

Technological issues of the shell-tempered ware from Gârcina (Neamț County, Romania)

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Abstract. *Shell-tempered ware identified at Gârcina-Slatina Cozla II-III (Neamț County) was analysed in terms of microscopic, mineralogical and chemical characteristics for revealing its technological parameters. The site located near Piatra Neamț, on the Cozla hillside was used for the exploitation of salt-water resources by the Cucuteni communities and, later on, during the Early Bronze Age. Selected pottery samples were examined using optical microscopy (OM), scanning electron microscopy coupled with energy dispersive X-ray spectroscopy (SEM-EDX) and X-ray diffraction (XRD). Results show that the studied pottery samples although similar in the added temper have distinctive features in terms of raw material quality, processing and firing regime.*

Rezumat. *Caracteristicile microscopice, mineralogice și chimice ale ceramicii cu scoică descoperite în situl de la Gârcina-Slatina Cozla II-III (jud. Neamț) au fost analizate pentru identificarea parametrilor tehnologici. Situl, localizat pe dealul Cozla, în apropiere de Piatra Neamț a fost utilizat pentru exploatarea izvoarelor de apă sărată de către comunitățile Cucuteni, dar și la începutul epocii bronzului. Fragmentele ceramice selectate au fost analizate cu ajutorul microscopiei optice (OM), microscopiei electronice de baleiaj cuplată cu spectrometria de raze X (SEM-EDX) și a difracției de raze X (XRD). Rezultatele au evidențiat existența unor diferențe calitative și de procesare a materiei prime, dar și a regimului de ardere a ceramicii cu scoică în pastă.*

Keywords: shell-tempered ware, microscopy, mineralogy, chemical composition, technology.

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Introduction

The manufacturing of the ceramic ware, besides offering valuable information on the cultural contacts and trade links between Chalcolithic communities, provides clues about their ability to select and to process variable types of raw materials. Mineralogical and chemical characterization of pottery may reveal the technology involved in the manufacturing process⁶ or may help to identify the raw material used⁷.

A wide range of treatments are available to produce a workable clay paste with more appropriate qualities in terms of paste recipes and firing treatments for obtaining a certain range of physical properties which will make the desired products more suitable for a certain function⁸. For inferring the intended function of the vessels, first we need to understand the *technological variability* registered within the shell-tempered ware. In order to obtain a proper understanding of the technological variability we need to start by determining the morphological parameters of the vessels (form, size, decoration) and continue with the clay matrix (chemistry and mineralogy), temper type (size, quantity, chemistry and mineralogy) and firing parameters (temperature, atmosphere, firing duration and soaking time).

Analytical methods extending from macroscopic observations to mineralogical compositions determined by petrographic analysis of thin-sections combined with X-ray diffraction (XRD) analysis and to microscopic observations combined with point chemical analysis (SEM-EDX) can provide valuable information about the technological variability.

This work continues the systematic investigation of the Cucuteni C ware started with the Poduri-Dealul Ghindaru site⁹. In the previous work, we took into consideration pottery samples containing grog and shell fragments as temper, attributed broadly to the Cucuteni B phase, which have revealed a certain degree of similarity in terms of their matrix composition and morphological features.

The aim of the present study is to determine the *technological parameters* of the shell-tempered ware identified at Gârcina (Neamț County) by determining its main technological features in order to assess the degree of similarity and variation of the Cucuteni C pottery production between sites. We present the characteristics of the raw materials used, and show a correlation between pottery composition and firing temperature, combining macroscopic examination with petrographic analysis of thin-sections, scanning electron microscopy coupled with energy dispersive X-ray spectrometry (SEM-EDX) and X-ray diffraction (XRD).

⁶ RATHOSSI *et alii* 2004; BELFIORE *et alii* 2007; IONESCU, HOECK 2011; MARITAN *et alii* 2017; YIOUNI, VASILEIOU 2018.

⁷ SPATARO 2011; MARITAN *et alii* 2013; BAKLOUTI *et alii* 2014; GIURGIU *et alii* 2016; BRORSSON *et alii* 2018.

⁸ TITE *et alii* 2001; FEATHERS 2006; SKIBO 2013, 27–54.

⁹ MĂȚĂU *et alii* 2015, with a brief state of the art regarding the Cucuteni C ware investigation in Eastern Romania.

The archaeological context

The site identified at *Gârcina-Slatina Cozla II-III* (Neamț County) is located in Eastern Romania, at the western part of the Cracău-Bistrița Lowland, on the north-western slopes of the Cozla hill, on the right bank of the Cuejdi river (Figure 1). Nowadays two modest saltwater spring are flowing nearby.

The site stratigraphy revealed by a small excavation conducted in 2011¹⁰ consists in a Cucuteni A layer (0.20 m thick), superposed by an ashy sediment (0.10 m thick) and a more extended Cucuteni B layer (0.30–0.40 m thick). The last one, which is the main anthropic deposit, contains Cucuteni B and C pottery fragments¹¹.

Most of the Cucuteni C pottery fragments were identified within the Cucuteni B layer; only two fragments with traces of secondary burning were found within the ash layer¹².

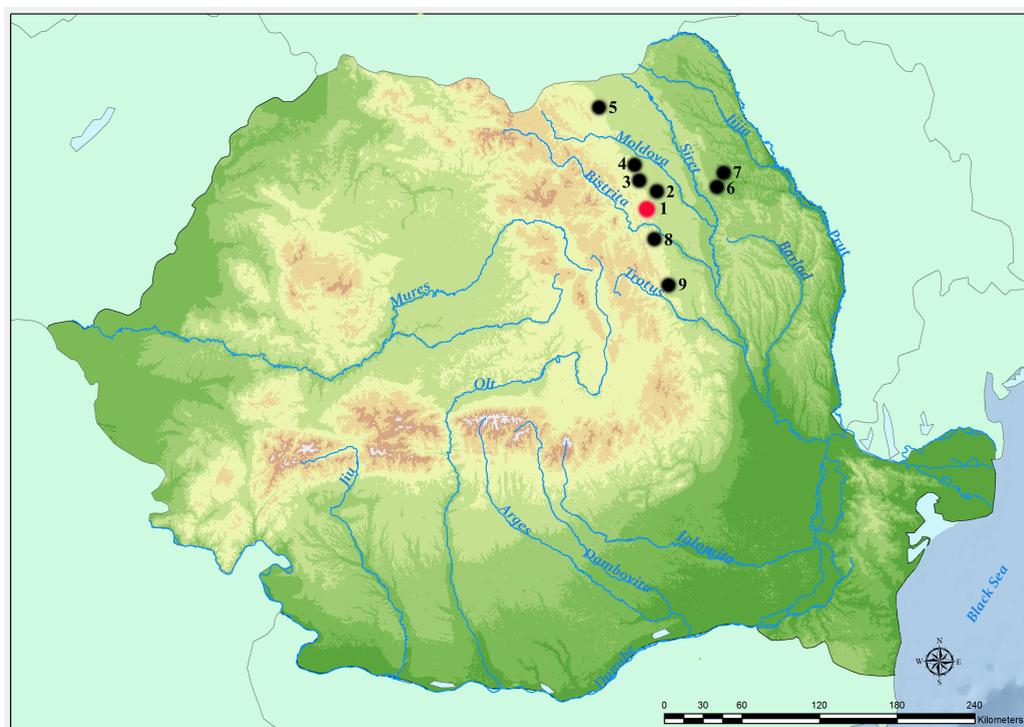


Figure 1. The location of the Gârcina archaeological site (1) and other sampling sites with Cucuteni C ware (2 – Bodești, 3 – Văleni, 4 – Lunca, 5 – Solca, 6 – Valea Lupului, 7 – Cucuteni, 8 – Piatra Șoimului, 9 – Poduri)

¹⁰ DUMITROAIA *et alii* 2012, 56.

¹¹ GARVĂN, MUNTEANU 2012, 31.

¹² GARVĂN, MUNTEANU 2012, 31.

We underline the particular nature of the archaeological deposit: the excavation did not reveal any defined structures such as dwelling remains, hearth or pits. The only type of artefact preserved is the pottery, which forms a highly fragmented assemblage. None of the potsherds retrieved from Trench 1 could be fitted together.

The whole archaeological feature should be seen as a midden area — a heap of soil, charcoal, ashes and potsherds accumulated sequentially, mainly throughout the 5th millennium BC.

Materials and methods

In the present study, we have included pottery samples (Figure 2) which are typologically and stylistically representative for the Cucuteni C ware present within the site.

All the pottery fragments were selected from known stratigraphic units. The small-scale excavation cannot offer reliable data on the extent to which the Chalcolithic inhabitants of the site used fine- and shell-tempered ware. Yet, it should be noted that the assemblage composition resembles that of the ceramic inventories discovered at Lunca and Solca (dating from the same period), where the shell-tempered potsherds amounts to 30–40 % of the earthenware.

The shell-tempered pottery represents the most striking aspect of the Gârcina assemblage. This specific inventory numbers 160 fragments. Identifying the number of pots is almost impossible due to variations in colour and wall thickness.

Only 40 % of the potsherds (from the upper end and the bases of the vessels) provided metric and morphologic data. The best-represented shape is a medium-sized pot with a curving upper body: wide-mouthed, slightly protruding shoulder and a narrow base, which usually measures less than half of the maximum diameter. The mouth diameter falls in the 18–31 cm range, and more frequently between 18 and 21 cm.



Figure 2. Shell-tempered pottery samples from Gârcina–Slatina Cozla II-III

Most likely, the specific technological features induced by the added temper and by the depositional context caused the high degree of fragmentation. No use-related alterations are visible macroscopically.

The finishing treatment of the vessels is limited sometimes to textured (grooved) surfaces or more commonly to lightly smoothed walls. The decoration covers the rim and the upper body, with plastic elements, incised or stamped patterns. The style of the ornamentation is common to Cucuteni C earthenware.

In order to understand the technological characteristics of the shell-tempered ware we have used a combined analytical approach starting with the macroscopic examination of the inner, outer and cross-section of the pottery fragments. The colour of the ceramic body was registered using Munsell Soil Colour Charts. Furthermore, we have performed compositional and textural analysis using polarized light optical microscopy (OM) analysis of thin-sections, microstructural investigations of small fresh cross-sections by scanning electron microscopy coupled with energy dispersive X-ray spectroscopy (SEM-EDX), we have determined the mineralogical content by X-ray diffraction (XRD) analysis and the chemical composition using X-ray fluorescence (XRF) measurements.

After cleaning the pottery samples with distilled water in an ultrasonic bath, we have cut the small slices across the ceramic wall for petrographic thin-section analysis using a Meiji ML9430 microscope and following the description system suggested by Whitbread¹³.

For the SEM-EDX analysis, the pottery fragments were sectioned and the resulting small sections were fixed on copper supports and their surface was examined using an Environmental Scanning Electron Microscope (ESEM) type Quanta 200, operating at 20 kV with secondary electrons in low vacuum mode coupled with an Energy Dispersive X-Ray (EDX) detection system for qualitative and quantitative analysis.

The mineralogical composition was identified using a Shimadzu XRD 6000 diffractometer using $\text{CuK}\alpha$ radiation ($\lambda=1.54059 \text{ \AA}$) 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 $2\theta=4^\circ\text{-}90^\circ$ 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).

The pottery samples (10 g) were grounded into a fine powder using ball-milling technique (Fritsch Planetary Mill Pulverisette 5). Afterwards, the samples were homogenized and mixed with a lubricant (wax containing only C and H) in a 1:6 ratio (1 part wax and 6 parts pottery sample) for eliminating wear and contamination. The homogeneous samples were pressed using a Fluxana PR-25A automatic press at pressure of 20 t/cm². The pressed pellets were

¹³ WHITBREAD 1995; 2017.

analysed using PANalytical Epsilon 5 Energy dispersive X-ray spectrometer with certified reference materials as standards.

Results and discussion

Two of the analysed pottery fragments (GRC-2, GRC-5) presented in Figure 2 have a diffused textured surface, sample GRC-4 show a more complex incised decorative pattern, while the other two potshards (GRC-1, GRC-3) show no decoration. The surfaces of the samples have generally lighter colours (GRC-2-5), ranging from very pale brown (GRC-2-4) to light yellowish brown (GRC-5). Sample GRC-1 has a dark orange colour with dark brown spots caused by the secondary burning.

In cross-section (Figure 3), only sample GRC-1 has a homogenous dark greyish brown colour (10YR4/2), while sample GRC-5 display very pale brown (10YR7/4) hues with diffused greyish brown (10YR5/2) small areas. Sample GRC-2 show a diffused *sandwich* structure consisting in various hues of very pale brown on the outer surface (10YR7/3) and inner surface (10YR7/2) to a dark grey colour in the core (10YR4/1). Two of the analysed pottery fragments presents a *bicoloured* structure, ranging from a diffused partly greyish brown (10YR5/2) with lighter spots (10YR6/3), partly brown (10YR5/3) in sample GRC-3, to a distinctive partly grey (10YR4/1) – partly brownish (10YR6/6) in sample GRC-4.

The greyish brown colour with more diffused or more intense darker hues indicates a Fe-rich matrix fired mostly under reducing atmosphere¹⁴. The existence of a layered structure of *sandwich* (Figure 3/2, 3, 5) or *bicoloured* (Figure 3/4) type could be the result of the incomplete transformation of the ceramic body at the end of the firing process¹⁵ or of the partial decomposition of the organic matter¹⁶.

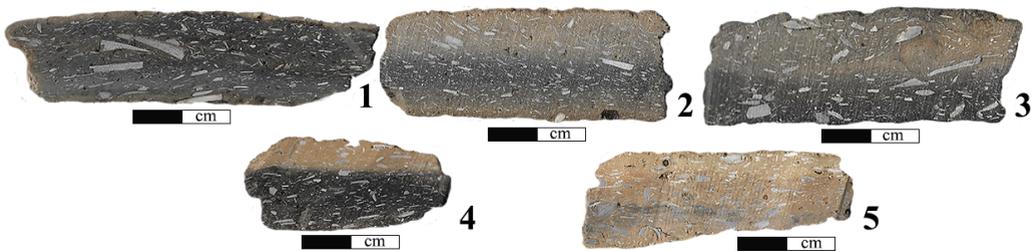


Figure 3. Cross-sections of the shell-tempered pottery samples from Gârcina–Slatina Cozla II-III

¹⁴ MOLERA *et alii* 1998, 188.

¹⁵ MOLERA *et alii* 1998, 201; NODARI *et alii* 2004, 126–127.

¹⁶ NODARI *et alii* 2004, 127; MARITAN *et alii* 2006, 6.

The pottery samples selected from Gârcina present a slightly similar matrix containing various amounts of clasts (Figure 4/a–d). The matrix is homogenous with a light brown colour range observed using parallel nicols. Samples GRC_1–3 and 5 displays a medium to low optical activity, while sample GRC-4 displays optical activity in the reducing area and shows less optical activity in the oxidizing area. Scarce rounded voids are present in the microstructure of samples GRC-1 and GRC-2, which are open-spaced distributed, without preferential orientation. The microstructure of samples GRC-3, GRC-4 and GRC-5 shows abundant planar voids, slightly preferentially oriented.

The quartz grains under 20 μm present in all the analysed samples are considered as part of the pottery matrix¹⁷. The non-plastic clasts are represented mainly by angular, sub-angular (GRC-1, GRC-2) and sub-rounded (GRC-3, GRC-4, GRC-5) grains of quartz which often have undulatory extinction (Figure 4/a–b). Samples GRC-1, GRC-2, GRC-4 and GRC-5 contains different amounts of small red grains, unevenly distributed throughout the matrix, which represent amorphous iron oxide (Figure 4/a–c).

The clasts are relatively well sorted and no larger than 260 μm for lithoclasts and over 1.5 mm only for bioclasts. Most of the quartz grains which composes the main part of the lithoclasts falls within the 50 and 200 μm , which corresponds to the silt to fine sand category, according to the Wentworth scale¹⁸. Only samples GRC-1 and GRC-2 contains a small amount of quartz grains larger than 200 μm .

All the pottery fragments contain various amounts of shells. In sample GRC-1 (Figure 4/a) the shells forms parallel oriented zones, while in the other samples are more randomly distributed. The shell temper registered a wide range of firing transformations, mainly, due to its original variety in sizes.

In samples GRC-1, GRC-2, GRC-4 and GRC-5 the small shell fragments have lost their internal microstructure, while the larger fragments still preserve, at least partially, a multilayer structure (Figure 5/1). The internal structure of the growth layer of the shell fragments embedded in the GRC-3 (Figure 5/2) ceramic paste have collapsed showing a more homogeneous internal morphology with a more dissipated frame along the lamellar border.

SEM microphotographs presented in Figure 6 exhibit the differences in terms of firing transformations between the smaller and thinner shells (Figure 6/a) and the coarser fragments (Figure 6/b). The structural disintegration of the small shell fragments (Figure 6/a) was caused by the accelerated decomposition of the organic matter followed by the decomposition of calcite, which appears in microstructural areas with low superficial tension and a higher Gibbs free energy, like the small gaps located alongside the growth lamellae¹⁹.

¹⁷ IONESCU *et alii* 2011, 469 with references therein.

¹⁸ WENTWORTH 1922, 389, 391.

¹⁹ MARITAN *et alii* 2007, 538.

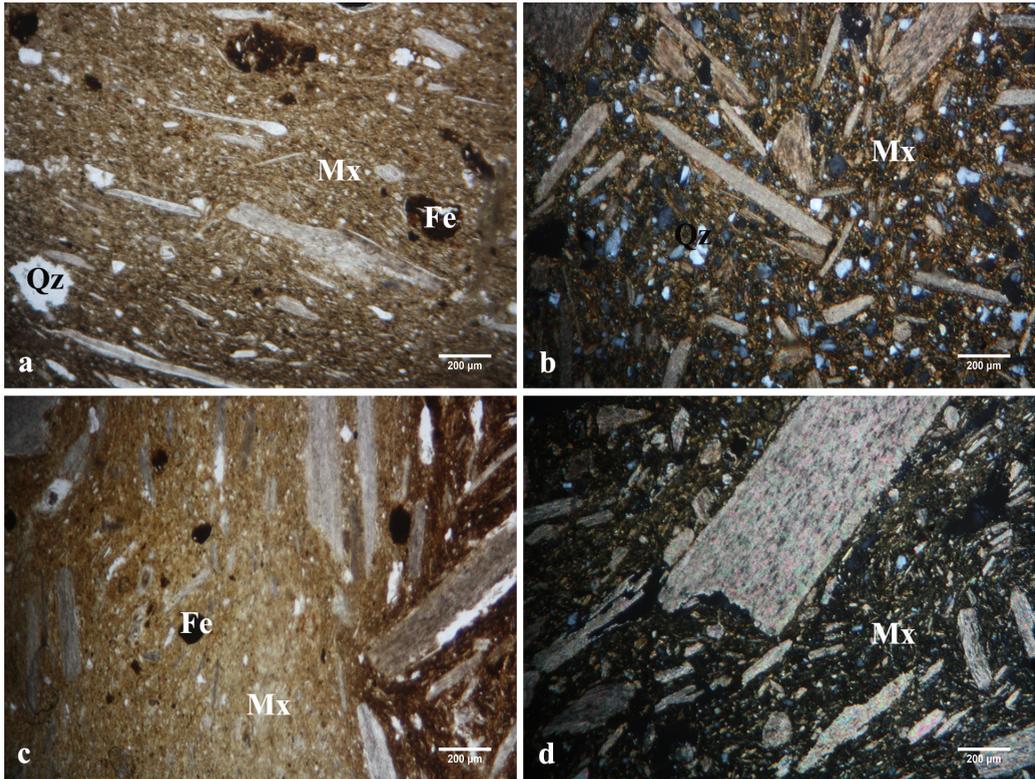


Figure 4: Polarized light microphotographs of shell-tempered ware from Gârcina (a – GRC-1 matrix (*Mx*) with iron oxides (*Fe*) and quartz (*Qz*) grains; b – GRC-2 matrix (*Mx*) with quartz (*Qz*) grains; c – GRC-4 matrix (*Mx*) with iron oxides (*Fe*); d – GRC-5 matrix (*Mx*).

Images a, b and d are with crossed polarizers at 4× and image c is with plane polarizers at 4×

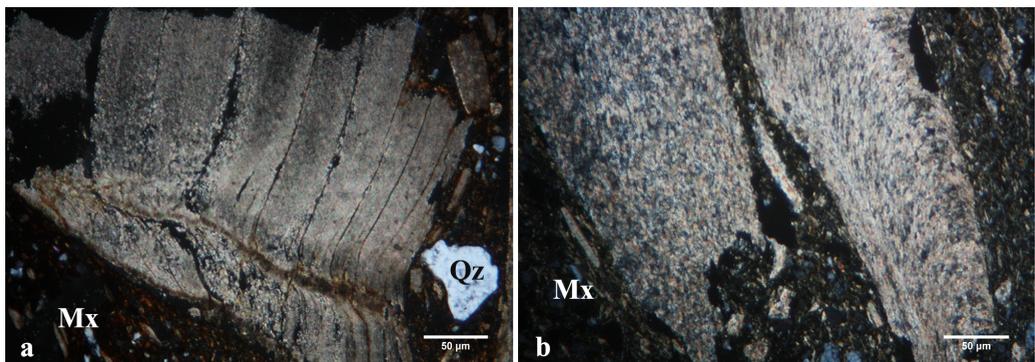


Figure 5: Polarized light microphotographs of the shell temper present in the pottery samples from Gârcina (a – GRC-1 matrix (*Mx*) with quartz (*Qz*) grains; b – GRC-3 matrix (*Mx*).

All images are with crossed polarizers at 20×.

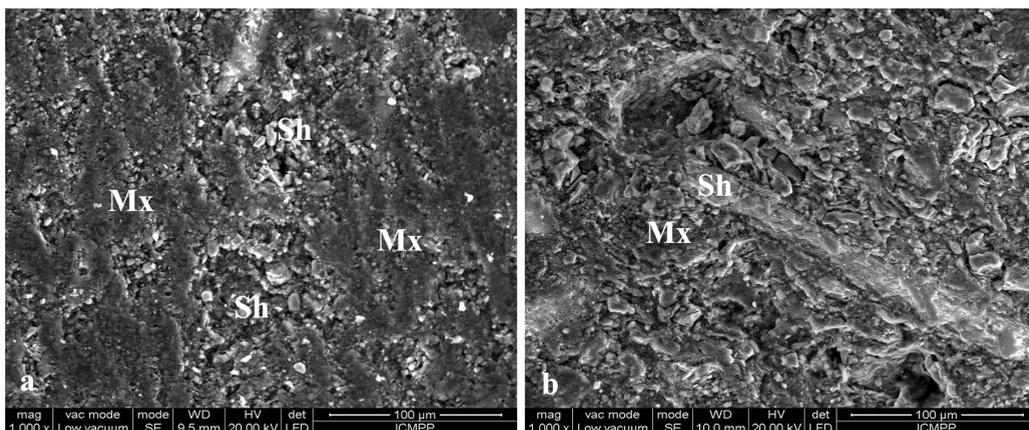


Figure 6: SEM images of pottery matrix and shell fragments observed in samples GRC-1 (a) and GRC-2 (b)

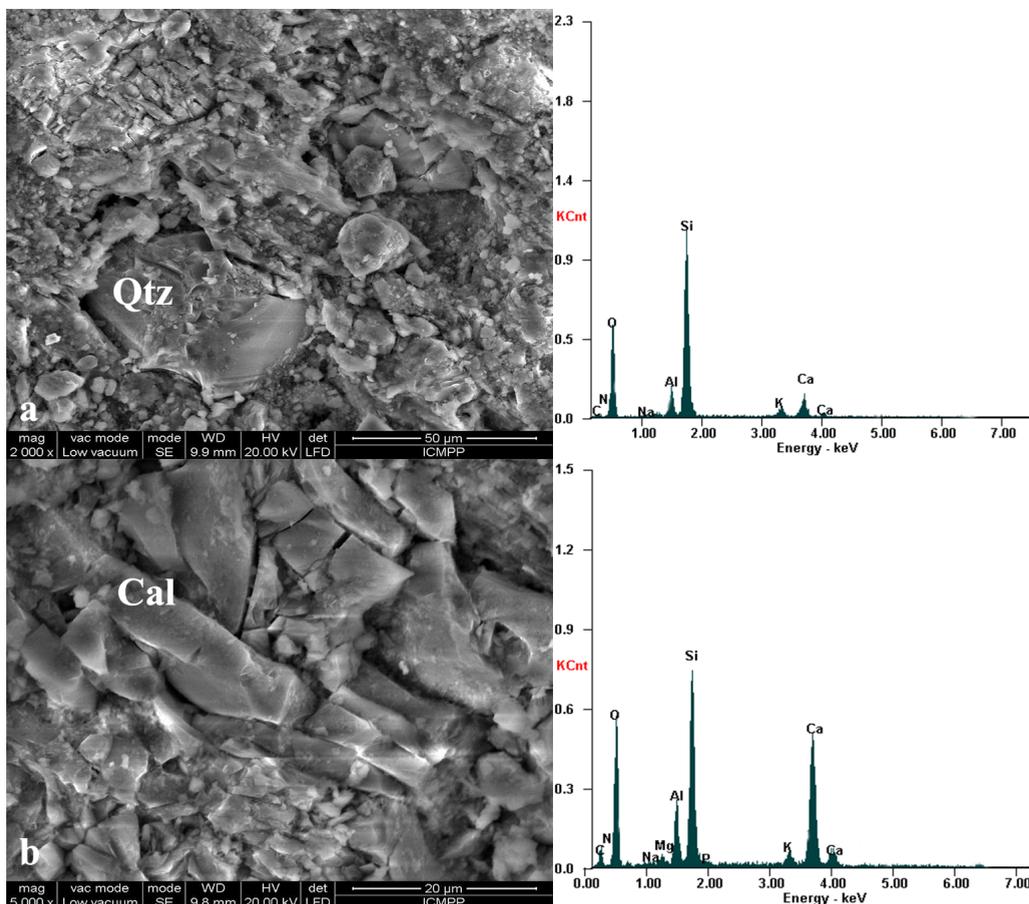


Figure 7: SEM images and EDX spectra of a quartz grain (a) and of calcite microstructure from the shell temper (b) identified in sample GRC-1

In the adjacent area, the matrix (Figure 6/a) registers a high degree of particle intertwining with low porosity causing thick reaction rims at the calcite-quartz/phyllsilicate interface²⁰. The coarser shell fragments have preserved their layered morphology as shown in sample GRC-2 (Figure 6/b), while in the surrounding matrix no bloating pores or reaction fringe have appeared.

The quartz grain (Figure 7/a) has almost sharp edges with no reaction rims indicating that the subjected temperature was below the vitrification point. Figure 7/b reveals very well preserved calcite prisms while the inter-prismatic organic membranes were destroyed during firing.

The mineral assemblages present in the shell-tempered ware selected from Gârcina were determined by XRD and are represented in Figure 8. The main diffraction peaks corresponds to quartz and calcite, with significant amounts of phyllosilicates and feldspar. The presence of the illite/muscovite in all the samples indicates that the firing temperature did not exceed 850–900°C²¹. The first mineral transformation affecting the initial shells composition consists in the breakdown of aragonite between 400°C and 450°C when its main reflection peaks disappear from the XRD pattern, probably to the polymorphic transformation to calcite. The absence of newly formed calcium-aluminium (gehlenite) and calcium-magnesium (diopside) silicate phases, which appears due to the decomposition of calcite and its reaction with silicates from the groundmass, prompts for firing temperatures lower than 800–850°C²². The increase in intensity of the feldspars diffraction peaks is related to the increase in the firing in temperature, suggesting that these phases are produced by the reactions involving illite and calcite²³, as can be stated for sample GRC-5 where we observe the disappearance of some of the adjacent peaks of illite/muscovite and calcite.

As previously stated when presenting the macroscopic features of the pottery samples, the first insights into the firing atmosphere can be obtained based on their colours. The selected potshards revealed a wide variety of colours corresponding to different firing regimes ranging from reducing (sample GRC-1) to oxidizing (sample GRC-5) conditions. Further, the thermal conditions of firing can be assessed based on variation of the optical properties of the matrix, the alteration of the diffraction patterns or the microtextural transformations of the shells and of the matrix identified by optical or electronic microscopy.

Based on the firing conditions, all the pottery samples falls within a low to medium fired group preserving, at least partially, the initial phyllosilicates included in the matrix as can be inferred based on the illite/muscovite diffraction peaks present in all the samples. These

²⁰ CULTRONE *et alii* 2001, 626.

²¹ CULTRONE *et alii* 2001, 624; MARITAN *et alii* 2007, 533; TRINDADE *et alii* 2009, 348.

²² MARITAN *et alii* 2007, 531.

²³ MARITAN *et alii* 2007, 533.

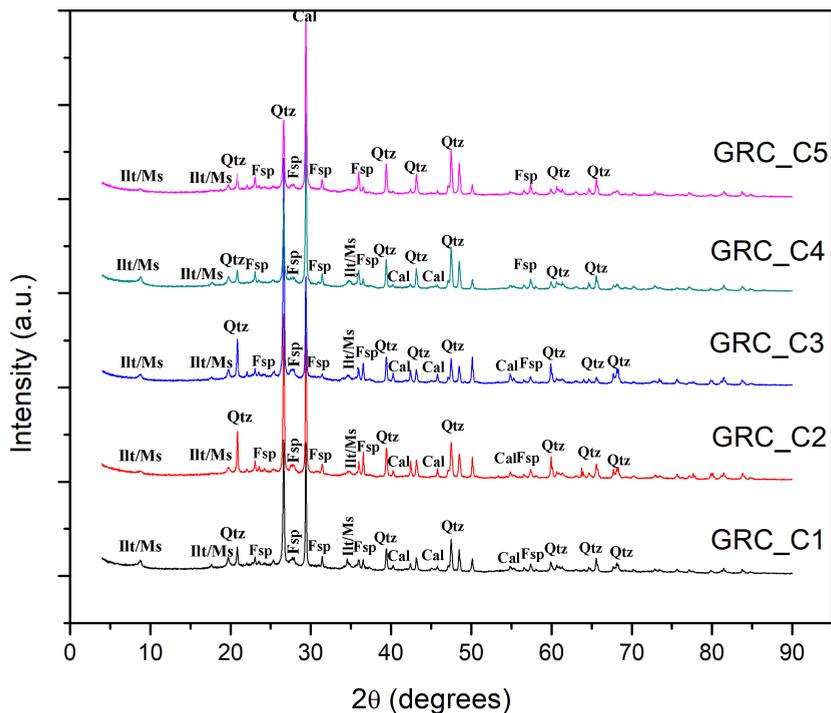


Figure 8: X-ray diffractograms of the shell-tempered pottery from Gârcina (Abbreviations: Illt/Ms – illite-muscovite; Qtz – quartz; Cal – calcite; Fsp – feldspar)

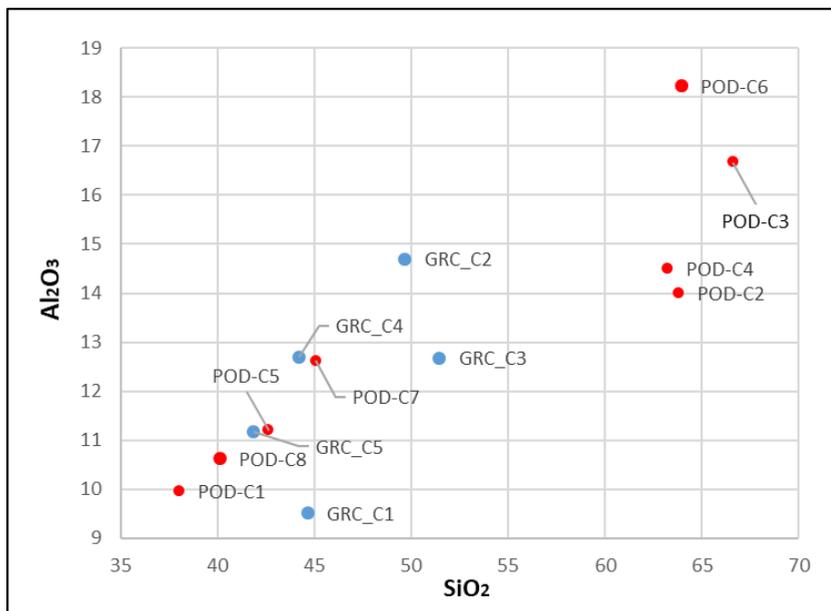


Figure 9: Bivariate SiO_2/Al_2O_3 graphic for pottery samples from Gârcina (GRC) and Poduri (POD)

corresponds with the absence of newly formed mineral assemblages in the XRD pattern, combined with the presence of small red grains in the matrix corresponding to amorphous iron compounds which was not exposed to higher enough temperatures to form magnetite or hematite. The simultaneous presence of hematite and magnetite in previously analysed Cucuteni C pottery from Poduri-Dealul Ghindaru suggested the existence of a higher firing regime, which attained 850°C²⁴.

Due to the absence of newly formed mineral phases during exposure at higher temperatures, we can estimate the firing conditions based on the morphological transformations of the shells present in the paste. The shells microstructure observed by optical and electron microscopy exhibits a wide range of transformations due to the firing process. The appearance of small inter-layer pores along adjacent growth layers and on the external surface²⁵ in the larger shells fragments, combined with the breakdown of the internal microstructure in the smaller shell fragments and the rise of small areas showing vitrification in the nearby matrix (Figures 5/a; 6/a) prompt for the existence of temperatures higher than 650°C. The existence of intra-layer pores, especially in the adjacent area of external wall of the shell fragments²⁶ combined with the maintenance of the prismatic layers of recrystallized calcite allows us to estimate that the firing temperature was between 750°C and 800°C.

As previously mentioned, this study is part of a larger project, which aims to determine the main technological features of the Cucuteni C ware identified in Eastern Romania. For understanding the type of raw materials used in the pottery production, we have tried to estimate the correlations of bivariate $\text{SiO}_2/\text{Al}_2\text{O}_3$, which may reveal the use of various raw clay materials. SiO_2 represents quartz as silt or sand, while Al_2O_3 exhibits the type of clay minerals²⁷ and the correlations of bivariate $\text{SiO}_2/\text{Al}_2\text{O}_3$ assumes for the use of clays without any previous preparation or for the existence of preliminary treatment such as levigation, or the addition temper bearing quartz (e.g. coarser sand grains, grog).

In order to obtain a more accurate perspective on the type of clay used for pottery making we have plotted in Figure 9 the data obtained by X-ray fluorescence analysis for the samples selected from Gârcina with the ones from Poduri²⁸. The pottery samples from Gârcina show a wider spread throughout the data, mainly due to the different amounts and grain sizes

²⁴ MĂȚĂU *et alii* 2015, 138–139.

²⁵ MARITAN *et alii* 2007, 540.

²⁶ MARITAN *et alii* 2007, 540.

²⁷ WEAVER, POLLARD 1973, 5–21; VELDE 1992, 2.

²⁸ The XRF data presented in Figure 9 were obtained on the same pottery samples previously published (MĂȚĂU *et alii* 2015). In the previous study, we have included the macroscopic observations, SEM-EDX and XRD analysis, while the XRF data presented here were not included. The labels used in Figure 9 for the pottery samples from Poduri corresponds to the ones used in the previous study.

of quartz as revealed by the petrographic analysis. Four of the shell-tempered ware from Poduri falls within the same group with the ones from Gârcina (Figure 9), which prompts for the use of a related type of illitic clay. A distinctive group with a higher spread of the data is formed from one of the shell-tempered pottery sample from Poduri (POD-C2)²⁹ and three pottery samples having grog as temper, which may suggest the use of different type of clay or a different way of processing the raw material.

Even though, the graph based on the correlations of bivariate $\text{SiO}_2/\text{Al}_2\text{O}_3$ showed a distinctive grouping of the samples, which corresponds to a certain degree of variation in the use of the same type of clay. These results agree with the presence of illite in all the pottery samples as revealed by the XRD analysis (Figure 8). Further, we have done Principal Component Analysis based on major (SiO_2 , Al_2O_3 , TiO_2 , Fe_2O_3 , MgO , MnO , CaO and K_2O)³⁰ and trace (V, Cr, Rb, Sr, Y, Zr, Nb, La, Pb, Th, U) elements. The results of the PCA analysis presented in Figure 10 shows the existence of three separate groups in the pottery samples from Gârcina and Poduri. The grog-tempered ware forms a distinctive group combined with one of the shell-tempered samples as shown, also, in Figure 9, while the shell-tempered ware from both sites spreads into separate groups. The association of the pottery samples in distinctive groups shown in Figure 10 is caused by the use of different sources of raw materials that was combined with different types of tempers.

Based on the archaeometric analysis of the shell-tempered ware from Gârcina and its comparison with the previously analysed Cucuteni C ware from Poduri, it is clear that we have some common technological trends such as the use of the same type of illitic clay with some variation in the firing characteristics. A lot more work needs to be done requiring the extension of the database with more Cucuteni C samples from the same sites, from the nearby area and the gathering of the Cucuteni painted, and unpainted ware. In addition, it is necessary to sample the available clay sources from the nearby area.

Complex technological affinities in terms of clay and temper type preferences indicate the existence of a dialogue facilitating the exchange of knowledge. This idea illustrates, also, the importance of tempering in pottery making for further understanding the social mechanisms behind this *technological choice*. Further, any specific *technological choice* relates to its performance in manufacture and use in agreement with the vessel's intended technological, economic, social or symbolic functions. Although all types of function can be

²⁹ The distribution of the pottery POD-C2 shell-tempered pottery sample from Poduri in Figure 9 is consistent with the distribution of the same sample (the matrix value) in the HCA dendrogram (Fig. 3 in MĂȚĂU *at alii* 2015) obtained based on the EDX analysis.

³⁰ We did not include Ca in the major elements due to the higher content induced by the shells addition which will generate an artificial spread of the data.

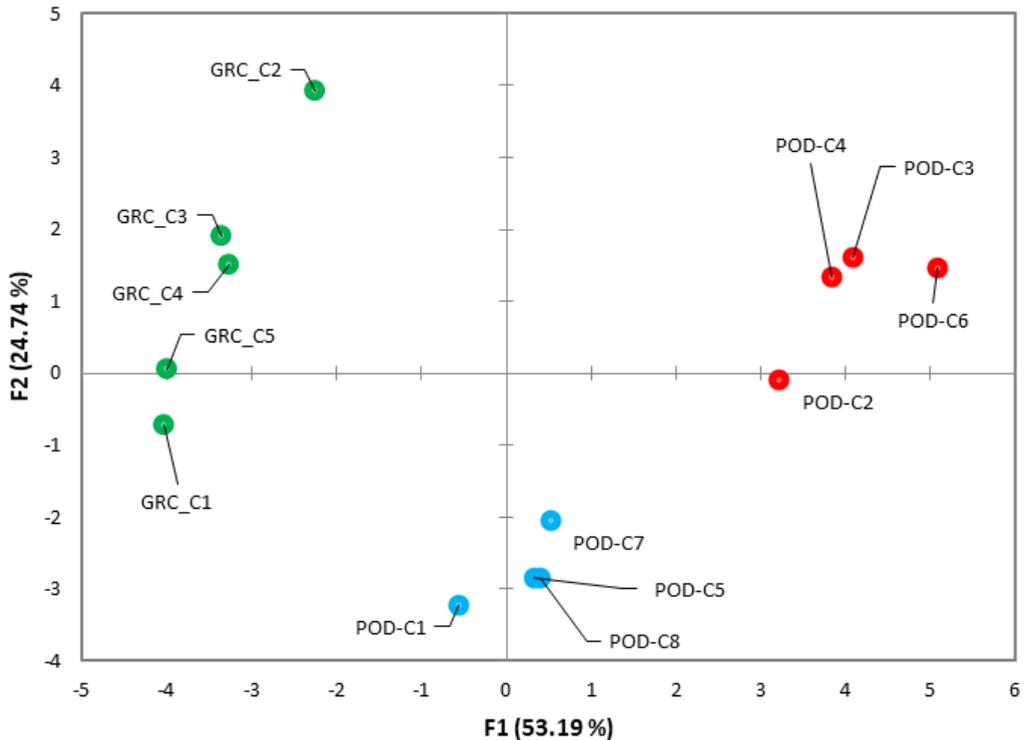


Figure 10: Principal component analysis (PCA) of the pottery from Gârcina (GRC) and Poduri (POD)

important in the design of the vessel, the overwhelming primary function of ceramic vessels, both prehistorically and ethnographically, is in processing, storing, and transporting food and liquids³¹. The recent use-wear analysis performed on Cucuteni C ware from several sites has revealed its use for food processing³².

Tempering represents a conscious material choice that is more controllable than the quality of clay, which is constrained by the local environment, but also potentially meaningful for understanding the possibility of combining the pottery with materials from other social spheres (e.g. shells as part of the culinary habits). The ware complexity prompts to the roe pottery played in the material worldview. Tempering traditions may even have carried a history of the potter's family heritage (e.g. the grog-tempered pottery³³) while at the same time defining the potters existence in the same natural and social environment.

³¹ SKIBO 2013, 27.

³² MUNTEANU 2015.

³³ The analysis performed on the grog fragments and on the pottery matrix from Poduri have revealed a similar chemical composition (MĂȚĂU *et alii* 2015).

Conclusions

The archaeometric investigations of the shell-tempered ware from Gârcina-Slatina Cozla II-III showed the existence of a homogenous group with relatively similar composition and technological features. In terms of raw materials selection and processing, we assume the use of the same type of illitic clay, mixed with different amounts of crushed shells.

The firing regime underwent a wide variety of firing atmospheres ranging from reducing to oxidizing regimes, or to the alternation of reducing and oxidizing conditions in the same firing cycle. Based on the mineralogical and textural characteristics of the potshards, most likely the firing temperature was between 750°C and 800°C.

Comparison with previously analysed shell-tempered pottery from Poduri-Dealul Ghindaru indicated the use of a similar type of illitic clay which distinguishes geochemically from the one used for producing the ware from Gârcina. In a few cases, samples from Poduri Poduri-Dealul Ghindaru pointed out to the existence of firing temperatures higher than 800°C. The variation in the firing atmosphere registered for both sites may be related to the type of added temper. Further analysis performed on the other types of pottery identified within the sites needs to be done in order to understand if the variation in firing atmosphere may also be caused by the imperfection of the firing devices.

Although we did not work on a much-extended database on Cucuteni C ware, we can assume, at least for Gârcina and Poduri the existence of some similarities in terms of the raw materials selection and some specific features for each site in terms of firing characteristics. Finally, more detailed archaeological and archaeometric analyses are needed for explaining the function and the social significance of the Cucuteni C pottery in Eastern Romania, and further on the whole area of the Cucuteni-Trypillia civilization.

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