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# PRELIMINARY DATA ON BRONZE AGE POTTERY FROM SĂVEŞTI (NEAMŢ COUNTY, ROMANIA)

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**ABSTRACT.** The paper presents the results of the mineralogical and physical analyses carried out on 20 potsherds from Săveşti (Neamţ county, Romania) belonging to Noua Culture. The goal of this investigation was to provide information on the type of temper materials, the way that the vessels were shaped, the temperature and firing conditions. Generally, the colour is homogenous, grey to black indicating reducing atmosphere. Exceptions are three samples with a “sandwich”-type structure and one sample with a yellowish-brown colour that suggest an oxidizing atmosphere during firing. The matrix is relatively uniform, with clasts of various sizes (up to 3-4 mm). Macroscopically, quartz grains, micas, and ceramoclast were identified. Based on microscopic grain size, two types of ceramics can be separated: semifine (lutitic-siltic-arenitic), and coarse (lutitic-arenitic-siltic). Based on the ratio between crystalline *vs.* amorphous phases, microcrystalline-amorphous and amorphous-microcrystalline to amorphous fabrics were described. The presence in some samples of elongated primary pores and the preferential orientation of micas lead to a flow texture. As non-plastic materials (temper), crystalloclasts (quartz, micas, iron oxi-hydroxides, feldspars, epidote, zircon, rarely carbonates), lithoclasts (quartzite, micaschist, gneiss), and ceramoclasts were identified. The X-Ray diffraction analyses confirm the microscopic observations. Some physical characteristics were also measured: the water adsorption values range between 7.17 % and 14.44 %. According to the macroscopic, microscopic and compaction features we estimate the firing temperature of the studied potsherds to be between 850-900°C.

***Key words:*** *archaeometry, Bronze Age pottery, mineralogical and physical analyses, Noua Culture, Romania.*

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## INTRODUCTION

The study of ancient ceramics is a necessary element for understanding prehistoric technology. This especially when it comes to investigating shaping of ceramic vessels, dimensional parameters, mineralogical composition, intensity and conditions of the firing process [1, 2, 3, 4].

The present study is of special significance, giving the fact that currently there are only a few mineralogical analyses on Bronze Age pottery from sites in the East Carpathians. Recently, several studies have been published on this topic, but they only focus on pottery lots from the Middle Bronze Age, namely the Komarov and Costişa cultures [5, 6, 7].

The site of Săveşti (Răuceşti commune, Neamţ county) is located on the right bank of Moldova River in a contact area between the Subcarpathians and the Suceava Plateau. In 1986, Gheorghe Dumitroaia undertook an archaeological survey of a Late Bronze Age settlement (Noua culture) located in the north-west part of the village, in the so-called “Izvoare” spot). A surface of approximately 150 square meters was investigated; the research revealed traces of a surface dwelling, hearths and stone agglomerations. The archaeological material is mainly represented by pottery, animal osteological remains and stone artifacts [8, 9].

We should emphasize that the site area is well known for the high density of the Noua culture settlements. This can be partly due to the existence in the region of numerous salt sources (namely saltwater springs) [10,11]. Twenty potsherds identified in the Săveşti settlement were analysed for their mineralogy and physical properties. They resulted from different types of vessels, most of them having medium and small sizes. In terms of shapes, jars, cups and bowls dominate. There is a close connection between the pottery types and the quality of the utilized clay. From this point of view, we can separate two categories of ceramics: coarse ware and fine pottery. For example, the jars and bowls are made of coarse/rough, inhomogeneous clay mixed with crushed shards, micro gravel and even crushed quartzite. Alternatively, the cups are made of more homogeneous clay, fact that allowed the potter to manufacture vessels with thin walls. In some cases, the surface of the ceramic vessels is rough and fine cracks are present, while in others the surface was covered with slip. Among the analyzed pieces, only two fragments were decorated.

The color of the potsherds is generally even with slight differences between the exterior and the interior vessels walls. The colors range from reddish to black, suggesting both reducing and oxidizing firing conditions.

In order to identify certain structural parameters, we have chosen to study potsherds that belong to all areas: top, middle and base.

The LBA populations (15$^{th}$–12$^{th}$ centuries BC) and especially the communities of the Noua culture distinguish themselves through a certain mobility determined by their economical behavior based on animal husbandry [12]. In this context, our study aims to clarify whether the ceramic production had a local character or on the contrary, clay and some of the degreasers were brought from the surrounding areas. Also, defining the quality of the paste correlated to the shape of the vessels could provide some clues concerning the pottery's functionality.

## RESULTS AND DISCUSSION

### *Macroscopical studies*

As a rule, the ceramic fragments show homogenous colour with grey to black shades that suggest reducing firing conditions. Only the outer walls show brownish to brown-reddish thin rims (< 1 mm-thick). Exceptions from this trend are samples 2, 12 and 19 showing a sandwich-type structure and sample 8 respectively, showing a light brown-yellowish color – all these samples point to oxidizing firing conditions.

In most of the samples, the matrix is relatively homogenous, with scattered clasts; exceptions are samples 17, 18 and 19. The grain-size distribution in the matrix ranges from semi-fine to coarse. The clasts show various sizes (*e.g.*, in samples 13, 16, 19 reaching up to 3-4 mm).

Macroscopically we could identify quartz grains, mica lamellae and fragments of ceramoclasts.

Porosity is relatively constant, being represented by both primary pores that are usually elongated and parallel to the ceramic surfaces, and irregular secondary pores. The pore sizes range from 0.5 x 1.0 to 1.5 x 3.0 mm.

### *Polarized light microscopy*

In order to identify the mineral components of the matrix and the flux, the fabric of the ceramic shards and the thermal transformations we have studied the samples by optical microscopy under transmitted light. The grain-size measurements led to defining two ceramic types: semifine (lutitic-siltic-arenitic type) and coarse (lutitic-arenitic-siltic) ceramics (these terms apply as follows: lutite < 0.004 mm, silt = 0.004-0.063 mm; arenite = 0.063-2 mm) [13, 14, 15]. Based on the ratio between crystalline vs. amorphous phases in the matrix, two fabric types can be defined: microcrystalline-amorphous and amorphous-microcrystalline to amorphous (Figs.1, 2).

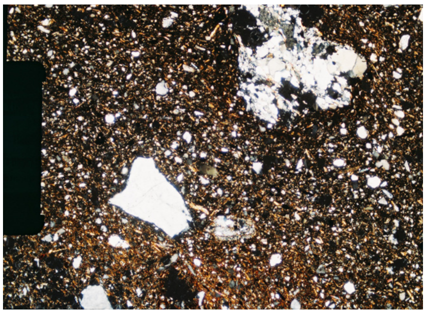

**Fig.1** ***Sample 2*** – Semifine ceramics with microcrystalline - amorphous matrix; quartz, micas, quartzite and micaschist clasts; N+, scale bar = 0.5 mm

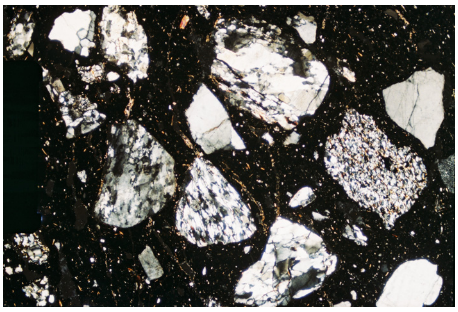

**Fig.2** ***Sample 18*** – Coarse ceramics with amorphous to microcrystalline matrix; quartz, micas, quartzite, micaschist and gneiss clasts; N+, scale bar = 0.5 mm

The presence of elongated pores in the studied shards suggests that the ceramics was obtained by plastic shaping. In some of the samples, the preferential orientation of the mice lamellae and of the primary, elongated pores define a relatively obvious flow texture (Figs. 3, 4, 5, 6).

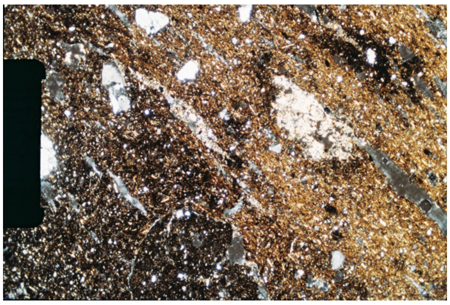

**Fig.3** ***Sample 17*** – Semifine ceramics with microcrystalline - amorphous matrix; elongated pores parallel to the surface; quartzite lithoclasts, quartz, calcite and micas crystalloclasts; N+, scale bar = 0.5 mm

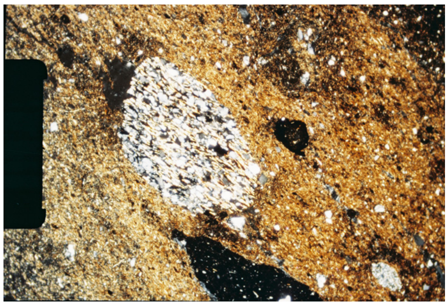

**Fig.4** ***Sample 9*** – Semifine ceramics with microcrystalline - amorphous matrix; micaschist lithoclasts, ceramoclasts, quartz and orientated micas; N+, scale bar = 0.5 mm

The crystalloclasts are represented by quartz (from subangular to rounded, with more or less pronounced fissures), micas (muscovite, and rare biotite), iron oxi-hydroxides (mainly hematite) aggregates and feldspars, plagioclases, epidote and zircon in subordinate amounts. The relative high birefringence of the micas (Figs. 5, 6) points to firing temperatures less than 850°- 900°C. Also, the specific features of the matrix and its low birefringence suggest that clay minerals are mainly represented by kaolinite/montmorillonite and subordinately by illite. Only a few samples (5, 10, and 17) contain carbonates.

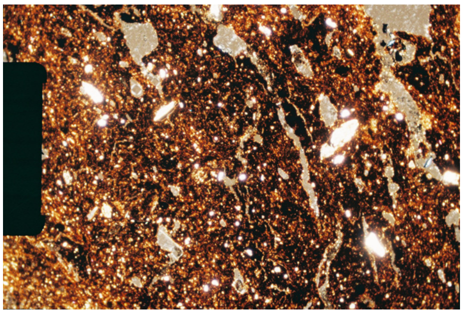

**Fig. 5** ***Sample 15*** – Semifine to coarse ceramics with microcrystalline - amorphous matrix; ceramoclasts, elongated pores / fissures, quartz and birefringent micas; N+, scale bar = 0.5 mm

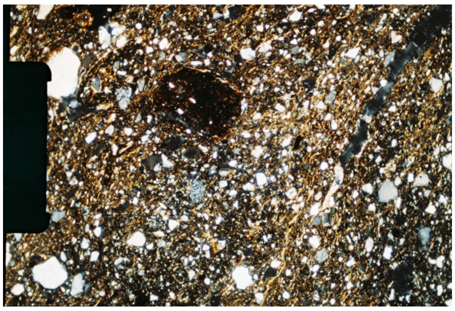

**Fig. 6** ***Sample 5*** – Semifine ceramics with microcrystalline to amorphous matrix; circular and elongated pores, ceramoclasts, quartzite lithoclasts, quartz, carbonates and micas; N+, scale bar = 0.5 mm

Lithoclasts are represented by quartzites, micaschists and gneisses (all metamorphic rocks) and their sizes normally range between 2 and 3 mm (maximum sizes in samples 12, 16, 18; Figs. 2, 7, 8). The plagioclase feldspars in these metamorphic lithoclasts are polysynthetically-twinned while the quartz grains show undulatory extinction and mosaic-type structure. The fact that some carbonate grains were not thermally-decomposed indicates low firing temperatures (<850°-900°C).

Ceramoclasts are present in all the studied samples in amounts of ~2 % and with sizes up to 2.5 mm.

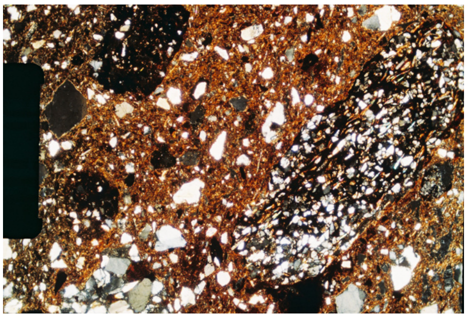

**Fig. 7** ***Sample 12*** – Semifine to coarse ceramics with microcrystalline - amorphous matrix; quartzite lithoclasts, ceramoclasts, quartz and micas; N+, scale bar = 0.5 mm

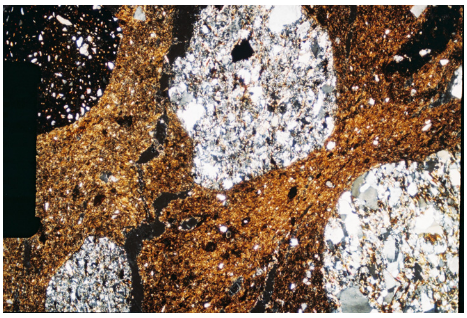

**Fig. 8** ***Sample 16*** – Semifine to coarse ceramics with microcrystalline - amorphous matrix; micaschist lithoclasts and ceramoclasts; N+, scale bar = 0.5 mm

### *X-Ray diffraction*

The mineralogical composition obtained by means of X-Ray diffraction (XRD) is relatively simple: it confirms the microscopic observations (Figs. 9 and 10). Due to the ubiquitous presence of quartz and quartzite clasts that dominate the XRD patterns, the presence of the other minerals is hard to be evidenced. However, besides quartz the following minerals could be easily identified: feldspars (albite–anorthite), illite, and muscovite. Montmorillonite-chlorite interstratifications are present only in samples 2 and 8. Calcite peaks were best observed in samples 1, 2, 4, 5, 10 and 17. Iron oxi-hydroxides (hematite, goethite) peaks are partly covered by those of phyllosilicates (illite, muscovite).

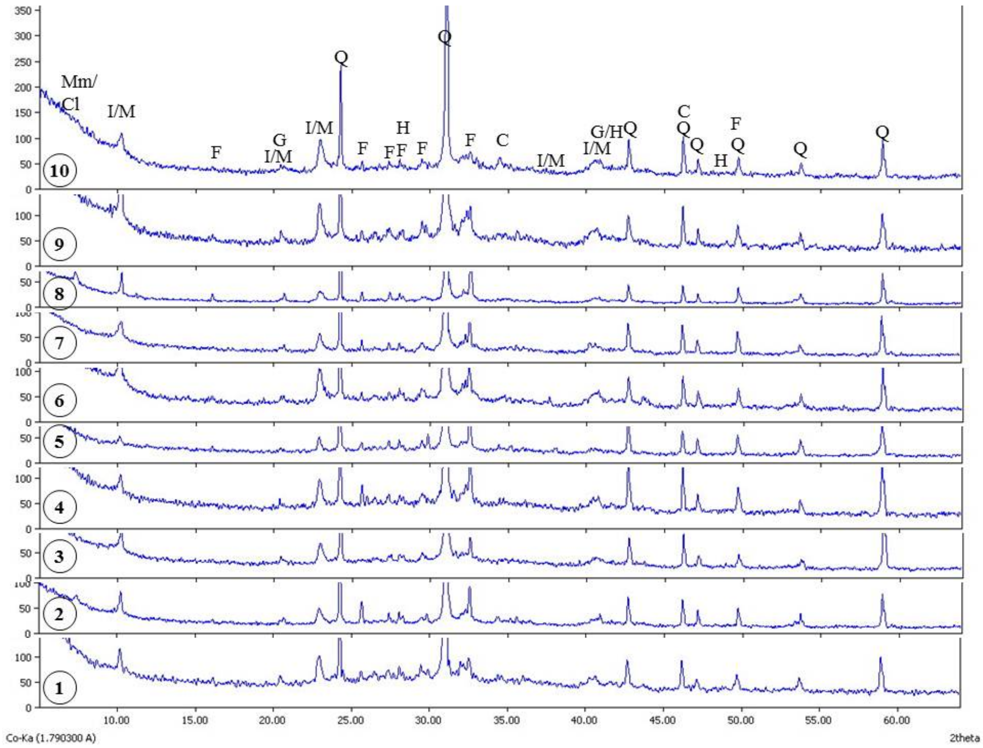


**Figure 9.** XRD patterns of the studied ceramic fragments; sample no. is indicated in the lower left corner; Q – quartz, F – feldspars (Ca-Na), I/M – illite/muscovite, C – calcite, Mm/Cl – montmorillonite/chlorite, H – hematite, G – goethite.

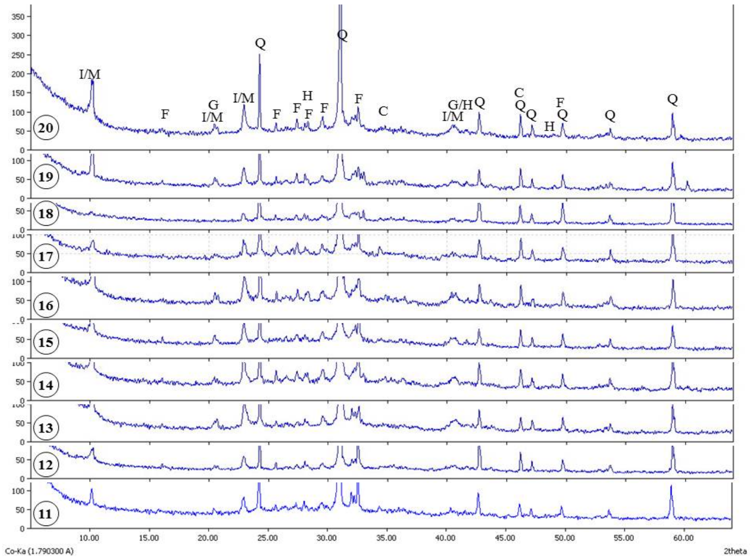


**Figure 10.** XRD patterns of the studied ceramic fragments; sample no. is indicated in the lower left corner; Q – quartz, F – feldspars (Ca-Na), I/M – illite/muscovite, C – calcite, H – hematite, G – goethite.

### *Physical characteristics*

In order to observe the variability of the compaction degree in each ceramic fragment, three samples from each potsherd were analysed. The values of the physical characteristics are presented in Table 1, where water absorption ranges from 7.17 % to 14.44 %.

**Table 1.** Compactness characteristics of some of the studied ceramic samples

| Sample no. | Apparent density [g/cm$^3$] | Water absorption [%] | Apparent porosity [%] |
|---|---|---|---|
| 1 | 1.89 | 10.46 | 19.82 |
| 3 | 1.87 | 10.84 | 20.32 |
| 4 | 1.86 | 12.00 | 22.41 |
| 5 | 1.93 | 11.76 | 22.74 |
| 6 | 2.00 | ***7.17*** | 14.37 |
| 7 | 1.97 | 9.47 | 18.72 |
| 8 | 1.96 | 10.28 | 20.15 |
| 10 | 1.99 | 7.46 | 14.85 |
| 11 | 1.83 | 9.79 | 17.95 |
| 15 | 1.84 | 12.35 | 22.73 |
| 17 | 1.93 | 9.99 | 19.30 |
| 20 | 1.81 | ***14.44*** | 26.18 |

For the rest of the analysed potsherds, the obtained water absorption values vary significantly. The variability of physical parameters even in the case of the same ceramic sherd can arise from several causes: (1) thickness of the ceramic body, (2) inhomogeneity of the material (the raw materials mixture), (3) variable temperatures of firing/unequable flames formed in different parts of the kiln, (4) the „sandwich" structure of the sherd revealing oxidizing/reducing atmosphere, (5) the fine fissures in quartz and quartzite clasts as a consequence of firing. These, togheter with the presence of fissures and pores resulted from processing, lead to variations of the physical parameters.

## CONCLUSIONS

The grey- to black colours of most of the studied potsherds suggest reducing firing conditions for this type of pottery. The rare samples showing exceptionally brownish-yellowish hues (*e.g.*, sample 8) point to oxidizing conditions, i.e. a better control during the firing. This latter case is suggested also by samples 2, 12 and 19 displaying a "sandwich"-type structure. The thin (often < 1 mm-thick) rim at the outer surface of the potsherds may be the result of both *in situ* weathering and a change in the firing regime.

The porosity features, marked by the presence of mainly elongated primary pores displayed parallel to the surface of the shard, and of irregular secondary pores indicate that this ceramics was obtained by plastic shaping. The ceramic shows a relatively high compaction degree, with the water absorption values ranging between 7.17 % and 14.44 %.

Based on the grain-size, two types of ceramics can be separated: semifine (lutitic-siltic-arenitic) and coarse (lutitic-arenitic-siltic) ceramics. The ratio between crystalline vs. amorphous phases defines the ceramic's fabric: microcrystalline-amorphous and amorphous-microcrystalline to amorphous. The typical features of the matrix and its low birefringence indicate that the main clay minerals are the kaolinite/montmorillonite interstratifications and subordinate illite.

The crystalloclasts are represented by quartz (from subangular to rounded, and with various degrees of fissuring), micas (often muscovite and rarely biotite), hematite aggregates and subordinately plagioclase feldspars, epidote and zircon. The lithoclasts consist of quartzites, micaschists and gneisses. Additionally, ceramoclasts were noticed in all the studied samples.

The corroborated macro- and microscopic results point to a firing temperature between 850°-900°C.

Concerning the source of the raw materials, we can only make assumptions based on our mineralogical-petrographical results and the information in the geological references [16, 17, 18, 19]. The sites where the potsherds were collected are located in the foredeep eastwards from the Eastern Carpathians border. Westwards, six tectonic napes build-up the Moldavides tectonic unit (from west to east): Teleajen, Macla, Audia, Tarcău, Vrancea and Peri-carpathian. They represent the East-Carpathian flysch unit represented by a succession of Cretaceous to Lower Miocene deposits. Among the sedimentary flysch formations it is worthy to mention the marls, clays, sands and various typed of quartzitic sandstones with lithic fragments (quartzites, micaschists, gneisses) (*e.g.*, Tarcău sandstone, Kliwa sandstone). Thus, the non-plastic raw materials that could have been used as ceramic flux are omnipresent in the alluvia of the rivers (usually having their sources in the west of the region) that flow into the Moldova River (eastwards).

The presence of the quartz, feldspar and micas crystalloclasts and of the lithoclasts (mainly represented by quartzites) supports the hypothesis of local raw materials for the studied ceramics.

The grey to black colour of most of the potsherds pointing to reducing conditions during firing, as well as the relatively low and very diverse compaction values within the same sherd plead additionally for a local ceramic industry.

## EXPERIMENTAL SECTION

The macroscopic investigation was performed by using a Nikon SMZ 645 binocular. The microscopic study was performed on thin sections (< 25 μm) in polarized light by using a Nikon Eclipse E200 microscope. The microphotographs were taken with a NIKON FDX-35 camera.

The XRD patterns were obtained with a Bruker D8 Advance (Bragg-Brentano geometry) diffractometer, with Co anticathode (Co-$K_a$, $\lambda_{Co}$ = 1.79026 Å), 35kV, 40 mA, in the 5°–65° 2Theta interval, $\Delta 2\theta = 0.02°$.

The physical characteristics (apparent density, water absorption, apparent porosity) were measured after water saturation, by boiling of the ceramic fragments. From every ceramic sample three fragments were collected for physical characterization.

## ACKNOWLEDGEMENTS

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## REFERENCES


[1]. W. Noll, "Alte Keramiken und ihre Pigmente. Studien zu Material und Technologie", E. Schweitzerbart'sche Verlagsbuchhandlung, Stuttgart, **1991**, 334 p.

[2]. M. Benea, M. Gorea, N. Har, *Rom. J. Materials*, **2007**, *37(3)*, 219-228.

[3]. M. Gorea, R. Creţ, F. Kristaly, *Studia Universitatis Babeş-Bolyai, Chemia*, **2011**, *LVI (4)*, 97-106.

[4]. M. Benea, M. Gorea, N. Har, *Studia Universitatis Babeş-Bolyai, Chemia*, **2013**, *LVIII (4)*, 147-159.

[5]. B.P. Niculică, V. Vasilache, D. Boghian, I. Sandu, An archaeometric study of several ceramic fragments from the Komariv (Komarow) settlement of Adâncata-Sub Pădure, Suceava County, in V. Cotiugă (ed.), Third Arheoinvest Congress. Interdisciplinary Research in Archaeology, June 6th–8th 2013, Iaşi, Romania, Programme and abstracts, Ed. Universităţii ,,Al. I. Cuza", Iaşi, **2013**, 68-69.

[6]. N. Bolohan, *Studia Antiqua et Archaeologica*, **2013a**, *XIX*, 199-239.

[7]. N. Bolohan, On Clay and Pots in the Middle Bronze Age. A Case Study from Siliștea-Pe Cetățuie, Neamț County. In: B. Rezi, R. Németh, S. Berecki (eds.), "Bronze Age crafts and craftsman in the Carpathian Basin". Proceedings of the International Colloquium from Târgu Mureş, 5-7 October 2012, Ed. Mega, Târgu Mureş, **2013b**, 33-56.

[8]. Gh. Dumitroaia, *Memoria Antiquitatis*, **1992a**, *XVIII*, 63-143.

[9]. Gh. Dumitroaia, *Carpica*, **1992b**, *XXIII*, 119-141.

[10]. V. Diaconu, *Cercetări istorice* (S.N.), **2011**, *XXVII-XXIX (*2008-2010), 45-66.

[11]. O. Weller, R. Brigand, M. Alexianu, *Memoria Antiquitatis*, **2007**, *XXIV*, 121-190.

[12]. A. C. Florescu, *Arheologia Moldovei*, **1964**, *II-III*, 143-216.

[13]. C. Ionescu, L. Ghergari, *Cercetări arheologice*, **2006**, *XIII*, 451-460.

[14]. C. Ionescu, L. Ghergari, O. Ţentea, *Cercetări arheologice*, **2006**, *XIII*, 413-436.

[15]. C. Ionescu, L. Ghergari, Caracteristici mineralogice şi petrografice ale ceramicii romane din Napoca. In: V. Rusu-Bolindeţ, "Ceramica romană de la Napoca. Contribuţii la studiul ceramicii din Dacia romană," Bibliotheca Musei Napocensis, XXV, Editura Mega, Cluj-Napoca, **2007**, 434-462.

[16]. D. Bădescu, "Tectono-stratigraphic evolution of the Eastern Carpathians during Mesozoic and Cenozoic", Ed. Economică, Bucureşti, **2005**, 312 p. (in Romanian)

[17]. V. Mutihac, M.I. Stratulat, R.M. Fechet, "Geologia României", Ed. Did. şi Ped., Bucureşti, **2007**, 249 p. (in Romanian)

[18]. M. Săndulescu, *Rom. J. of Tectonics and Regional Geology*, **1994**, *2*, 3–16.

[19]. *** Geological Map of Romania, 1:200.000, Piatra Neamţ Sheet, Geological Institute, Bucharest, **1968**.