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CONTRIBUTION TO THE STUDY OF SUCEAG POTTERY, CLUJ COUNTY, ROMANIA

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ABSTRACT. The site at Suceag, Cluj county, Romania, is composed of three different overlapping settlements, each having its own chronology: the first one is dated during the time of the Roman province of Dacia, the second one dated between the second half of the 4th century and the beginning of the 5th century AD and the last one broadly dated during the 7th-8th century AD. Because of this particular situation, our first attempt was to determine whether some direct connections between them truly existed. The petrographic analysis performed on a series of 56 samples coming from different types of pottery established after analysing all the ceramic material coming from the settlement at Suceag (cca. 4500 pottery fragments) showed that in this case we are only dealing with local products.

The colour of the analysed potsherds vary from grey to black indicating reducing atmosphere (25 samples), from reddish-brown to yellowish-brown (24 samples) suggesting an oxidizing atmosphere during firing and 7 samples have a “sandwich”-type structure probably an incomplete thermal treatment. The matrix is relatively uniform, with clasts of various sizes (up to 3-4 mm). Macroscopically, quartz grains, micas, and ceramoclast could be observed. According to the 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, and microcrystalline-amorphous fabrics were identified. As temper, crystalloclasts (quartz, micas, iron oxi-hydroxides, feldspars, amphibole, garnets, epidote, zircon), lithoclasts (quartzite, micaschist, gneiss, limestones), and ceramoclasts were identified. The observed bioclasts are represented by algae, and foraminifera remnants. The porosity consists of both primary, and secondary pores. The pore size vary from 0.5 x 1.5 mm to1.5 x 2.0 mm. Open porosity determined by water absorption capacity vary between 9.09 % - 23.10 %. The X-Ray diffraction analyses

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confirm the microscopic observations. According to the macroscopic aspects, microscopic features, and physical characteristics the firing temperature of the studied ceramic fragments is estimated to be between 800-900°C.

***Key words**: ancient pottery, mineralogical and physical analysis, Suceag archaeological site, Romania.*

INTRODUCTION

The settlement at Suceag (N46º47', E23º27'), on the Nadăş river valley at about 12 km from the actual city of Cluj-Napoca, was archaeologically researched during the years 1991-2000, in the topographical point known under the name of „Oradba". It was situated on top of a Roman rural habitation, very close to the main Roman road connecting in antiquity the Colonia Aurelia Napocensis to the most important military fort of the Northern frontier, Porolissum (Pl. 1).

The archaeological excavations started in 1989 as rescue excavations for the construction of the Plant Extract facility which partially destroyed the site. During this campaign several archaeological features were identified, but the most important ones refer to the discovery of two pottery kilns which lead to the assumption that the Early Migration Period settlement at Suceag was a pottery production centre. The importance of this site was that beside this new identified settlement, an older Roman *villa rustica* or maybe a *vicus* were formerly known. Scientists thought that maybe by analysing these two settlements, some conclusions regarding the withdrawal of the Roman Dacia and the period immediately after can be drawn [1-2].

The first systematic archaeological excavations started in 1991 and with this occasion several houses were identified alongside numerous storage or waste pits dated during the second half of the 4th century AD. A very interesting discovery was that of a workshop specialized in producing antler combs, a quite rare feature found in Central and Eastern Europe. This made archaeologists believe that we are facing a quite important production centre for the whole Northern Transylvanian region [3-4].

During the 1994 campaign, some new features were identified and documented and for the first time the approximate extent of the site was presumed covering an area of about 4 hectares. The novelty of these excavations consisted apart from the excavating another pottery kiln, the documentation of another settlement overlapping the Roman and the Early Migration Period one, dated during the 7th-8th centuries AD [4-6].

The site at Suceag is composed of three chronologically distinct settlements as follows: the first one is dated during the time of the Roman province of Dacia, the second one dated between the second half of the 4th century and the beginning of the 5th century AD and the last one broadly dated during the 7th-8th century AD. The main aim of the archaeological excavations was that of establishing the topography of each settlement only afterwards some conclusions related to the inhabitancy continuity being possible [7-8]. The analysis needed to focus upon certain aspects of the pottery production such as technological tradition and regional patterns of distribution as well as the habitation of the entire studied area in order to identify possible similar or different models that will clarify the problem of ethnical continuity versus habitation continuity.

As one of the main unknown of the archaeological landscape at Suceag was the extent of the habitation, a comprehensive ground and aerial-based set of physical sensing techniques has been proposed. Within this new approach a large area in the southern part of the settlement was explored in 2012 by the means of geophysical techniques [9] as well as large scale low altitude remote sensing data acquisitions for the entire micro region, which were undertaken in 2014. The site area is highly disturbed by modern human activities and therefore only a total surface of 1.6 hectares, was mapped using geophysical magnetic techniques, while ERT (Electrical Resistivity Tomography) measurements were performed in order to reveal the main stratigraphic sequences only in the areas where the nature of the archaeological features demanded such an approach. Regarding the possible interpretation of the geophysical survey, a series of anomalies can be identified after the processing of the data, having both archaeological significance or being either of recent origin or geologic nature. The results point to the fact that all the investigated area is composed of numerous archaeological features, having a certain tendency of disappears towards the northern part. The soil seems to be abundant in highly remnant magnetized materials, out of which some could be interpreted as pottery kilns (Pl. 2).

As a hypothesis, we can presume, based on the data gathered from the excavations in 2012 that the rectangular structures identified on the magnetic map belong to Roman time while the pottery kilns should be linked to the Early Migration Period settlement. Some fundamental differences observed for the inner structure of the two settlements were documented. The Roman settlement resembles what we all know to be a rural settlement in which at least two large stone structures were determined occupying a very large area inside the site itself while the barbarian settlement is characterized by the agglomeration of archaeological features such as sunken dwellings, pits and pottery kilns clustered in a limited area of the site illustrating the tribal manner of organizing the landscape (such inner structure being typical for the barbarian settlements known from all over Northern Europe). Moreover, these two settlements do not share the same spatial distribution and landscape arrangement, the Roman site occupying a larger territory. Maybe the best argument in resolving the so called "continuity question" refers to the stratigraphic data that clearly indicates that the two settlements are overlapping one another and thus having no direct chronological or ethnical link. We refer here to a situation observed in 2012 when we managed to identify and date a late 4th century feature overlapping the collapsing layer of one of the Roman stone structures dated with a coin from the 3rd century AD, a fact which implies that the stone structure was already collapsed and therefore not functioning during the 4th century AD.

One of the main problems that the site raised refers to the possibility of identifying certain ceramic imports that might allow us to establish some inter-regional connection patterns. In the same time, following the "chaîne operatoire" concept, our focus was directed upon the technological recurrences rather than on typological aspects while trying to follow and understand problems such as "technological tradition" [10] and in doing so, we tackled these aspects by focusing our attention upon the petrographic and chemical study of a batch of samples that are relevant from this point of view. Such questions have proven to be of great importance while establishing different classifications of the ceramic artefacts [11-12] taking into account not only the shape of the pottery [13] but also other aspects such as the modelling techniques, raw materials and their provenance, forming techniques, firing, decorative aspects, function etc. all of which will contribute to the better understanding of the process of pottery production and distribution [14-16].

The petrographic analysis performed on a series of 56 samples coming from different types of pottery established after analysing all the ceramic material coming from the settlement at Suceag (cca. 4500 pottery fragments) and ranging from the Roman time until the Early Medieval period showed that in this case we are only dealing with local products. This situation, together with the relatively limited number of pottery kilns (3 previously identified during archaeological investigations and other 3 based on the geophysical surveys) suggests that we are facing an autarchic pottery production model which was active only when a certain market demand existed. We are basically talking about closed communities capable of auto-subsistence, as opposed to the big pottery production centres oriented towards the surplus needed in order for the export to different market places that they supply to have place, as for example is the case of the pottery production centre at Medieșul Aurit [17]. As for the history of the economical pottery production we are unable to determine such well established distribution networks which can be only supported by some thorough mineralogical and petrographic analysis of the pottery collected from different contemporaneous settlements situated very close to one another. It is worth to mention several other archaeometry studies on ancient ceramics and the provenience of the raw materials in the nearby regions [18-23].

RESULTS AND DISCUSSION

Macroscopically aspects

The colour of the analysed potsherds vary from grey to black indicating reducing atmosphere (25 samples), from reddish-brown to yellowish-brown (24 samples) suggesting an oxidizing atmosphere during firing and 7 samples have a “sandwich”-type structure due to an incomplete firing or high content of water in raw ceramics. The matrix is relatively uniform, with clasts of various sizes (up to 3 mm) and shapes. Macroscopically, quartz grains, micas, and ceramoclast could be observed.

Porosity is marked by both primary pores, generally elongated from shaping method and irregular to rounded secondary pores resulted by later decomposition of some compounds from raw mixtures or bioclasts combustion. The pore size varies from 0.5 x 1.5 mm to1.5 x 2.0 mm.

Polarized light microscopy

Transmitted light optical microscopy was used for additional information on the mineral components of the matrix and the non-plastic materials, on the thermal treatments, and on the fabric of the potsherds.

According to the microscopic grain size, two types of ceramics can be separated (Table 1 and Plate 3, 4): semifine (lutitic-siltic-arenitic), and coarse (lutitic-arenitic-siltic) [24]. Sample 50 to 56, without inventory number, were described as semifine ceramics.

Table 1. Catalogue of the studied samples based on the microscopic grain size

	Types of ceramic (microscopic grain size)					
	Coarse (lutitic-arenitic-siltic)		Semifine (lutitic-siltic-arenitic)			
	Sample No.	Inv.No.	Sample No.	Inv.No.	Sample No.	Inv.No.
Items	2	3728	1	3745	30	2357
	4	-	3	3749	32	2336
	5	-	6	3708	33	2338
	7	3743	9	3709	35	2882
	8	3727	10	3699	37	2699
	14	3732	11	3665	39	3127
	16	-	12	3735	40	3128
	20	-	13	3733	41	3144
	21	3906	15	3934	42	3147
	25	3992	17	3945	43	3058
	26	3997	18	2716	45	2821
	28	2360	19	3113	46	2838
	31	2353	22	3957	47	2875
	34	2302	23	3966	48	2823
	36	2908	24	3968	49	3027
	38	3154	27	2376		
	44	3069	29	2366		

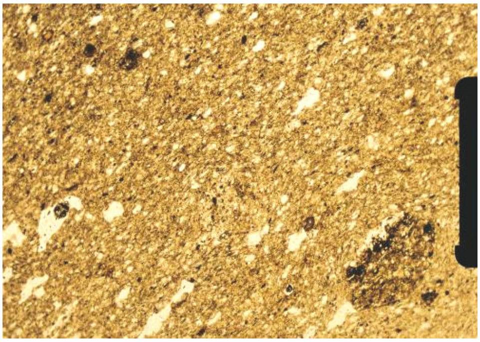
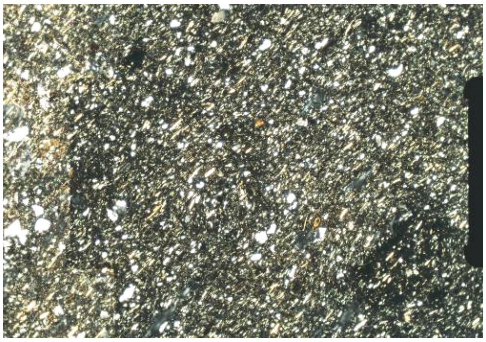

Fig.1 (left) and **Fig.2** (right). Sample 23 – Semifine ceramics with microcrystalline matrix, elongated pores parallel to the micas lamellae, angular quartz crystalloclasts, plagioclase feldspars, quartzite lithoclasts, and ceramoclasts, 1N (left), N+ (right), scale bar = 0.5 mm

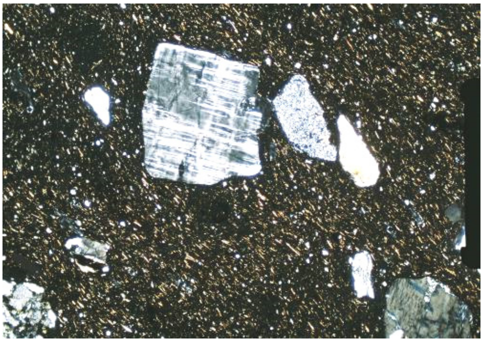

Fig.3. Sample 1 – Semifine ceramics with microcrystalline to microcrystalline - amorphous matrix; angular quartz, feldspars (microcline-perthite), oriented thin mica lamellae, and quartzite lithoclasts; N+, scale bar = 0.5 mm

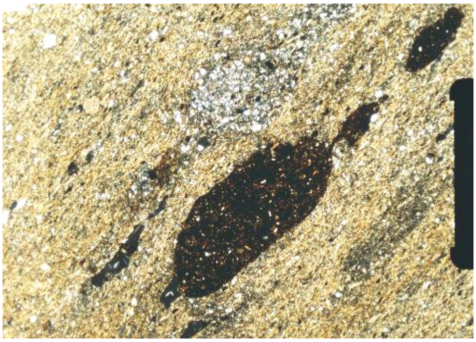

Fig.4. Sample 27 – Semifine ceramics with microcrystalline, with elongated pores and fissures paralel with the thin mica lamellae, angular quartz, quartzite fragments and ceramoclasts; 1N, scale bar = 0.5 mm

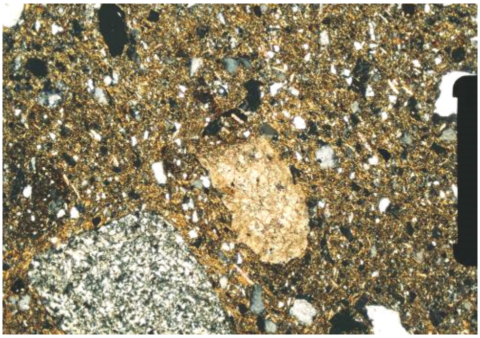

Fig.5. Sample 29 – Semifine to coarse ceramics with microcrystalline matrix; limestone fragments, quartz, plagioclase feldspars, mica lamellae with yellowish birefringence, iron oxi-hydroxide clusters, quartzite, and opaque minerals; N+, scale bar = 0.5 mm

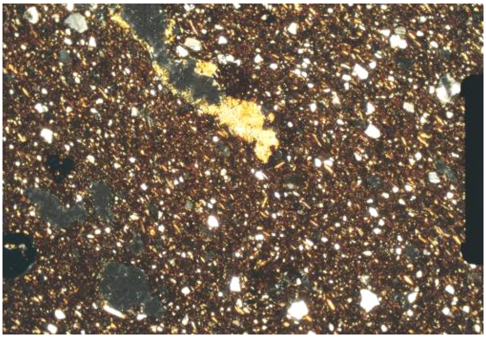

Fig.6. Sample 41 – Semifine to coarse ceramics; microcrystalline reddish matrix with quartz clasts, mica lamellae, plagioclase feldspars, ceramoclasts, and secondary carbonates inside the pores; N+, scale bar = 0.5 mm

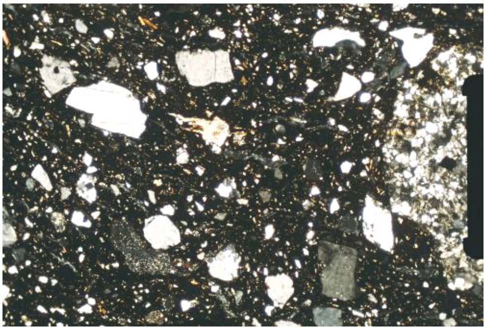

Fig.7. Sample 38 – Coarse ceramics with microcrystalline – amorphous matrix; quartz crystalloclasts, twinned plagioclase feldspars, ceramoclasts, and gneiss, quartzite and limestone lithoclasts; N+, scale bar = 0.5 mm

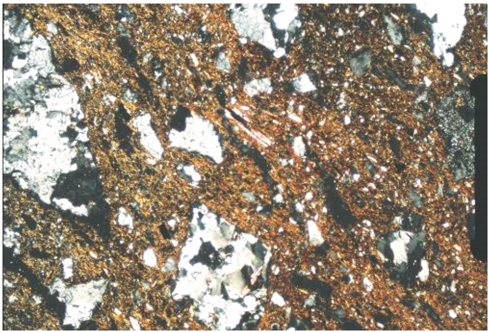

Fig.8. Sample 44 – Coarse ceramics with microcrystalline to microcrystalline - amorphous matrix; quartz, micas, plagioclase feldspars crystalloclasts, and quartzite and gneiss lithoclasts; N+, scale bar = 0.5 mm

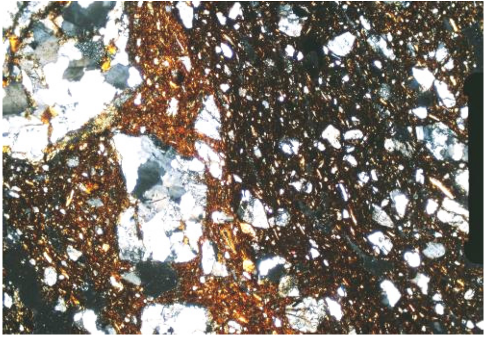

Fig.9. Sample 16 – Contact between inner and outer part of the ceramic body; quartz, micas and feldspars crystalloclasts, iron oxi-hydroxide clusters, quartzite and micaschists lithoclasts; N+, scale bar = 0.5 mm

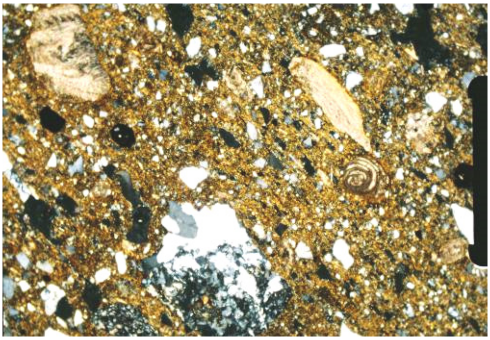

Fig.10. Sample 14 – Semifine ceramics with microcrystalline matrix; ceramoclasts, bioclasts (foraminifera and algae remnants), quartz and micas crystalloclasts, quartzite lithoclasts; N+, scale bar = 0.5 mm

Fig.11. Sample 36 – Semifine to coarse ceramics with microcrystalline - amorphous matrix; quartz, micas, plagioclase felspars, ceramoclasts, bioclasts (foraminifera), and quartzite lithoclasts; N+, scale bar = 0.5 mm

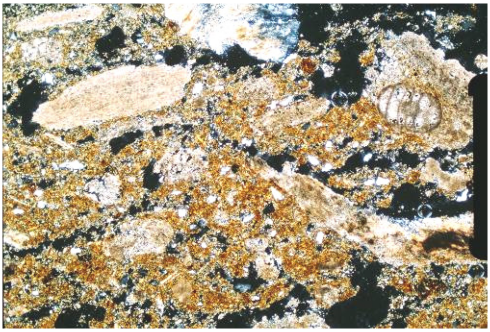

Fig.12. Sample 5 – Semifine to coarse ceramics with microcrystalline matrix; bioclasts (foraminifera, algae), iron oxi-hydroxide clusters, and limestone lithoclasts; N+, scale bar = 0.5 mm

Different types of fabric were described in the ceramic matrix based on the ratio between crystalline *vs.* amorphous phases: microcrystalline, and microcrystalline-amorphous (Fig. 1, 2, 4, 5, 6, 10, 12, respectively 3, 7. 8, 11). As non-plastic materials (temper), crystalloclasts as quartz, micas, feldspars (Fig. 1 to 12) are present in all the samples, while iron oxi-hydroxides (Fig. 5, 9, 12), amphibole, garnets, epidote, zircon were observed in subordinate amounts. Lithoclasts are mainly represented by quartzite (Fig. 1 to 12), and in some samples micaschist (Fig. 9), gneiss (Fig. 7, 8), and limestones (Fig. 5, 6, 7, 12) are to be mentioned. Ceramoclasts (Fig. 1, 2, 4, 6, 7, 10, 11) are present in all the studied potsherds, with participation up to 2 - 3% and sizes between 0.70 x 2.00 mm. The observed bioclasts are represented by algae, and foraminifera remnants (Fig. 10, 11, 12).

X-Ray diffraction

The X-Ray diffraction (XRD) patterns of some selected samples confirm the microscopic observations revealing a relatively simple mineralogical composition (Figs. 13 and 14). All the samples contain quartz, K-feldspars (orthoclase and microcline), Ca-Na feldspars (albite – anorthite) and micas (muscovite/illite) as main minerals. Clay minerals have been thermally affected and they are evidenced only by the lines at 4.5 Ǻ and 2.6 Ǻ. As an exception, in sample 7 and 21, the mica lines are missing. The “accesory” minerals are represented by carbonates (calcite), and iron oxi-hydroxides (hematite – samples 2, 8, 19).

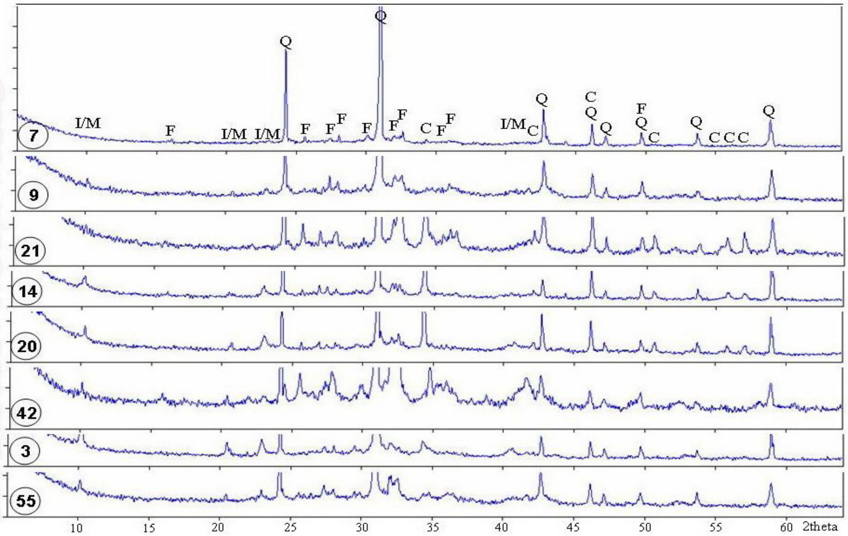

Fig. 13. XRD patterns of the studied ceramic fragments; sample no. is indicated in the lower left corner; Q – quartz, F – feldspars (Ca-Na + K), I/M – illite/muscovite, C – calcite.

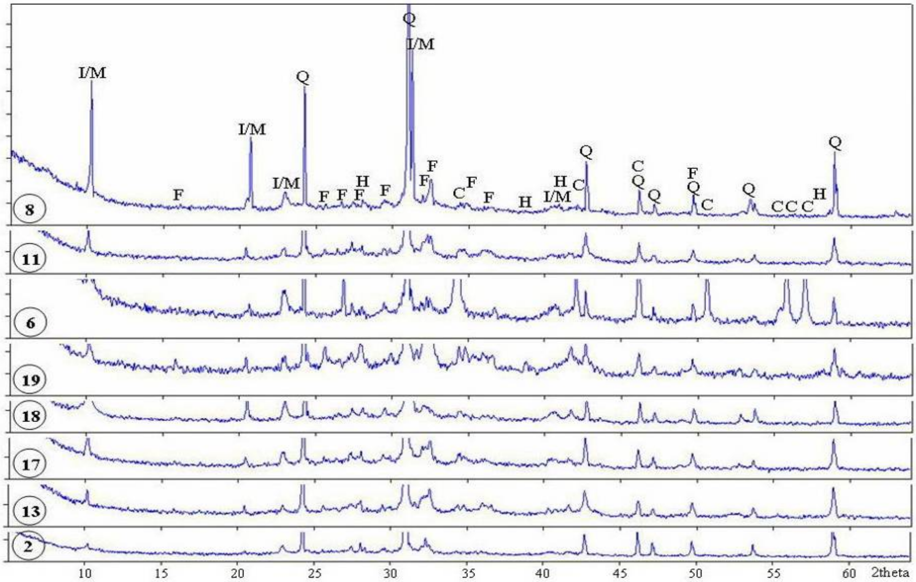

Fig. 14. XRD patterns of the studied ceramic fragments; sample no. is indicated in the lower left corner; Q – quartz, F – feldspars (Ca-Na + K), I/M – illite/muscovite, C – calcite, H – hematite.

Physical characteristics

From every ceramic sample, three fragments were collected for determining of physical characteristics. The fragments were dried in an oven and weighted. Then, they were boiled in water for 2 hours and weighted afterwards again (Archimedes' principle).

The compaction characteristics, *i.e.* water absorption, apparent density and porosity are presented in Table 2. The data for water absorption are showing a broad range of values (9.09 % - 23.10 %) having direct impact upon the functionality of the pottery vessels.

The differences could be explained in correlation with several features: (1) inhomogeneity of the raw materials mixture (clay materials / temper), (2) the thickness of the ceramic body (only 3-4 mm in the case of sample 42), (3) the type (primary, secondary), size, and the abundance of pores and fissures, (4) variable firing temperatures in different parts of the kiln or uncontrolled flames, (5) the „sandwich"-type structure of the shred as a result of a less suitable thermal treatment and the change of the firing condition (oxidizing/reducing atmosphere) or high water content in raw mixture [25-28].

Table 2. Compaction characteristics of some selected ceramic samples

Sample	Apparent density (g/cm^3)	Water absorption (%)	Apparent porosity (%)
13	1.78	16.17	28.89
18	1.82	15.44	28.16
2	1.92	13.79	26.56
7	1.93	14.14	27.28
20	1.98	9.78	19.39
14	1.91	13.67	26.15
55	1.83	15.44	28.24
9	1.83	15.37	28.25
6	1.89	13.31	25.19
17	1.82	15.21	27.73
19	1.70	19.86	33.76
21	1.22	10.48	19.21
42	1.64	23.10	37.94
3	1.86	14.07	26.22
8	1.98	9.09	18.04
11	1.86	14.05	26.13

The apparent porosity for most of studied ceramic samples is in a narrow range (26 – 29 %) fact that demonstrates the similar conditions of firing. Except the sample 42 – 2nd-3rd century AD (Roman period) being fired in an oxidizing firing atmosphere (red colour of the ceramic) that has a high apparent porosity. Sample 8 – 7th-8th century AD (Early Middle Age) fired in reducing firing atmosphere is a dense ceramic due to the presence of Fe^{2+} compounds witch has a lower melt temperature comparing with Fe^{3+} compounds.

CONCLUSIONS

A number of 56 samples from different types of pottery, and from different periods (from Roman time until the Early Medieval period) were analysed using petrographic and physical analysis.

The colour of the analysed potsherds suggest both reducing, respectively oxidizing atmosphere. Macroscopically, quartz grains, micas, and ceramoclast could be observed. The pore sizes vary from 0.5 x 1.5 mm to1.5 x 2.0 mm. According to the microscopic grain size, two types of ceramics can be separated: semifine, and coarse. Different types of fabric were described in the ceramic matrix based on the ratio between crystalline *vs.* amorphous phases: microcrystalline, and microcrystalline-amorphous.

As non-plastic materials (temper), crystalloclasts (quartz, micas, feldspars, iron oxi-hydroxides, amphibole, garnets, epidote, zircon), lithoclasts (quartzite, micaschist, gneiss, limestones), and ceramoclasts were identified. The high birefringence of the micas and of the whole matrix beside its characteristics indicates low firing conditions. The presence of the carbonates confirms these firing conditions. The bioclasts are represented by algae, and foraminifera remnants, typical for the geological Eocene deposits in the Mera– Suceag – Baciu area.

The presence of the elongated pores and the preferred orientation of mica lamellae suggest both a plastic shaping and potter's wheel.

The X-Ray diffraction patterns of some selected samples confirm the microscopic observations revealing a relatively simple mineralogical composition.

Samples compaction (water absorption capacity) varies between 9.09 % - 23.10 %.

Based on the microscopic features, mineralogical composition, and the compaction characteristics, the firing temperature of the studied potsherds could be estimate to be between 800°-900°C. The archaeological information (three documented kilns and other three presumed) and the performed analyses suggest that the Suceag pottery is a local product. Based on the analysed ceramic fragments, at this time, no connection between the three overlapping settlements could be determined.

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, λ_{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.

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Plate 1. General plan of the site at Suceag

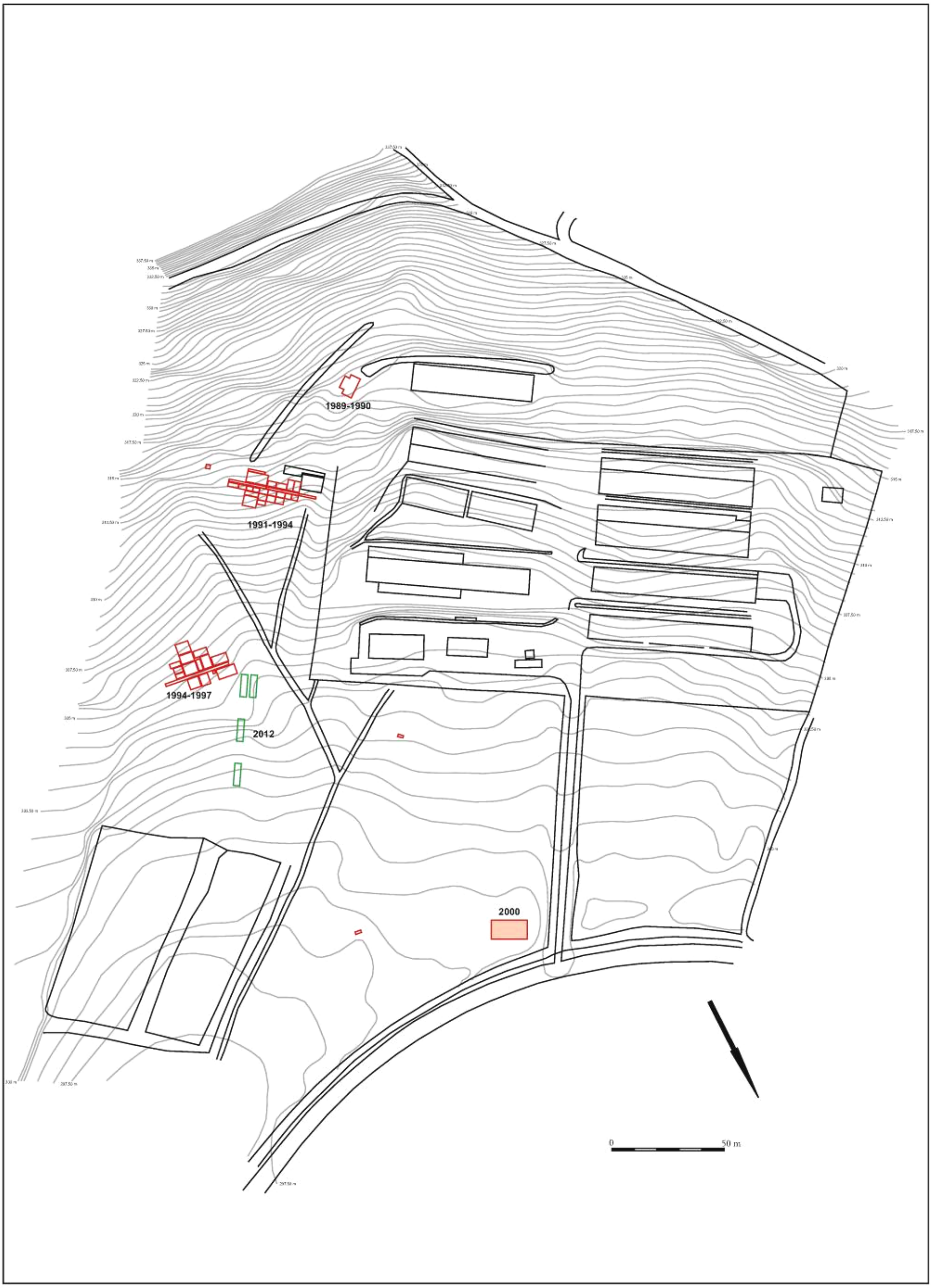

Plate 2. Electrical resistivity tomography; a. – 3D Inversion of the P1 ÷ P5 profiles at 0.40 m depth; b. – location of the 3D ERT slice on the magnetic map illustrating a pottery kiln.

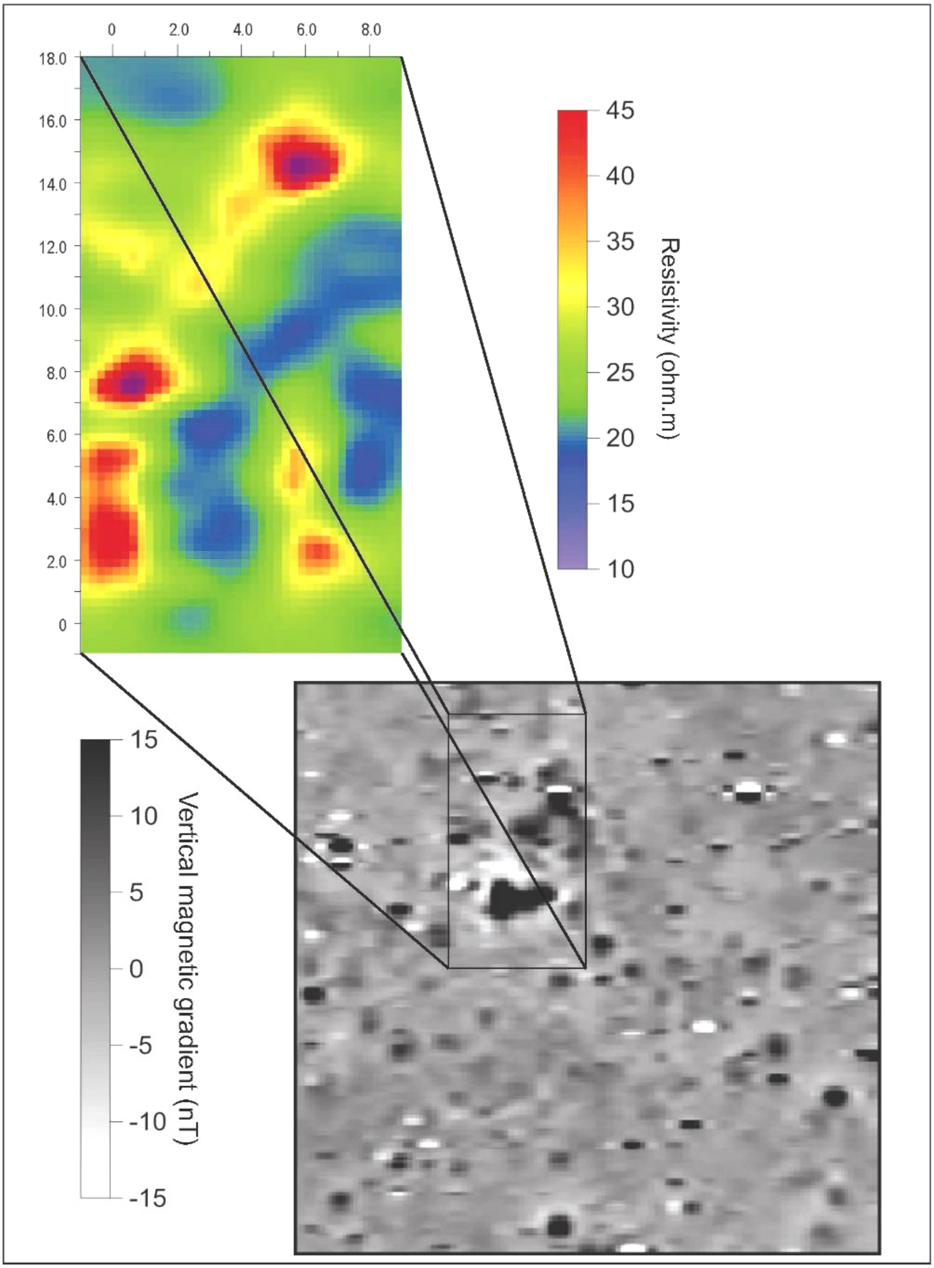

Plate 3. Pottery fragments from which the samples were taken (see Table 1).

Plate 4. Pottery fragments from which the samples were taken (see Table 1).