nodari *et alii*, 2007, p. 4668.
[31] Cultrone *et alii*, 2001, p. 631.

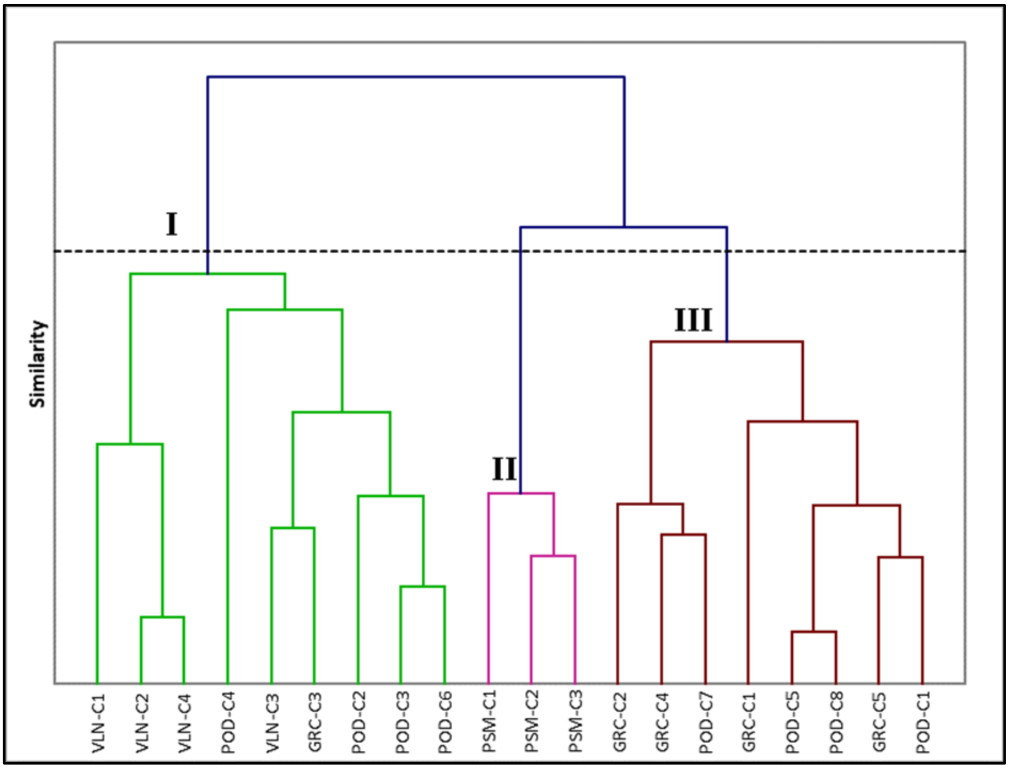

Fig. 10. Hierarchical cluster analysis (HCA) dendrogram based on the chemical composition of the Cucuteni C ware from Văleni (VLN), Piatra Șoimului (PSM), Poduri (POD) and Gârcina (GRC).

by X-ray fluorescence analysis (XRF) containing major (SiO_2, Al_2O_3, TiO_2, Fe_2O_3, MgO, MnO, CaO and K_2O) and trace elements (Nb, Ta, Zr, Hf, Rb, Sr, Ba, Th, U, Y) (**Fig. 10**). The P_2O_5 varies over a wide range suggesting possible contamination for this element. For this reason, we did not include P_2O_5 in the statistical treatment of the chemical data. In addition, to the compositional data obtained for the Cucuteni C ware from Văleni and Piatra Șoimului we have plotted, also, the previously analysed samples from Poduri and Gârcina.

The results of the HCA shows the existence of three separate compositional groups within the analysed Cucuteni C pottery samples (**Fig. 9**). The shell-tempered ware from Piatra Șoimului forms a distinctive group (group II), while most of the other shell-tempered ware from Poduri and Gârcina falls within a separate group (Group III). The pottery samples from Văleni, which contains various amounts of sandstones, is very similar in terms of type of clay used with the grog-tempered pottery from Poduri. Two of the shell-tempered ware samples, one from Poduri (POD_C2) and one from Gârcina (GRC_C3), falls within the same group (Group III) containing grog and sandstone tempered ware from Poduri and Văleni. Based on the compositional data, we observe a higher spread of the shell-tempered ware between compositional groups caused by the use of different clay sources and the existence of more than one recipe for the paste preparation[32].

The pottery samples from Piatra Șoimului show a very homogeneous chemical composition indicating the use of a single clay type as a raw material, while the samples from Văleni falls within separate subgroups as revealed by the hierarchical cluster analysis suggesting two different clayey materials. The association of some of the pottery samples from Văleni (VLN_C3), Poduri (POD_C2), and Gârcina (GRC_C3) produced by different recipes may be caused by the use of similar starting clay materials, but they also may indicate trade.

Raw material selection and preparation cannot be comprehensively understood unless the social practice involved in pottery making is examined. The possible clayey resources have to be perceived as *places* by adding the social, symbolic and perceptual value to the physical dimension of the spaces people appropriate and use[33]. The use of similar type of illitic clay identified in the Cucuteni C ware from Văleni, Piatra Șoimului, Gârcina and Poduri could be the result of functional and economic necessities due to their specific quality or because of their higher availability within the landscape. The constant handling of similar clay type could point to all the previously mentioned reasons, favouring strong ties with the landscapes. Further, they can indicate inter-generational exploitation of raw materials, reiterating symbolic contacts among members of the community[34].

In order to clarify the relationship between the initial clayey material, the various types of paste recipes and the vessels trade, the extension of the Cucuteni C sampling material is necessary. In addition, it is necessary to analyse the other types of Cucuteni ware identified within each site and to add clay samples from the nearby area.

5. Conclusions

The archaeometrical analysis of the Cucuteni C ware from Văleni-*Cetățuia* and Piatra Șoimului-*Horodiștea* have revealed the use of a similar type of illitic clay with different origin combined in distinctive paste recipes. The pottery sample from Văleni containing shells as temper falls within a separate subgroup in terms of chemical compositional content, most probably, due to the use of a slightly different raw material source. The other pottery samples from Văleni contains various amounts of sandstones as temper and are relatively similar in composition with the grog-tempered pottery from Poduri. All the pottery samples from Piatra Șoimului forms a homogenous group in terms of added shell-temper and raw material composition forming a separate compositional group exploiting a different source of illitic clay.

The firing cycle of the pottery samples from Văleni experienced a wide range

[32] The association of some of the shell-tempered pottery with the ones containing sandstones and grog-temper confirms our previous observations (Mățău *et alii*, 2015, p. 133) based on the investigation of the Cucuteni C pottery from Poduri-*Dealul Ghindaru*.

[33] Santacreu, 2017, p. 509-510.

[34] See, for instance, the similar composition of the grog and of the matrix previously identified in a Cucuteni C pottery sample (POD_C3) from Poduri (Mățău *et alii*, 2015, p. 131, Fig. 3).

of firing regimes varying from reducing to oxidizing conditions or from oxidizing to reducing ones, which caused the appearance of a *sandwich structure*. Based on the microstructural characteristics of the paste, the almost complete structural collapse of the shells and the mineralogical composition, most probably, the firing temperature was between 850°C and 950°C. The potshards from Piatra Șoimului were fired in similar reducing atmosphere, most likely, between 750°C - 800°C what favoured the maintenance of the structural integrity of the shells.

In comparison with our previously analysed Cucuteni C ware from Poduri-*Dealul Ghindaru* and Gârcina- *Slatina Cozla II-III* shows the use of a different illitic materials for the ware selected from Piatra Șoimului, while the samples from Văleni experienced the highest firing temperatures. However, the mineralogical and microstructural analysis seems to indicate the existence of multiple recipes in the paste preparation, which are more site related.

Further analysis needs to be done in order to understand if the clayey material selection is caused by the natural availability or is culturally mediated. In addition, the inclusion of the painted and other types of unpainted pottery identified within the sampling sites is necessary for fully evaluating the specific features in terms of raw material processing and firing temperatures. Lastly, by extending the archaeological and archaeometrical analysis of the Cucuteni C ware we could infer the relationship between the raw materials, technical choices and vessel's function.

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