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The technology of LBK ceramics in eastern Romania

The paper shows selected aspects of the technology of ceramic production within the Linear Pottery culture (LBK) in eastern Romania. The authors present the results of mineralogical and petrographic analyses which have covered 23 ceramic samples from that area. Together with the analysis of 6 samples from the neighbouring Republic of Moldova, the research has provided the basis for more general conclusions concerning prehistory. The results of the analysis of ceramics technology clearly indicate the NW genesis of LBK in the territory of Romanian Moldova. They also support the thesis that local settlement agglomerations should be dated not only to the music-note phase of this culture but also to the period contemporary with the Želiezovce phase, despite the lack of ceramics in this style on this area.

KEY WORDS: LBK, technology of ceramics, mineralogical and petrographic analysis, eastern Romania, Neolithic

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The paper shows selected aspects of the technology of ceramic production within the Linear Pottery culture (LBK) in eastern Romania. The authors center on the mineralogical and petrographic composition of the paste used in the production of ceramics. The analyses, which have covered 23 ceramic samples taken from five LBK sites in the Prut and the Siret basins and from one site in Transylvania (Fig. 1), have given the first results of the technological analysis of LBK ceramics in Romania. The mineralogical and petrographic composition and the archaeological context of each of the analyzed samples have already been published in a tabular form (S. Kadrow, A. Rauba-Bukowska 2017a, Table 1 and 2); this paper presents the results in detail, complementing them with conclusions concerning prehistory. The authors also refer to the recently published analysis of a short series of five LBK samples from the neighboring Republic of Moldova (S. Kadrow, A. Rauba-Bukowska, S. Țerna 2017). The results of the analysis of ceramics technology contribute to explaining the problems of the origin and chronology of LBK in the area of Romanian Moldova. The paper has been written with the financial support of the Polish National Science Centre (NCN) grant No 2013/09/B/HS3/03334.

THE LBK IN ROMANIA: AN OVERVIEW

Although the remains of the LBK have been recovered in present-day Romania, at Poiana in Romanian Moldova (C. Matasă 1940, p. 33; I. Nestor 1951, p. 18)[1] and at Turdaş in Transylvania (M. Roska 1936, pp. 72, 73; N. Vlassa 1959, pp. 239, 240, Fig. 1), since the interwar period, the culture is not well known at present because of the inconsistent archaeological investigation, with interdisciplinary research being almost absent, and because of poor analysis of the results.

The LBK materials have often been discovered during excavations of multi-layered sites where the artefacts belonged to the Precucuteni-Cucuteni-Tripolye cultural complex, e.g. at Olteni, Mihoveni, Târpeşti, Traian and Isaiia (Fig. 1).

Romanian archaeologists were moderately interested in the research of LBK in their country. Except the few publications (N. Ursulescu 1991, S. Marinescu-Bîlcu 1993), it is difficult to list more serious syntheses about LBK pottery. The only example of such a work is a synthetic study of the relative chronology of that culture in eastern Romania, based on the analysis of ceramics, which was published in 2014 (J. Braungart 2014, pp. 9–42).

[1] Ion Nestor wrongly connects those LBK finds with the village of Ilişeni in the former Piatra-Neamț district. In fact, Constantin Matasă made the discovery at Dealul Ilişeştilor (the Ilişeşti hill) in Poiana Negreştilor (presently the village of Poiana, Negreşti commune, Neamț județ (ro.) – county (en.), never district) as a result of his surface survey.

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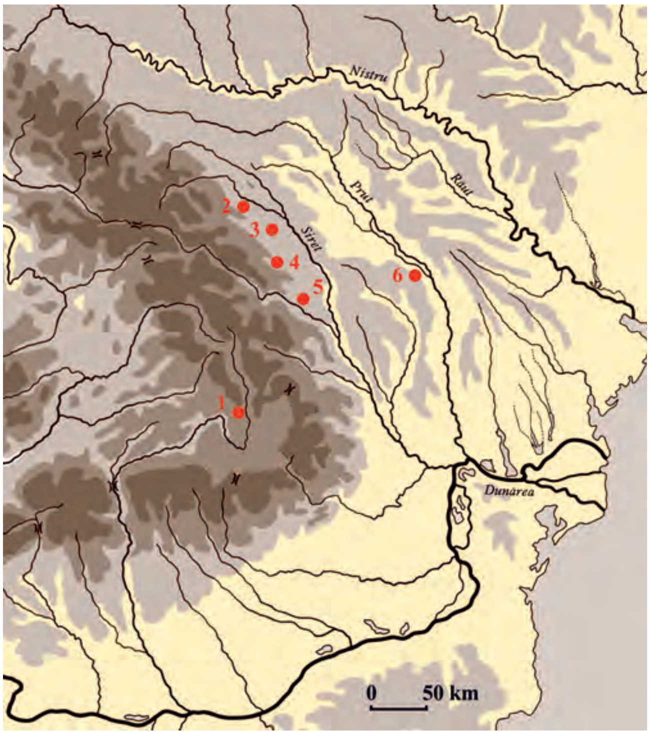

Fig. 1. A map of the LBK sites in Romania which have provided the samples subjected to the physico-chemical analysis: 1 – Olteni; 2 – Mihoveni; 3 – Preutești; 4 – Târpești; 5 – Traian; 6 – Isaiia

Ryc. 1. Mapa stanowisk KCWR w Rumunii, z których dostarczono próbki poddane analizom fizyko-chemicznym: 1 – Olteni; 2 – Mihoveni; 3 – Preutești; 4 – Târpești; 5 – Traian; 6 – Isaiia

DESCRIPTION OF THE LBK SITES PROVIDING THE CERAMIC SAMPLES FOR THE TECHNOLOGICAL ANALYSIS

We quote fairly detailed descriptions of the circumstances of the LBK sites' findings, from which samples of ceramics were taken for technological analysis to show how modest is still the state of studies on LBK in Romania and how much progress is being made in the research presented in this article.

Olteni – "Sand Quarry" / "Tag" / "Site B" (Bodoc commune, Covasna county) – Fig. 1:1; 2

This multi-layered site (published till now as Site B in Olteni) is located in the Sfântu Gheorghe depression on the right-bank terrace over the Olt river, at the absolute altitude of 569 m, near saltwater springs. It now covers approx. 1.5 ha, with its anthropic deposits (currently 0.2–0.8 m thick) being partially destroyed by a sand quarry, by a national road in the area and by farming (V. Cavruc, D. Buzea 2002, p. 220; V. Kavruk, D. Buzea 2006, pp. 242, 244; D. Buzea, A. Deák 2008, p. 58).

The site was discovered by Dan Lucian Buzea in 2001. Later on, Buzea carried out a survey there together with Valeriu Cavruc and, since 2005, has coordinated rescue excavation related to the industrial exploitation of the sand quarry (V. Kavruk, D. Buzea 2006, p. 242).

The excavation has led to the discovery of Neolithic (LBK) and Eneolithic settlements (the Precucuteni-Cucuteni-Tripolye cultural complex),[2] as well as a flat incineration cemetery from the Dacian period (La Tène; the 4th–3rd centuries BC) (D. Buzea, A. Deák 2008, p. 58; V. Kavruk, D. Buzea 2008, p. 210).

The archaeological investigation carried out there, involving several dwellings and pits with ceramic fragments as their predominant inventory, has uncovered one of the crucial LBK („music notes") settlements in Romania (D. Buzea, V. Kavruk, A. Mateş, R. Zăgreanu 2010, p. 286).

Mihoveni – "Cahla Morii" (Şcheia commune, Suceava county) – Fig. 1:2; 3

This multi-layered site is located on the Fălticeni plateau on the right-bank terrace over the Suceava river. Its surviving area is approx. 1.5 ha; its anthropic deposits have been affected by roads crossing the site, by exploited clay deposits and by farming (P.V. Batariuc, M. Gogu, B. Amarandei 2002, p. 205).

The site was discovered by Mircea Ignat in 1971. Several surface surveys were carried out there later, and in 1973, 1975, 1981, 1990 and 2001 systematic excavations were organised under the supervision of Nicolae Ursulescu and Paraschiva-Victoria Batariuc (P.V. Batariuc, M. Gogu, B. Amarandei 2002, p. 205).

The exploration has resulted in the discovery of features and artefacts dating from the Upper Palaeolithic (Gravetian), Neolithic (Starčevo-Criş and LBK), Eneolithic (Precucuteni-Cucuteni-Tripolye cultural complex), the Bronze Age (Horodiştea-Erbiceni-Folteşti, Costişa-Komarov and Noua cultures), the first (Hallstatt – Gáva-Holihrady culture) and the second Iron Age (La Tène; the 3rd–2nd centuries BC, the 2nd–4th centuries AD), the Middle Ages and the early modern period (the 13th–17th centuries) (N. Ursulescu, M. Ignat 1977, p. 319; N. Ursulescu, P.V. Batariuc 1978, p. 89; M. Andronic, P.V. Batariuc 1993, pp. 12, 13; P.V. Batariuc, M. Gogu, B. Amarandei 2002, p. 205).

In 1975, two LBK dwellings were explored in two sections (S. 2 and S. 4), one being on the surface (a house), and the other being earthen feature (N. Ursulescu, P.V. Batariuc 1979, p. 271).

The remains of the surface dwelling (L. 1) covered 8–9 m^2 and were approx. 0.15 m thick. Inside, a small hearth was found (0.25 m^2). The inventory of the dwelling consisted of a few ceramic fragments made of coarse, semi-fine or fine paste and decorated with protrusions, alveoli, incised lines or „music notes", and of carved (scraper, blade) or polished (hoe, adze, axes) stone tools (N. Ursulescu, P.V. Batariuc 1979, pp. 273–281, Table 1, Fig. 2; 4; 5/1–4; 6; 8/1; 9).

The earthen feature (L. 2) covered approx. 9.6 m^2, its entrance being on the southern side. On the northern side, the floor and the bottom of the wall bore distinct traces of burning, which had not been caused by a hearth. The construction was sunk into the ground to the depth of up to 0.70 m, with the layout of the walls marked by the traces of pole-pits. The inventory of the dwelling consisted of a few ceramic fragments made of coarse, semi-fine or fine paste and decorated with protrusions,

[2] Although the authors of those discoveries sometimes refer to the putative remains of a settlement of the Boian culture (Giuleşti phase) (D. Buzea 2002, p. 194; D. Buzea, V. Cavruc 2006, p. 67; D. Buzea, A. Deák 2008, pp. 58, 72, 73), we think that those finds may have been early elements of the Precucuteni culture (phase I), as suggested by the cultural synthesis of elements of the Boian-Giuleşti with those of the LBK („music notes").

alveoli, incised lines or „music notes", and carved (core, scraper, blade) or polished (chisels) stone tools (N. Ursulescu, P.V. Batariuc 1979, pp. 274–282, Table 1, Fig. 3; 5:5–7; 7; 8:2–6; 10).

Târpești – "Râpa lui Bodai" (Petricani commune, Neamț county) – Fig. 1: 4; 4

This multi-layered site is located in the Neamț depression (Ozana – Topolița) on a left-bank terrace over the Topolița stream, at the absolute altitude of 325 m, covering approx. 1 ha. It has been affected by farming and by water catchments (S. Marinescu-Bîlcu 1981, pp. 3, 5).

The site was discovered in 1937 by the ethnographer Neculai Popa; it was surveyed by Constantin Matasă and Radu Vulpe in 1938 and by Nicolae Constantinescu in 1958. Systematic multidisciplinary archaeological exploration (S. Marinescu-Bîlcu, M. Cârciumaru, A. Muraru 1981, pp. 7–31; 1985, pp. 643–684) was carried out under the supervision of Vladimir Dumitrescu and Silvia Marinescu-Bîlcu in 1959–1965 and 1968 (S. Marinescu-Bîlcu 1981, pp. 4, 5; S. Marinescu-Bîlcu, M. Cârciumaru, A. Muraru 1985, pp. 644, 667, n. 13). The site is now fully researched with the results published in a monograph (S. Marinescu-Bîlcu 1981).

The exploration have uncovered remains dating to the Neolithic (LBK), the Eneolithic (Precucuteni-Cucuteni-Tripolye cultural complex), the Bronze Age (Horodiștea-Erbiceni-Foltești and Noua cultures), the first (Hallstatt – Poienești-Lukashevka culture) and the second Iron Age (La Tène – the Carpian culture), and the Migration Period (the 6th–7th centuries) (S. Marinescu-Bîlcu 1981, pp. 5, 6).

The LBK dwelling level contained one house, two small concentrations of daub or pottery fragments and nine circular or oval pits with the diameter of 1–3 m and the depth of 1.80–3 m (S. Marinescu-Bîlcu 1981, p. 8).

The house was oval in shape, 5 and 3 m in diameter, 0.90–1 m deep, with the remains of a hearth in its centre (S. Marinescu-Bîlcu 1981, p. 8, Fig. 15).

Among the discovered artefacts, ceramic fragments predominated, made of fine, semi-fine or coarse paste with oxidizing or reducing firing and ornamented with protrusions, alveoli, variously arranged incised lines or „music notes" (S. Marinescu-Bîlcu 1981, pp. 9–11, Fig. 18: 3–5; 19–26; 27: 3, 6–13; 28–31). There were also carved (cores, scrapers, blades, chips) or polished (chisels, adzes, axes) stone tools (S. Marinescu-Bîlcu 1981, p. 8, Fig. 16, 17). Next to them lay a bone awl, an anthropomorphic handle of a bowl, and a fragmentary feminine anthropomorphic statuette (S. Marinescu-Bîlcu 1981, p. 11, Fig. 18: 1, 2; 27: 1, 2, 4).

Traian – "Dealul Fântânilor" (Zănești commune, Neamț county) – Fig. 1: 5; 5

This multi-layered site is located in the Cracău – Bistrița depression, on the left-bank terrace over the Bistrița river, at the absolute altitude of 277 m. At the foot of the hill, there are several springs called Izvoarele Doamnei (V. Dumitrescu 1945, pp. 11, 12). The site, covering ca. 2.5 ha (according to the new geomagnetic prospections), has been disturbed by exploited clay deposits, a local road, a water catchment basin and by farming.

The site was uncovered by Constantin Matasă in 1930 (C. Matasă 1940, p. 6). The first series of systematic archaeological excavations took place in 1936, 1938 and 1940, followed by the second series between 1951 and 1960, under the supervision of Hortensia Dumitrescu and Vladimir Dumitrescu (C. Bem 2007, pp. 17–22).

The exploration has uncovered dwelling levels dating back to the Neolithic (Starčevo-Criş and LBK), the Eneolithic (Precucuteni-Cucuteni-Tripolye cultural complex), the Bronze Age (Horodiştea-Erbiceni-Folteşti culture) and the first Iron Age (Hallstatt), as well as a 16th-century cemetery (C. Bem 2007, pp. 22–24).

The LBK dwelling level was approx. 0.40 m thick. It contained four concentrations of different artefacts (A–D), as well as ceramic fragments (made of coarse or fine paste subjected to oxidizing or reducing firing, decorated with protrusions, alveoli, barbotine, incised lines or „music notes"), pieces of carved (blades) or polished (axes, grinders) stone tools, bone or horn artefacts and animal remains (H. Dumitrescu 1955, pp. 462–467, Fig. 6–10; H. Dumitrescu 1959, pp. 195–197).

Isaiia – "Balta Popii" (Răducăneni commune, Iaşi county) – Fig. 1: 6; 6

This multi-layered site is located on the right-bank terrace over the Jijia river in the Central Moldavian Plateau, with its anthropic deposits disturbed by farming.

The site was discovered by Vicu Merlan (N. Ursulescu, V. Merlan, A.F. Tencariu 2001, p. 110). Systematic archaeological excavation supervised by Nicolae Ursulescu has been carried out there since 1996, with some interruptions.

The exploration has uncovered dwelling levels from the Neolithic (LBK), the Eneolithic (Precucuteni-Cucuteni-Tripolye cultural complex), the Bronze Age (Noua Culture), the first Iron Age (Hallstatt – Corlăteni-Chişinău culture), the Migration Period (the 4th century), the Middle Ages (the 11th–12th centuries) and the modern period (the 19th century), as well as a cemetery from the Bronze Age and the second Iron Age (La Tène) (N. Ursulescu, V. Merlan, A.F. Tencariu 2001, p. 110; N. Ursulescu, V. Merlan, A.F. Tencariu 2002, pp. 160, 161; N. Ursulescu, A.F. Tencariu, V. Merlan, R. Kogălniceanu, L. Chirilă, M. Văleanu, L. Tencariu, A. Ichim, M. Cozma, D. Ionică, L. Solcan, I. Robu 2004, pp. 150, 15; N. Ursulescu, A.F. Tencariu, L. Scarlat, G. Bodi, C. Lazanu, L. Solcan, I. Robu, M. Cozma, Al. Bounegru, M. Vornicu, A. Vornicu 2006, p. 189; N. Ursulescu, F.-A. Tencariu, D.-M. Vornicu, I. Ignat, S. Enea, A. Asăndulesei, B. Venedict, C. Nicu, R. Balaur, R.-G. Furnică, V. Rumega, I. Lionte 2010, p. 80; N. Bolohan, F.-A. Tencariu, D.-M. Vornicu, N. Ursulescu, L. Solcan, A. Vornicu, A. Asăndulesei, R. Furnică, A. Mihu-Pintilie, C. Nicu, S. Drob, M. Danu, D. Amarandei, C. Brașoveanu, A. Doroftei, Al.-E. Dolineanu, I. Ene, T. Crețu, D. Croitoru, M. Huzun, N. Pashenchuk, A. Bogaciuc, Gh. Toma 2016, pp. 39, 40).

The uncovered LBK features include a surface dwelling (L. 4) and a pit-house (L. 10) (N. Ursulescu, V. Merlan, A.F. Tencariu 2002, pp. 161, 162; N. Ursulescu, A.F. Tencariu, V. Merlan, R. Kogălniceanu, L. Chirilă, G. Bodi, L. Solcan, I. Robu, L. Tencariu, M. Gheorghiță, M. Cozma 2005, p. 189).

The remains of the surface dwelling (a house), approx. 3.5×2.7 m, are disturbed by a Precucuteni pit (G. 11) in their central part. The inventory consists of many pottery fragments (coarse or fine ceramics with imprinted, embossed or incised motifs, lines or „music notes"), carved (flint tools) or polished (axes, grinders, scrapers) stone tools and numerous shells (N. Ursulescu, V. Merlan, A.F. Tencariu 2002, pp. 161, 162, 418, 419, pl. 66: 1, 67: 3).

Preutești – "Ciritei" (Preutești commune, Suceava county) – Fig. 1: 3.

This LBK site has been unknown and unpublished yet. It has been discovered by Dr Sorin Ignătescu from the Suceava University during his surface survey. The inventory of the site consists of several pottery fragments.

TECHNOLOGICAL ANALYSIS OF POTTERY

Materials and methods

The analysis has covered 23 samples: 14 thin-walled vessels and 9 thick-walled vessels, produced by the Linear Band Pottery culture (LBK). The samples came from the archaeological sites in Isaiia, Olteni, Mihoveni, Preutești, Traian and Târpești (Fig. 1; Table 1). These studies are part of a larger project in which 148 ceramic samples were tested and the results in this paper include samples 70–92. A thin section was taken from each vessel to be examined under a polarizing microscope in transmitted light. The quantitative petrographic method (point counting) was used to determine the percentage of individual components: clay minerals, quartz, alkali feldspars, plagioclases, muscovite, biotite, carbonates, grains of sedimentary, igneous or metamorphic rocks, grog fragments and organic materials. The study involved schematic petrographic description of individual thin sections, which were examined under the polarized light microscope Nikon Eclipse LV100N POL, the diameters of crystal grains and clay clasts being subjected to granulometric analysis. After preparing the thin sections for microscopic examination, the cross-sections of 500–1000 grains were measured by automatic image analysis with the MATLAB R2007b software. Calculations were done within the following ranges: 0.002–0.02 mm, 0.02–0.05 mm, 0.05–0.1 mm, 0.1–0.2 mm, 0.2–0.5 mm, 0.5–1 mm, 1–2 mm and $\varnothing > 2$ mm. The classification proposed by the Polish Society of Soil Science (Polskie Towarzystwo Gleboznawcze 2009) served as the point of reference. The approximate temperature of firing was estimated by observing thermally induced changes in the clay matrix (P.S. Quinn 2013, pp. 190–203).

Results

Mineral-petrographic composition and petrographic groups

The main constituents of the raw materials are clay minerals (39.2–81.1%) and grains of silty fraction (2.3–23.1%). Coarse fraction (> 0.02 mm) is represented by quartz grains (2.8–24.5%), feldspars (1–9%), fine mica flakes (0.6–9.8%), carbonate components and fragments of rocks (Table 2). The analyzed samples are made of various raw materials, and their diversity corresponds roughly with the individual sites. Like Traian and Târpești, Isaiia has primarily provided raw material rich in carbonates. Apart from common micrite, the analysis has revealed grains of calcite, oolites (sample 70) and bioclasts, relics of plankton and fragments of shells (samples 70, 71, 72, 73, 74, 89, 90, 92). The raw material from Isaiia is uniform; all samples from that site seem to be made of one type of clay. The diversity of the samples may result from differences in the preparation of the clay. While the fine fraction and clay matrix are always similar, the coarse fraction may vary in a significant way. In sample 70, which belongs to a separate category because of its content of ooids (Table 5), the coarse fraction (ooids, calcite grains, fragments of shells etc.) corresponds with the clayey-carbonate matrix. Samples from Olteni contain grains of extrusive rock (samples 75, 76, 77) and amphiboles (e.g.

Table 1/Tabela 1

List of the analyzed samples from Romania

Spis analizowanych próbek

Number of sample	State	Site	Cultural affiliation
70	Romania	Isaiia	Linear Pottery culture (LBK)
71	Romania	Isaiia	Linear Pottery culture (LBK)
72	Romania	Isaiia	Linear Pottery culture (LBK)
73	Romania	Isaiia	Linear Pottery culture (LBK)
74	Romania	Isaiia	Linear Pottery culture (LBK)
75	Romania	Olteni	Linear Pottery culture (LBK)
76	Romania	Olteni	Linear Pottery culture (LBK)
77	Romania	Olteni	Linear Pottery culture (LBK)
78	Romania	Olteni	Linear Pottery culture (LBK)
79	Romania	Mihoveni	Linear Pottery culture (LBK)
80	Romania	Mihoveni	Linear Pottery culture (LBK)
81	Romania	Preutești	Linear Pottery culture (LBK)
82	Romania	Preutești	Linear Pottery culture (LBK)
83	Romania	Traian	Linear Pottery culture (LBK)
84	Romania	Traian	Linear Pottery culture (LBK)
85	Romania	Traian	Linear Pottery culture (LBK)
86	Romania	Traian	Linear Pottery culture (LBK)
87	Romania	Traian	Linear Pottery culture (LBK)
88	Romania	Târpești	Linear Pottery culture (LBK)
89	Romania	Târpești	Linear Pottery culture (LBK)
90	Romania	Târpești	Linear Pottery culture (LBK)
91	Romania	Târpești	Linear Pottery culture (LBK)
92	Romania	Târpești	Linear Pottery culture (LBK)

Table 2/Tabela 2

Mineral and petrographic composition of the samples. Values in percentage

Skład mineralny i petrograficzny badanych próbek, wartości w procentach objętościowych

No	Site	Clay minerals	Grains < 0.02 mm	Quartz (>0.02 mm)	Flint/chalcedony	K-feldspars	Plagioclases	Fragments of sedimentary rocks	Fragments of igneous rocks	Fragments of metamorphic rocks	Muscovite	Biotite	Opaque minerals	Iron oxides and hydroxides	Grog	Clasts of unmixed clay	Organic fragments	Voids	Carbonates	Amphiboles	Others
70	Isaiia	45.0	16.8	13.4	0.5	1.4			0.8	0.8	3.4	0.3	0.0	1.1	0.0	0.6	0.8	5.9	8.9		0.3
71	Isaiia	61.0	23.1	3.8		1.0					2.0	0.5	0.5			1.4		3.8	2.4		0.5
72	Isaiia	52.8	9.9	14.1		1.5		1			2.2	0.6			1.6	0.6	1.9	9.9	3.5		0.4
73	Isaiia	60.3	12.2	5.4		1.5					1.8		0.3	2.7		1.2	4.2	9.2	0.9		0.3
74	Isaiia	66.7	10.6	5.0		3.1					1.4		1.4	1.0			2.0		8.6		0.2
75	Olteni	46.5	7.9	4.2		2.5	0.3	2.3			1.1		2.3	3.1	0.0	15.5	4.5	9.6		0.2	
76	Olteni	55.7	14.0	9.7		1.7	0.3		2.3		0.6	0.3	0.3	0.6	0.0	0.9	4.3	7.7		0.9	0.7
77	Olteni	54.7	20.0	3.3		1.8			1.4		6.9	2.9	0.4	1.8		4.7	0.0	1.4			0.7
78	Olteni	57.6	11.8	8.6		5.0		0.3			6.5	0.5	1.0	5.8		1.2	0.0	1.5			0.2
79	Mihoveni	68.7	10.3	12.8		3.5					0.6		1.3	0.3		2.2		0.3			
80	Mihoveni	53.7	16.3	9.0		2.9				0.3	3.4		0.6	0.6		0.6	4.6	8.0			
81	Preutești	70.5	2.3	13.3		4.9		0.6				0.3	1.0	3.9		0.6	0.0	2.3			0.3
82	Preutești	50.4	8.0	24.5		7.2		0.5		1.8	2.1		2.1	0.3		0.3	0.0	2.8			
83	Traian	52.0	7.0	7.0		3.0					2.5		0.6		12.6	8.2	1.0	4.6	0.2		1.3
84	Traian	81.1	6.5	3.0		1.2					2.4	0.3		2.7		0.3		0.6	1.5		0.4
85	Traian	58.2	16.1	6.9		4.0		1.2		0.3	3.5		0.6	2.9		1.4	1.7	2.9			0.3
86	Traian	52.6	10.5	13.2		9.0					0.9	0.6	1.5	0.3		0.6	1.8	8.4			0.6
87	Traian	59.9	20.0	7.1	0.3		3.8				3.2		1.3	1.9		1.3		0.3			0.9
88	Târpești	55.3	14.0	13.5		4.3			0.3	0.6	1.2		1.2	0.9			3.5	2.6			2.6
89	Târpești	39.2	19.1	13.6	0.3	3.7				0.3	1.9	1.1	0.8	1.3		1.6		1.3	14.4		1.4
90	Târpești	60.7	14.3	7.5		2.2					1.6			1.2		3.1		1.9	6.5		1.0
91	Târpești	79.4	8.7	2.8		1.4					0.9		0.9	1.8		2.3	0.9	0.9			
92	Târpești	60.4	20.2	3.8		2.2					1.6		0.6	2.2			1.0	1.6	5.8		0.6

hornblende). The site in Mihoveni has yielded less characteristic raw materials: medium-grained silts, mostly with quartz grains and feldspars (the sample series is not representative; only two fragments have been examined). Subangular metamorphic rock fragments have been identified in several samples from Olteni (sample 78), Preuteşti (sample 82), Traian (samples 85, 86) and Târpeşti (sample 88). One vessel (sample 91) from Târpeşti is made of rarely used heavy clay with a small amount of fine-grained clastic material.

Granulometry and roundness of the grains

Granulometry has shown small diversity in the content of coarser grains. Significant differences are visible in clay and silt fraction, which is shown by the standard deviation (Table 3; Fig. 7, 8). This suggest that the content of the silt and sand fraction is a natural component of the clay. In the whole series, angular and sub-angular grains dominate, while rounded grains are very rare.

Types of fabric

The analysis has shown that the samples differ from one another in their raw material and the method of preparing the ceramic body. The differences are visible especially between coarse (thick-walled) and fine (thin-walled) ceramics. Thick-walled vessels are made of pastes containing thicker (>0.1 mm) grains and admixtures of organic material, and their clay is poorly mixed. Thin-walled ceramics are made of fine-grained, homogeneous and compact fabric with no organic temper. Two main types of fabric have been identified: type I (coarse ceramics) and type II (fine ceramics) (Table 4, 5).

Type Ia contains thicker grains and an organic admixture (N=6 – samples 70, 72, 73, 76, 86, 88, all of them representing thick-walled ceramics). The fabric is usually optical active, consisting of clayey groundmass, silty fraction and micaceous minerals. It often contains bigger (>0.1 mm) angular to sub-angular grains of quartz, feldspars and fragments of metamorphic, igneous or sedimentary rock, which are moderately to well sorted. Small (approx. 0.05 mm) concentrations of iron oxides and hydroxides are rare. There is always an admixture of organic material (Fig. 9, 10, 11, 12, 13, 14).

Type Ib contains thicker grains and is poorly mixed with organic temper (N=1, sample 75, thick-walled ceramics). Being optical inactive, it consists of clayey groundmass (with iron oxides and hydroxides), silty fraction, micaceous minerals

Table 3/Tabela 3

Grain size distribution and the standard deviation of the analyzed samples. Values in percentage

Zawartość procentowa poszczególnych frakcji ziarnowych w analizowanych próbkach, wartości w procentach

No	d<0.002 mm	0.002–0.02 mm	0.02–0.05 mm	0.05–0.1 mm	0.1–0.2 mm	0.2–0.5 mm	0.5–1 mm	1–2 mm	d>2 mm
84	81.10	11.70	6.00	1.30	0.00	0.00	0.00	0.00	0.00
91	79.40	14.10	6.10	0.40	0.00	0.00	0.00	0.00	0.00
81	70.50	11.90	10.70	5.80	1.10	0.00	0.00	0.00	0.00
79	68.70	17.40	10.70	2.80	0.40	0.10	0.00	0.00	0.00
74	66.70	22.50	10.10	0.70	0.00	0.00	0.00	0.00	0.00
71	61.00	25.80	12.10	1.00	0.20	0.00	0.00	0.00	0.00
90	60.70	25.10	12.20	1.90	0.10	0.00	0.00	0.00	0.00
92	60.40	28.90	10.10	0.50	0.00	0.00	0.00	0.00	0.00
73	60.30	26.20	11.70	1.20	0.60	0.00	0.00	0.00	0.00
87	59.90	25.10	13.00	1.90	0.10	0.00	0.00	0.00	0.00
85	58.20	25.60	12.80	2.80	0.50	0.10	0.00	0.00	0.00
78	57.60	27.80	12.00	2.00	0.50	0.00	0.00	0.00	0.00
76	55.70	25.20	14.60	3.70	0.60	0.10	0.00	0.00	0.00
88	55.30	24.10	13.90	5.20	1.50	0.00	0.00	0.00	0.00
77	54.70	31.00	12.30	1.60	0.30	0.10	0.00	0.00	0.00
80	53.70	29.20	13.40	3.50	0.30	0.00	0.00	0.00	0.00
72	52.80	23.80	18.50	4.60	0.30	0.00	0.00	0.00	0.00
86	52.60	25.00	17.10	4.90	0.30	0.10	0.00	0.00	0.00
83	52.00	27.30	16.70	3.50	0.50	0.00	0.00	0.00	0.00
82	50.40	21.10	21.20	6.70	0.60	0.00	0.00	0.00	0.00
75	46.50	32.40	16.60	3.70	0.70	0.10	0.00	0.00	0.00
70	45.00	32.30	15.60	5.40	1.50	0.20	0.00	0.00	0.00
89	39.20	37.40	19.40	3.50	0.60	0.00	0.00	0.00	0.00
standard deviation	10.03	6.39	3.80	1.82	0.43	0.05	0.01	0.00	0.00

Fig. 2. An LBK potsherd from Olteni – “Sand Quarry” / “Tag” / “B Site” (Bodoc commune, Covasna county) (apud http://ran.cimec.ro/sel.asp?imgid=38354, pl. III: 11)

Ryc. 2. Fragment ceramiki z Olteni – „piaskownia” (gm. Bodoc, pow. Covasna) (wg http://ran.cimec.ro/sel.asp?imgid=38354, tab. III: 11)

(1.1%) and very few heavy minerals. The mineralogical composition includes poorly sorted angular to sub-angular grains of quartz (4.2%), feldspars (2.5%) and opaque (2.3%). The maximum grain size does not exceed 1.5 mm. Rounded claystone (sometimes saturated intensively with iron oxides or hydroxides), mudstone with a higher content of mica flakes (max. >2 mm) and angular sandstone with iron cement (max. >1 mm) are common, while angular fragments of volcanic rock (approx. 0.2 mm) and fragments of plutonic rock (approx. 0.2–0.5 mm) are rare. The ceramic paste has an admixture of organic material (Fig. 15).

Type Ic is determined by thicker grains, poor mixing and the absence of organic temper (N=2, samples 81, 82, thin-walled ceramics). The fabric is optical active, consisting of clayey groundmass and small amounts of silty fraction and of micaceous minerals. Concentrations of iron oxides or hydroxides and opaque are common. The mineralogical composition includes moderately to well sorted angular to sub-angular grains of monocrystalline quartz, feldspars, thin flakes of muscovite or biotite, and opaque, with few sub-angular fragments of igneous, metamorphic or sedimentary rock (Fig. 16, 17).

Type IIa contains fine-grained, homogeneous, compact paste with no organic admixture (N=10, samples 71, 77, 78, 79, 84, 87, 89, 90, 91, 92, thin-walled ceramics). It is usually optical active, consisting of clayey groundmass, silty fraction, concentration of iron oxides or hydroxides and opaque. Heavy minerals are rare. The mineralogical composition includes angular to sub-angular, moderately to well sorted grains of quartz and feldspars, with few rounded claystone grains, some sub-rounded grains of volcanic or metamorphic rock and some rounded fragments of micrite limestone. The grain size does not exceed 0.25 mm. The well prepared ceramic paste is very homogenous and uniform, with no organic or mineral admixture (Fig. 18, 19, 20, 21, 22, 23, 24, 25, 26, 27).

Type IIb is made of heavy fine-grained clay with clay clasts and grains of sedimentary rock, with no organic temper (the only sample 148 from the Republic of Moldova; S. Kadrow, A. Rauba-Bukowska, S. Ţerna 2017, pp. 257–274).

Type IIc has fine-grained, homogeneous, compact paste with an organic admixture (N=3, samples 74, 80, 85, thick-walled ceramics). It is optical active, consisting of clayey groundmass, silty fraction and micaceous minerals. The mineralogical composition includes moderately sorted angular to sub-angular grains of quartz (5%), feldspars (3.1%) and opaque (1.4%). The grain size does not usually exceed 0.15 mm. One sample has a few sub-angular to sub-rounded fragments of metamorphic rock up to 0.3 mm. The common elements are fine-grained mica-schist and rounded clay clasts similar to the clay matrix. The paste is well mixed, fine-grained, homogenous, with organic temper (Fig. 28, 29, 30).

The analysis has also revealed items difficult to classify, e.g. two fragments (sample 87 and 90) of fine pottery with properties of type IIa (fine-grained compact paste) and Ia (organic temper), and one fragment of fine pottery (sample 85) with properties of type IIc (fine-grained, homogeneous, compact, with an organic admixture) and Ib (thicker grains in the ceramic body).

Sample 83 (type IId) stands out against the collection. It is made of moderately sorted medium-grained heterogeneous ceramic paste (Fig. 31) and contains a grog admixture (reused fragments of pottery) in its ceramic body.

The above analysis shows that the overriding technological criterion in identifying fine or coarse ceramics is the presence or absence of an organic admixture in the clay (Table 6).

Table 4/Tabela 4

Descriptions of the types of fabrics

Opisy typów mas ceramicznych

Symbol of the fabric types	Description	Sample
I a	thicker grains in the ceramic body, organic admixture	70, 72, 73, 76, 86, 88
I b	thicker grains in the ceramic body, presence of unmixed clay clasts (poorly mixed), organic admixture	75
I c	thicker grains in the ceramic body, poorly mixed, without organic admixture	81, 82
II a	fine grained, homogeneous, compact, without organic admixture	71, 77, 78, 79, 84, 87, 89, 90, 91, 92
II b	heavy clay, fine grained, with clay clasts and fragments of sedimentary rocks, without organic admixture	(only sample 148 from Moldova, S. Kadrow *et al.* 2017, p. 257–274)
II c	fine grained, homogeneous, compact, with organic admixture	74, 80, 85
II d	fine grained, heterogeneous, with grog admixture	83

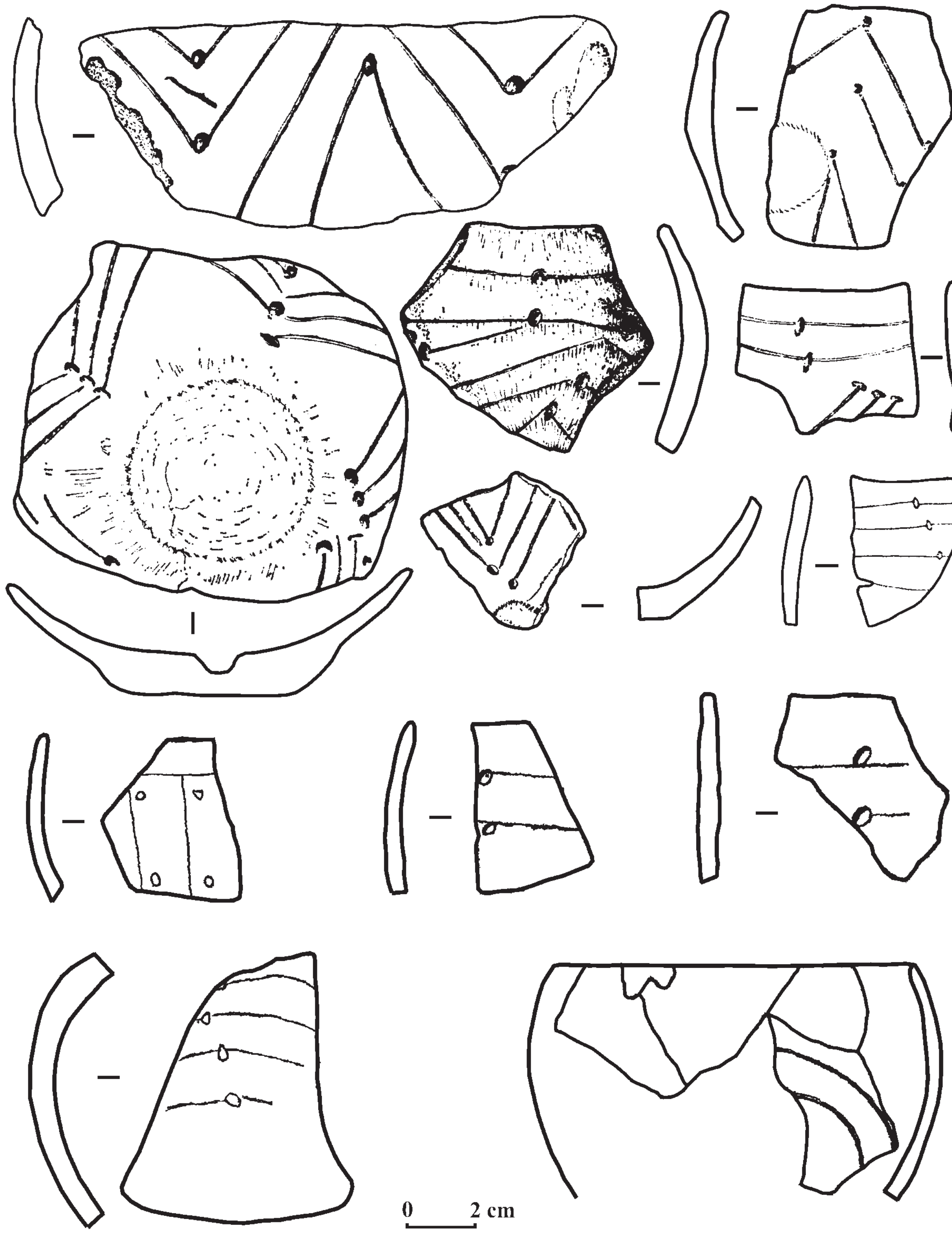

Fig. 3. LBK potsherds from Mihoveni – "Tile Mill" (Şcheia commune, Suceava county) (*apud N. Ursulescu, P.V. Batariuc 1979, pp. 279, 280, Fig. 6:3–7,10; 7:1,2; 8:1,4–6*)
Ryc. 3. Fragmenty ceramiki KCWR z Mihoveni – „Tile Mill" (gm. Şcheia, pow. Suceava) (*wg N. Ursulescu, P.V. Batariuc 1979, ss. 279, 280, ryc. 6:3–7,10; 7:1,2; 8:1,4–6*)

Results of petrographic and mineralogical analysis

The analysis has revealed certain rules concerning the preparation of the material. The earlier conclusions (S. Kadrow, A. Rauba-Bukowska, S. Ţerna 2017, pp. 257–274) have shown different methods for coarse and fine ceramics. Two basic groups have been identified, which differ in the way the clay mixture was prepared.

Potters were selective in their use of raw material, using fine-grained clays to make fine ware and different types of clay to make coarse and thick-walled vessels. In the case of thick-walled vessels the clay was not always well-processed, as some

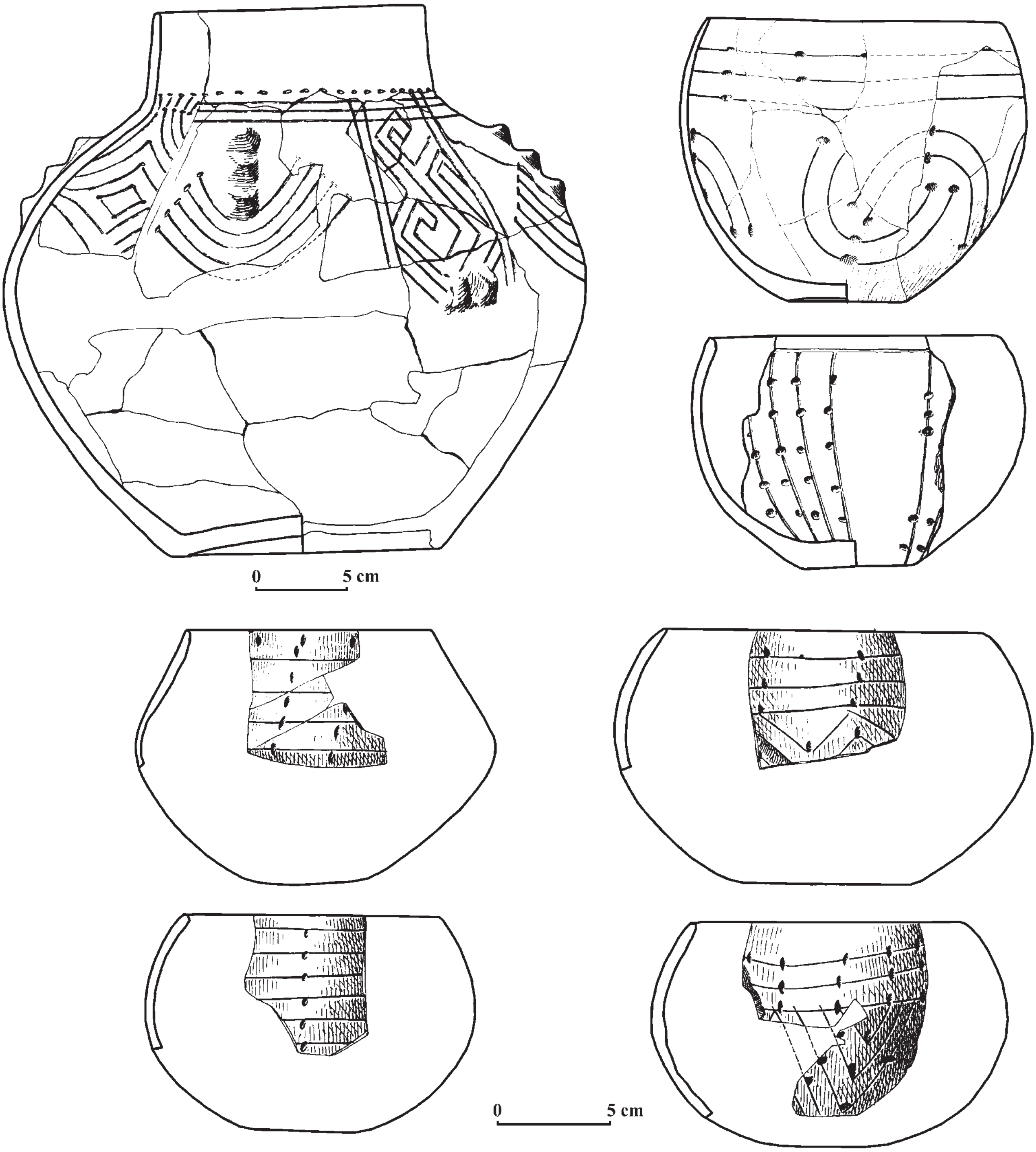

Fig. 4. LBK potsherds from Târpeşti – "Ravine of Bodai" (Petricani commune, Neamţ county) (*apud S. Marinescu-Bîlcu 1981, Fig. 27:8; 28:10; 29:1,2,10–12*)

Ryc. 4. Fragmenty ceramiki KCWR z Târpeşti – „Ravine of Bodai" (gm. Petricani, pow. Neamţ) (*wg S. Marinescu-Bîlcu 1981, ryc. 27:8; 28:10; 29:1,2,10–12*)

clay pellets recur in the fabrics (e.g. sample 75). Coarse ceramics were produced without a significant admixture of very coarse grains (d>0.2 mm; e.g. samples 74, 80). They were always made of paste with organic temper, while fine ceramics were usually made of clay with no intentional admixture. Vessel 83 stands out against other thick-walled vessels, because its ceramic paste contains an admixture of grog.

Both thick-walled and thin-walled vessels were fired in reducing atmosphere with small inflow of air at the end of the firing process or during the cooling process. The temperature of firing ranged from 700 to 800°C for thick-walled vessels (only samples 80 and 83 indicate the temperature of approx. 850°C). Fine ceramics were usually fired in more than 750°C. Not all those rules were obligatory. For example, samples 81 and 82, representing fine ceramics, have more coarse grains than other items of fine vessels. However, sorting and mixing were of good quality. It seems that the only permanent rule was making coarse pottery from paste containing an organic admixture.

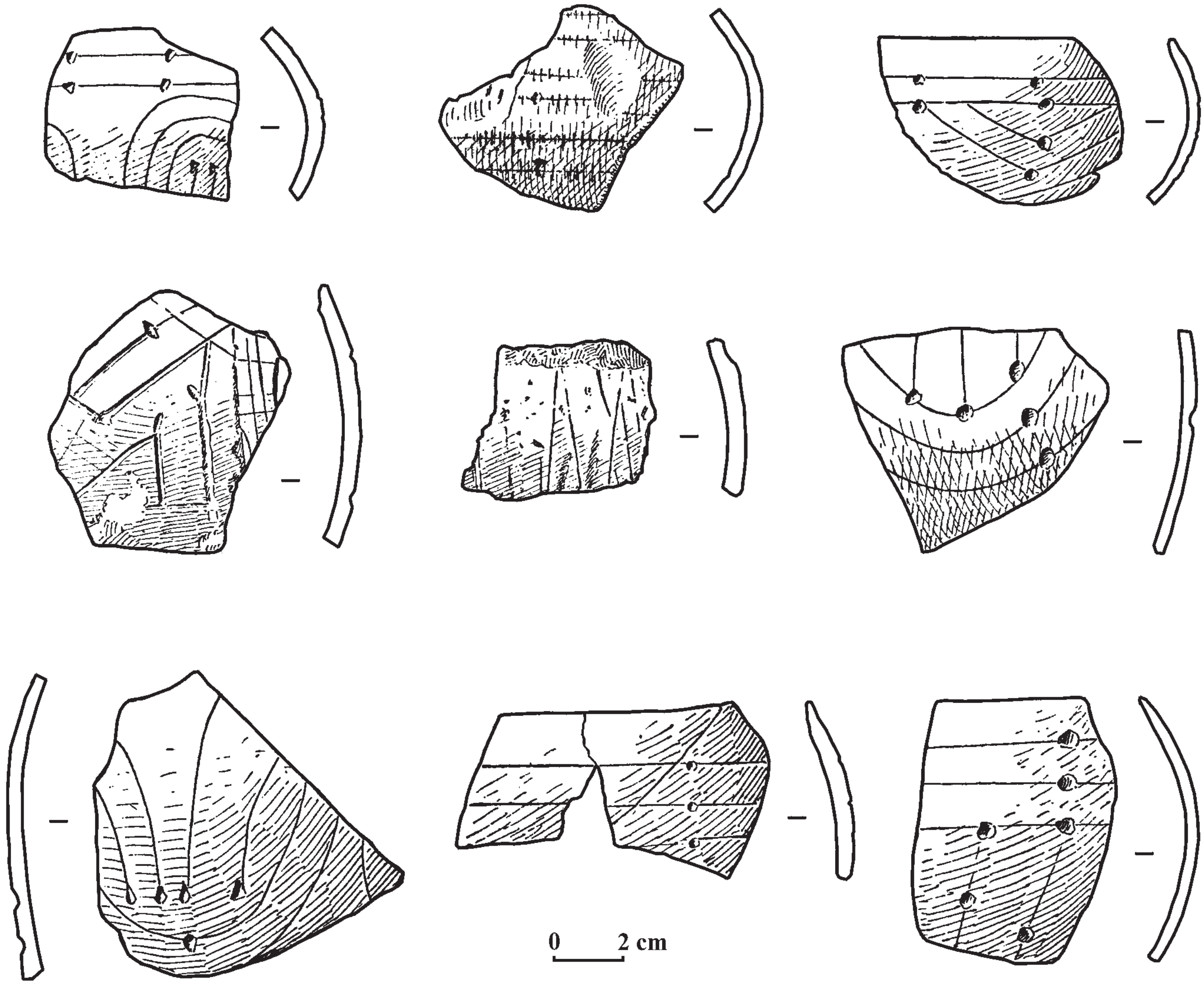

Fig. 5. LBK potsherds from Traian – "Fountains Hill" (Zăneşti commune, Neamț county) (*apud H. Dumitrescu 1955, Fig. 9:10–12,14–16,18–21*)
Ryc. 5. Fragmenty ceramiki KCWR z Traian – „Fountains Hill" (gm. Zăneşti, pow. Neamț) (*wg H. Dumitrescu 1955, ryc. 9:10–12,14–16,18–21*)

The analysis has shown that the ceramics recovered from individual archaeological sites were made from local sources, and that there were rules concerning the preparation of the clay. This may mean that certain procedures were accepted not only in the local production, but also on a wider scale.

The tendency to use fine-grained ceramic mixture is noticeable particularly in the thin-walled vessels. The clay was most probably purified from larger components. The preparation of raw materials for ceramics of the LBK music-note phase in the Upper Vistula Basin in Poland also varied depending on the type of the vessel. Thin-walled vessels were made of fine-grained paste, while thick-walled ones had an admixture of thicker grains and unmixed clay. Both thin-walled and thick-walled ceramics contained organic material (A. Rauba-Bukowska 2014; M. Moskal del Hoyo, A. Rauba-Bukowska, M. Lityńska-Zając, A. Mueller-Bieniek, A. Czekaj-Zastawny 2017).

Late Starčevo-Criş ceramics (from Tăşnad, Călineşti and Homorodul) have provided no traces of that method. The paste of thin – and thick-walled vessels consisted of fine-grained clay with numerous coarse grains of minerals, mostly quartz, feldspars and sometimes flint, and with fragments of volcanic or metamorphic rock. The ceramic bodies of the late Starčevo-Criş items contained an abundant organic admixture and no grog temper (S. Kadrow, A. Rauba-Bukowska 2017a, pp. 261–280).

Description of individual samples
(PG – petrographic group, FT – fabric type)

Below, we decided to fully publish the descriptions and results of petrographic and mineralogical analyzes of samples of LBK ceramics collected in eastern Romania. These are the first LBK ceramic analyzes of this kind from this country. As such, they will become a reference point for other studies of this type in the coming years.

Isaiia, (Răducăneni commune, Iaşi county) (N=5) 70–74
Sample 70 (Fig. 9a, b, c), thick-walled ceramics
Matrix: Matrix (d<0.05 mm): brown in PPL, brown-yellow in XPL (50x); optical active, consists of clayey-carbonate groundmass (45%), silty fraction (16.8%) and micaceous

Table 5/Tabela 5

Other properties of the samples: the atmosphere of firing, the approximate temperature of firing, morphology, the type of fabric and the petrographic group

Inne cechy badanych próbek: warunki wypału, orientacyjna temperatura wypału, typ naczynia, typ masy ceramicznej i grupa petrograficzna

No	Site	Condition of firing	Temperature of firing	Morphology	Fabric types	Petrographic group
70	Isaiia	redox	750–800	thick-walled	Ia	Isa1
71	Isaiia	redox	800–850	thin-walled	IIa	Isa2
72	Isaiia	redox	700–750	thick-walled	Ia	Isa2
73	Isaiia	redox	700–750	thick-walled	Ia with some features of IIc (fine grained)	Isa2
74	Isaiia	redox	750–800	thick-walled	IIc	Isa2
75	Olteni	redox	750	thick-walled	Ib	Olt 1
76	Olteni	redox	750–800	thick-walled	Ia	Olt 2
77	Olteni	red	750–800	thin-walled	IIa	Olt 2
78	Olteni	redox	750–800	thin-walled	IIa	Olt 3
79	Mihoveni	redox	850	thin-walled	IIa	Mih 1
80	Mihoveni	redox	800–850	thick-walled	IIc	Mih 1
81	Preutești	ox	850	thin-walled	Ic	Pre 1
82	Preutești	red	800	thin-walled	Ic	Pre 1
83	Traian	redox	850	thin-walled?	IId	Tra 1a
84	Traian	red	>850	thin-walled	IIa	Tra 1b
85	Traian	red	750	thin-walled	IIc with some features of Ib (presence of coarse grains)	Tra 2
86	Traian	red	750	thick-walled	Ia	Tra 2
87	Traian	redox	850	thin-walled	IIa with some features of Ia (organic admixture)	Tra 3
88	Târpești	redox	750	thick-walled	Ia	Tarp 1
89	Târpești	redox	800–850	thin-walled	IIa	Tarp 2
90	Târpești	ox	750	thin-walled	IIa with some features of Ib (worse mixing)	Tarp 2
91	Târpești	ox	750–800	thin-walled	IIa	Tarp 3
92	Târpești	ox	750	thin-walled	IIa	Tarp 2

minerals (3.7%). Small (approx. 0.05 mm) concentrations of iron oxides or hydroxides are rare.

Inclusion (d>0.05 mm), (26.1%): the mineralogical composition includes poorly sorted angular to sub-angular grains of quartz (13.4%) and feldspars (1.4%). Carbonate components, mainly dispersed fine micrite particles or bigger intraclasts (approx. 0.5 mm), and ooliths or ooids (approx. 0.15–0.3 mm) with the quartz, calcite or aragonite cores, are common (8.9%). The clay also contains angular calcite grains and bioclasts (shells, Foraminifera relics). Angular grains of amphiboles (probably hornblende) are very rare.

Lithoclasts: sub-rounded micrite (approx. 0.15–0.5 mm), sub-rounded mudstone with carbonate cement (one grain approx. 2 mm), infrequent (0.8%) sub-angular metamorphic or igneous rock fragments with the diameter of 0.2 mm, very infrequent sub-rounded or rounded flint fragments.

Secondary: numerous carbonates in voids created by the destruction of plant material.

Intentional temper: plant material, mineral? – angular sand grains.

Atmosphere and temperature of firing: groundmass has the properties of reducing to oxidising firing: both surfaces are oxidized and the core is dark; the approximate temperature of firing was 750–800°C.

Comments: ceramic paste is poorly mixed and porous (voids 5.9%)

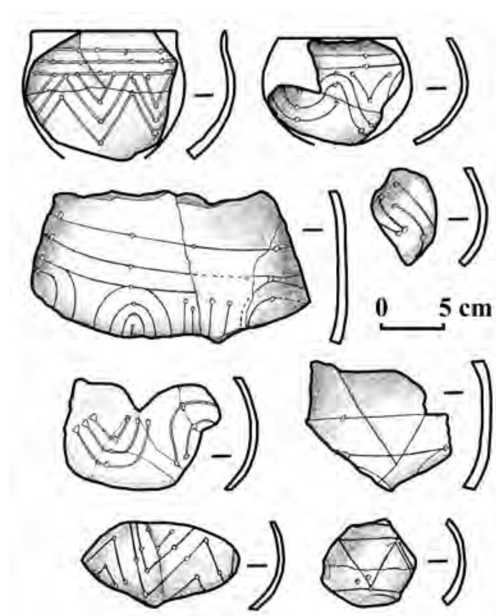

Fig. 6. LBK potsherds of Isaiia – "Priest Pond" (Răducăneni commune, Iași county) (*apud J. Braungart 2014, pp. 35–37, Fig. 16:2,3,5; 17:1–3,7; 18:9*)

Ryc. 6. Fragmenty ceramiki KCWR z Isaiia – „Priest Pond" (gm. Răducăneni, pow. Iași) (*wg J. Braungart 2014, s. 35–37, ryc. 16:2,3,5; 17:1–3,7; 18:9*)

Table 6/Tabela 6

Number of samples (vessels) in the individual categories of the types of fabrics

Ilość próbek (naczyń) w wykonanych z poszczególnych mas ceramicznych

Fabric types	Ia	I b	I c	II a	II b	II c	II d
thick-walled ware	6	1	0	0	0	2	0
thin-walled vessels	0	0	2	10	0	1	1
all	6	1	2	10	0	3	1

PG: Isa 1, clay with carbonates, including micrite, calcite, ooids (or ooliths) and bioclasts.
FT: Ia, coarse-grained, poorly mixed, poorly sorted, with organic temper.

Sample 71 (Fig. 18), thin-walled ceramics
Matrix (d<0.05 mm): light brown with opaque spots (approx. 0.01 mm) in PPL, dark grey with yellow dots (approx. 0.02–0.05 mm) in XPL; optical inactive, consisting of clayey-carbonate groundmass (61%), silty fraction (23.1%) and micaceous minerals (2.5%). Small (approx. 0.05 mm) concentrations of iron oxides or hydroxides are rare.

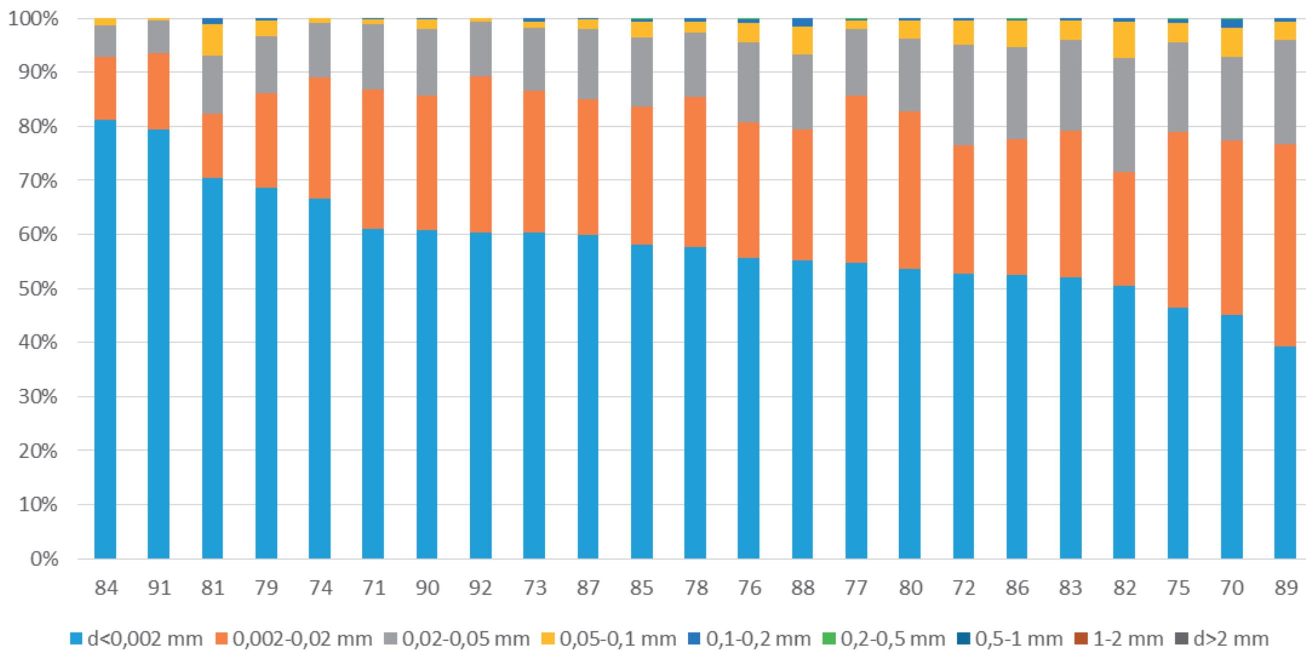

Fig. 7. Granulometry. The percentage of individual grain fractions in the analyzed samples
Ryc. 7. Granulometria. Zawartość procentowa poszczególnych frakcji ziarnowych w analizowanych próbkach

Inclusion (8.2%): the mineralogical composition includes well sorted angular to sub-angular grains of quartz (3.8%), feldspars (1%) and opaque (0.5%). The grains do not exceed 0.15 mm; most of them range from 0.05 to 0.1 mm. Carbonate components, mainly dispersed fine micrite particles (approx. 0.05 mm), are common (2.4%). The clay contains visible bioclasts (probably Foraminifera).
Lithoclasts: absent.
Secondary: absent.
Intentional temper: absent.
Atmosphere and temperature of firing: groundmass has the properties of reducing to oxidising firing: both surfaces are slightly oxidized and the core is light grey; the approximate temperature of firing was 800–850°C.
Comments: clay at the surfaces has no carbonate components, which is probably due to post-depositional processes (those layers are approx. 0.06–0.08 mm thick).
PG: Isa 2, clay with carbonates including fine particles of micrite and bioclasts.
FT: IIa, very fine-grained, homogenous, compact, well mixed, well sorted, with no organic or mineral temper.

Sample 72 (Fig. 10), thick-walled ceramics
Matrix (d<0.05 mm): brown in PPL, brown-orange in XPL; optical active, consisting of clayey groundmass with an admixture of fine micrite (52.8%), a small amount of silty fraction (9.9%) and micaceous minerals (2.8%). Small concentrations (approx. 0.05 mm) of iron oxides or hydroxides are rare.
Inclusion (d>0.05 mm), (20.5%): the mineralogical composition includes well sorted angular to sub-angular grains of quartz (14.1%), feldspars (1.5%) and opaque. Grains do not exceed 0.25 mm; most of them range from 0.05 to 0.1 mm and from 0.1 to 0.2 mm. Carbonate components, mainly dispersed fine micrite particles (approx. 0.05 mm) or bigger intraclasts (up to 0.5 mm), are common (3.5%). The clay contains visible bioclasts (fragments of shells or Foraminifera relics) and rare angular grains of calcite. Clay clast saturated with iron oxides and hydroxides, sometimes with fine clastic material, has been identified in the paste.
Lithoclasts: absent.
Secondary: numerous carbonates in voids created by the destruction of plant material.

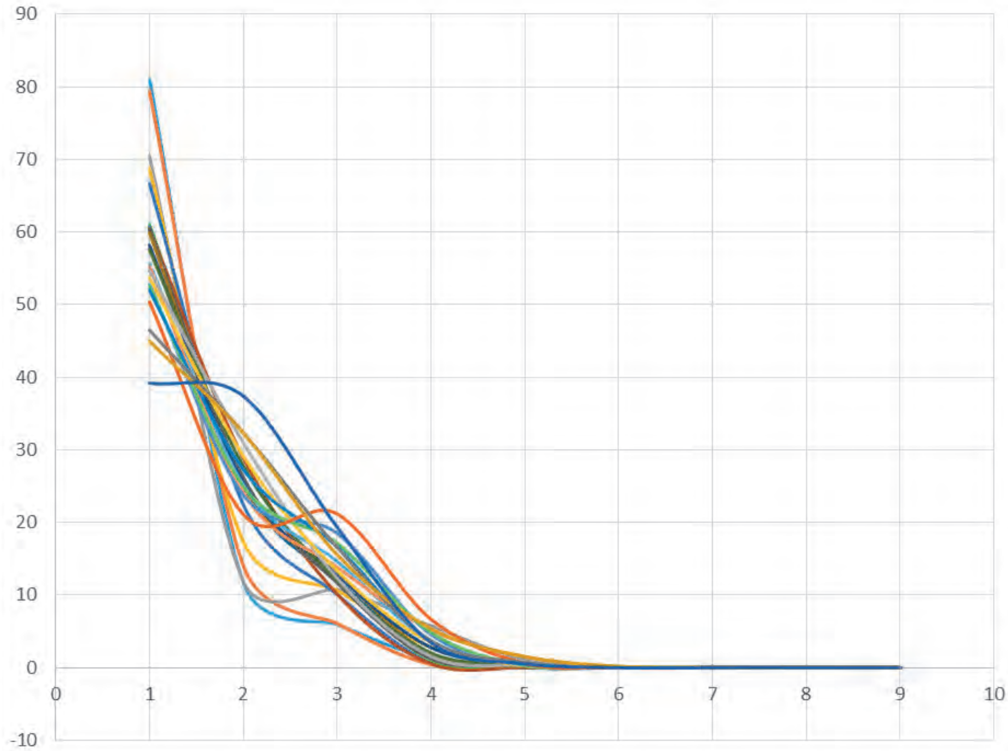

Fig. 8. Differentiation within grain fractions: 1. d<0.002 mm; 2. 0.002–0.02 mm; 3. 0.02–0.05 mm; 4. 0.05–0.1 mm; 5. 0.1–0.2 mm; 6. 0.2–0.5 mm; 7. 0.5–1 mm; 8. 1–2 mm; 9. d>2 mm

Ryc. 8. Zróżnicowanie w obrębie frakcji ziarnowych: 1. d<0.002 mm; 2. 0.002–0.02 mm; 3. 0.02–0.05 mm; 4. 0.05–0.1 mm; 5. 0.1–0.2 mm; 6. 0.2–0.5 mm; 7. 0.5–1 mm; 8. 1–2 mm; 9. d>2 mm

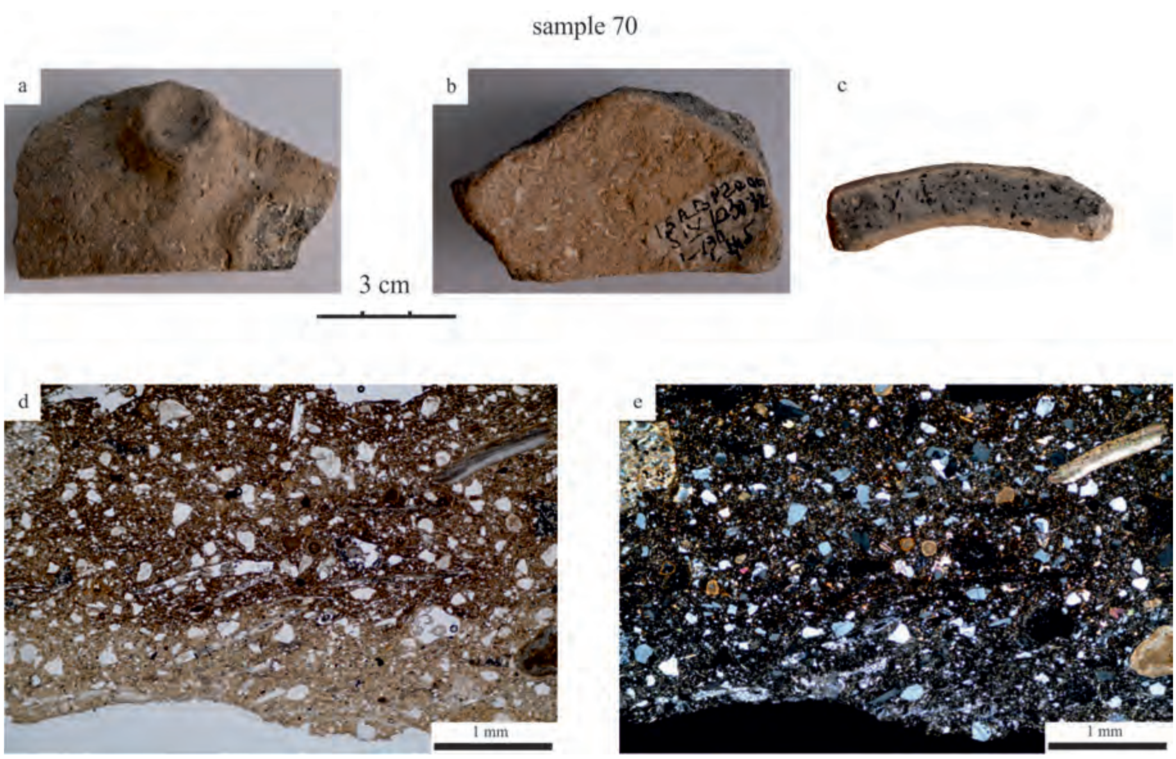

Fig. 9. Sample 70, coarse ceramics, Isaiia; a, b – photographs of the analyzed sample of pottery; c – a fresh section of the pottery with numerous pores ; d, e – photomicrographs of a thin section with fragments of shells, ooliths and coarse grains; d – PPL, e – XPL

Ryc. 9. Próbka 70, naczynie grubościenne, stanowisko Isaiia; a, b – fotografia analizowanego fragmentu ceramiki; c – przełam fragmentu, w którym widoczne są liczne pustki; d, e – mikrofotografia cienkiego szlifu, w którym widoczne są fragmenty muszli, oolity i grubsze ziarna krystaliczne; d – 1N; e – NX

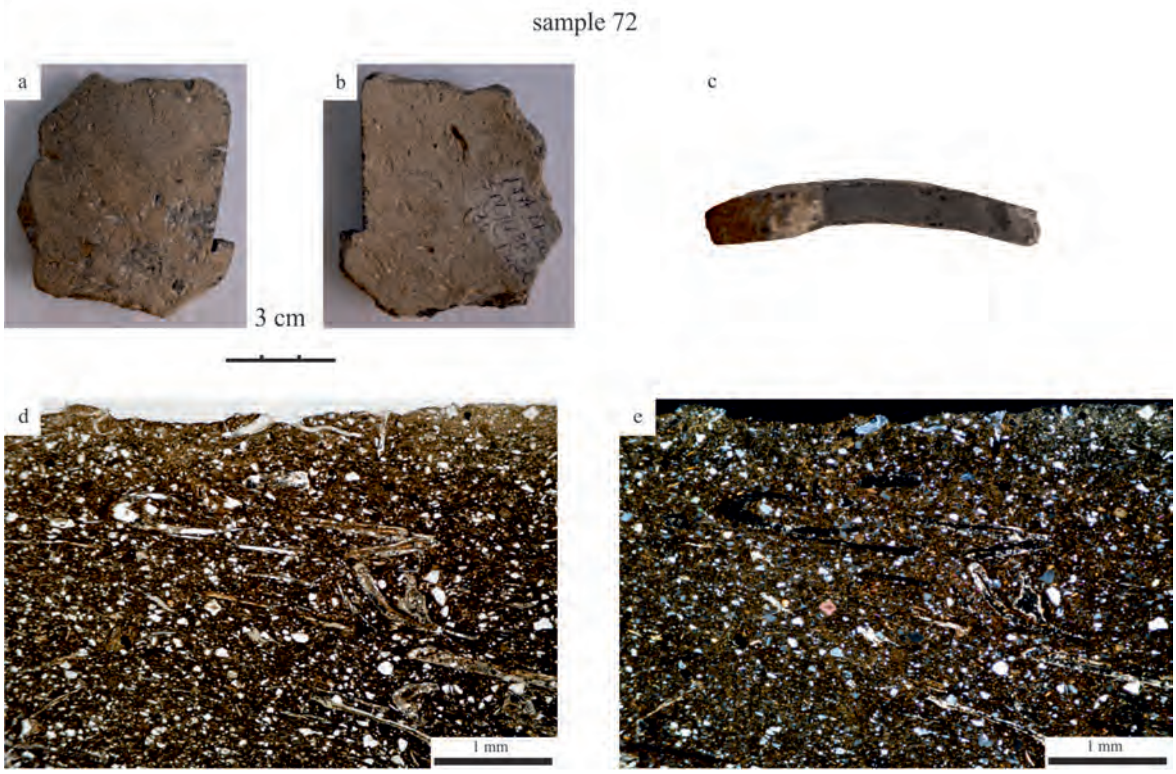

Fig. 10. Sample 72, coarse ceramics, Isaiia; a, b – photographs of the analyzed sample of pottery; c – a fresh section of the pottery; d, e – photomicrographs of a thin section with numerous fragments of carbonized organic material, d – PPL, e – XPL

Ryc. 10. Próbka 72, naczynie grubościenne, stanowisko Isaiia; a, b – fotografia analizowanego fragmentu ceramiki; c – przełam fragmentu; d, e – mikrofotografia cienkiego szlifu, w którym widoczne są liczne fragmenty materiału organicznego; d – 1N; e – NX

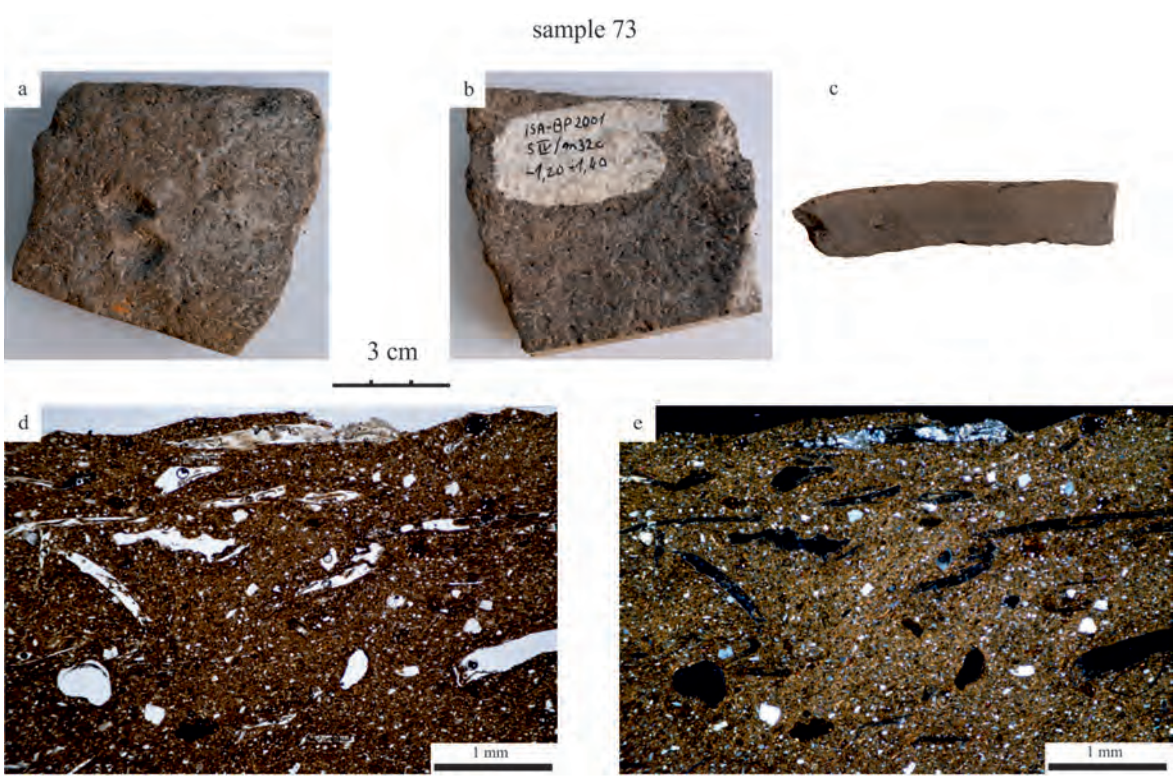

Fig. 11. Sample 73, coarse ceramics, Isaiia; a, b – photographs of the analyzed sample of pottery; c – fresh section of the pottery; d, e – photomicrographs of a thin section with numerous fragments of organic material and secondary carbonates in voids; d – PPL, e – XPL

Ryc. 11. Próbka 73, naczynie grubościenne, stanowisko Isaiia; a, b – fotografia analizowanego fragmentu ceramiki; c – przełam fragmentu; d, e – mikrofotografia cienkiego szlifu, w którym widoczne są liczne fragmenty organiczne oraz wtórne węglany w szczelinach; d – 1N; e – NX

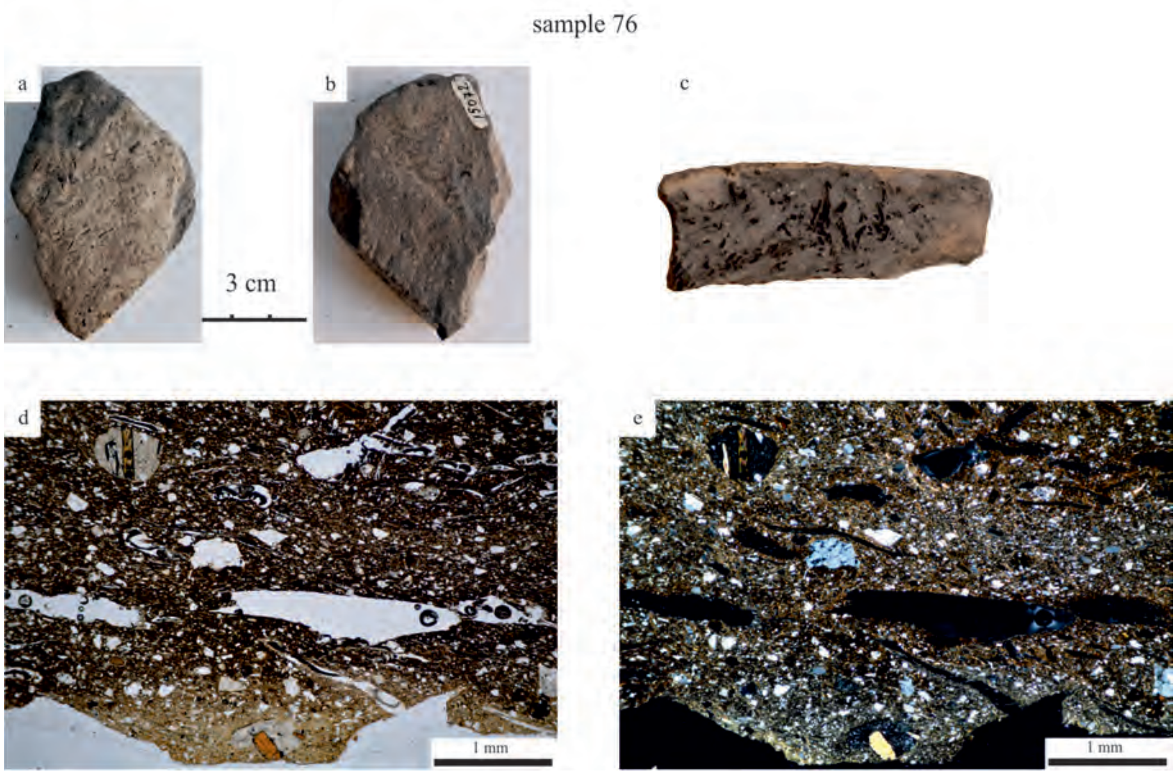

Fig. 12. Sample 76, coarse ceramics, Olteni; a, b – photographs of the analyzed sample of pottery; c – a fresh section of the pottery with numerous pores; d, e – photomicrographs of a thin section with fragments of extrusive rock, organic material and voids created by the destruction of plant material; d – PPL, e – XPL

Ryc. 12. Próbka 76, naczynie grubościenne, stanowisko Olteni; a, b – fotografia analizowanego fragmentu ceramiki; c – przełam fragmentu, w którym widoczne są liczne pustki; d, e – mikrofotografia cienkiego szlifu, w którym widoczne są fragmenty skały wylewnej, materiał organiczny i pustki po zniszczeniu materiału organicznego; d – 1N; e – NX

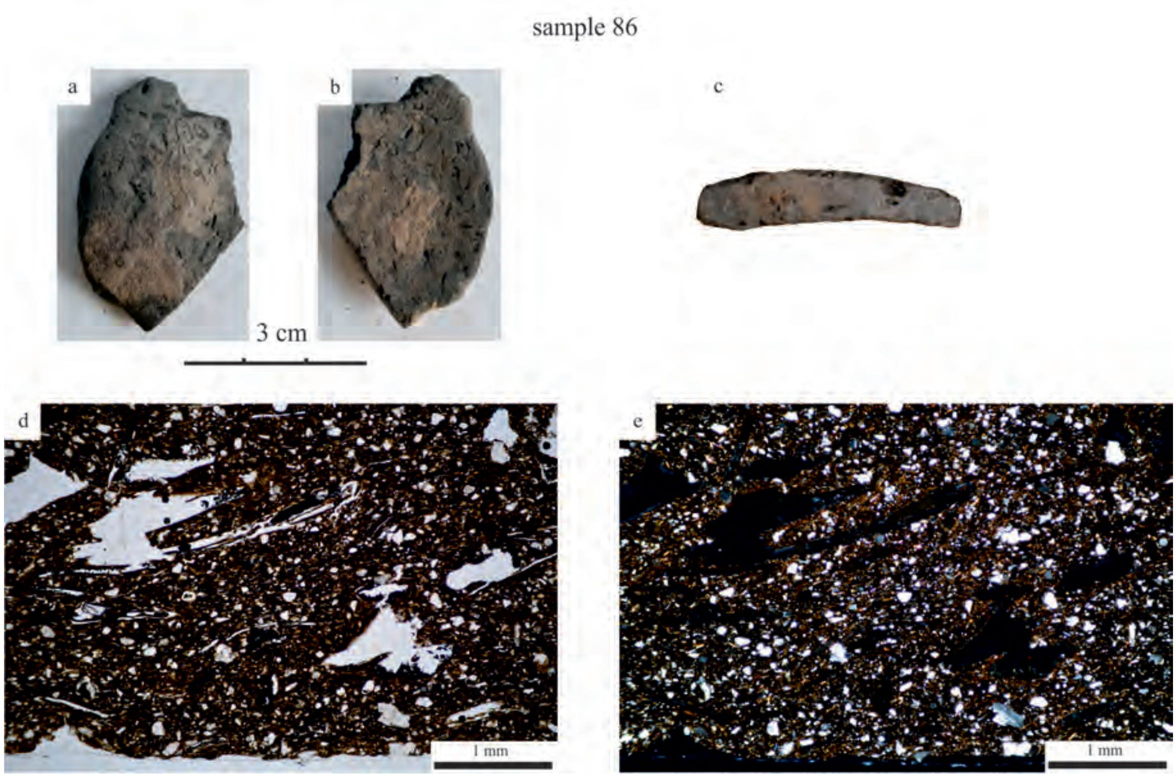

Fig. 13. Sample 86, coarse ceramics, Traian-Dealul Fântânilor; a, b – photographs of the analyzed sample of pottery; c – a fresh section of the pottery; d, e – photomicrographs of a thin section with thicker grains, an organic admixture and voids in the ceramic body; d – PPL, e – XPL

Ryc. 13. Próbka 86, naczynie grubościenne, stanowisko Traian-Dealul Fântânilor; a, b – fotografia analizowanego fragmentu ceramiki; c – przełam fragmentu; d, e – mikrofotografia cienkiego szlifu, w którym widoczne są grubsze ziarna krystaliczne, fragmenty organiczne oraz pustki; d – 1N; e – NX

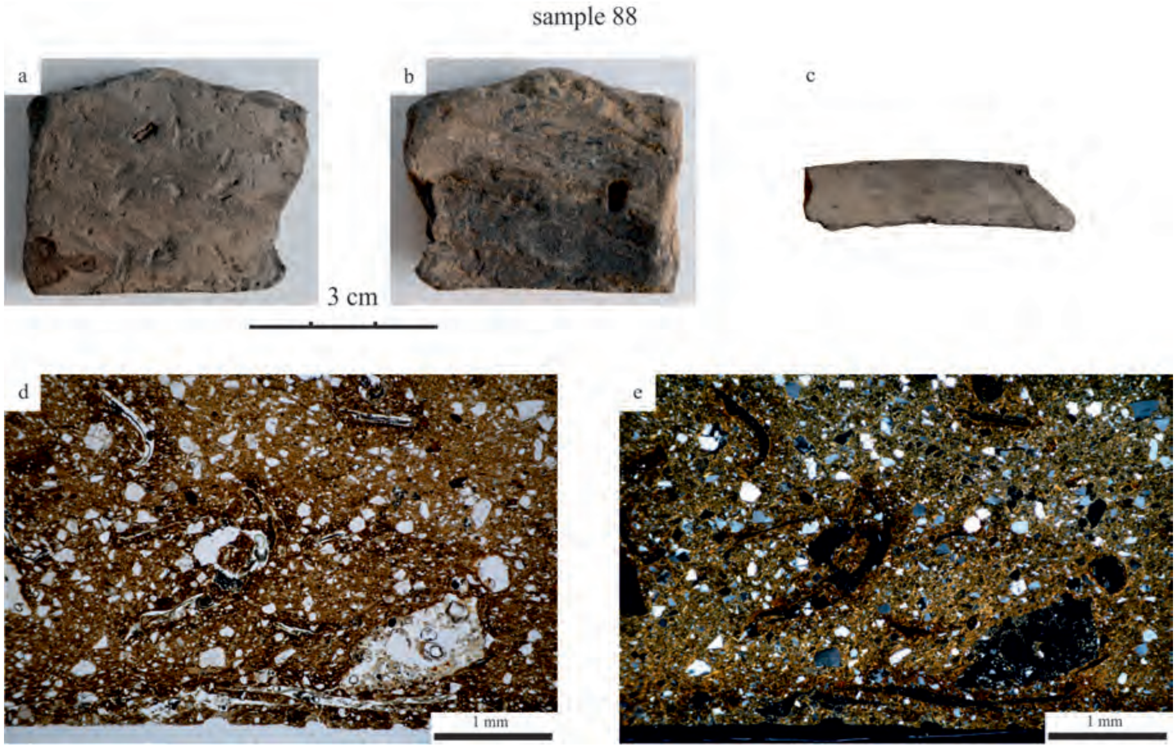

Fig. 14. Sample 88, coarse ceramics, Târpeşti; a, b – photographs of the analyzed sample of pottery; c – a fresh section of the pottery; d, e – photomicrographs of a thin section with thicker grains and an organic admixture in the ceramic body; d – PPL, e – XPL

Ryc. 14. Próbka 88, naczynie grubościenne, stanowisko Târpeşti; a, b – fotografia analizowanego fragmentu ceramiki; c – przełam fragmentu; d, e – mikrofotografia cienkiego szlifu, w którym widoczne są grubsze ziarna krystaliczne oraz fragmenty organiczne; d – 1N; e – NX

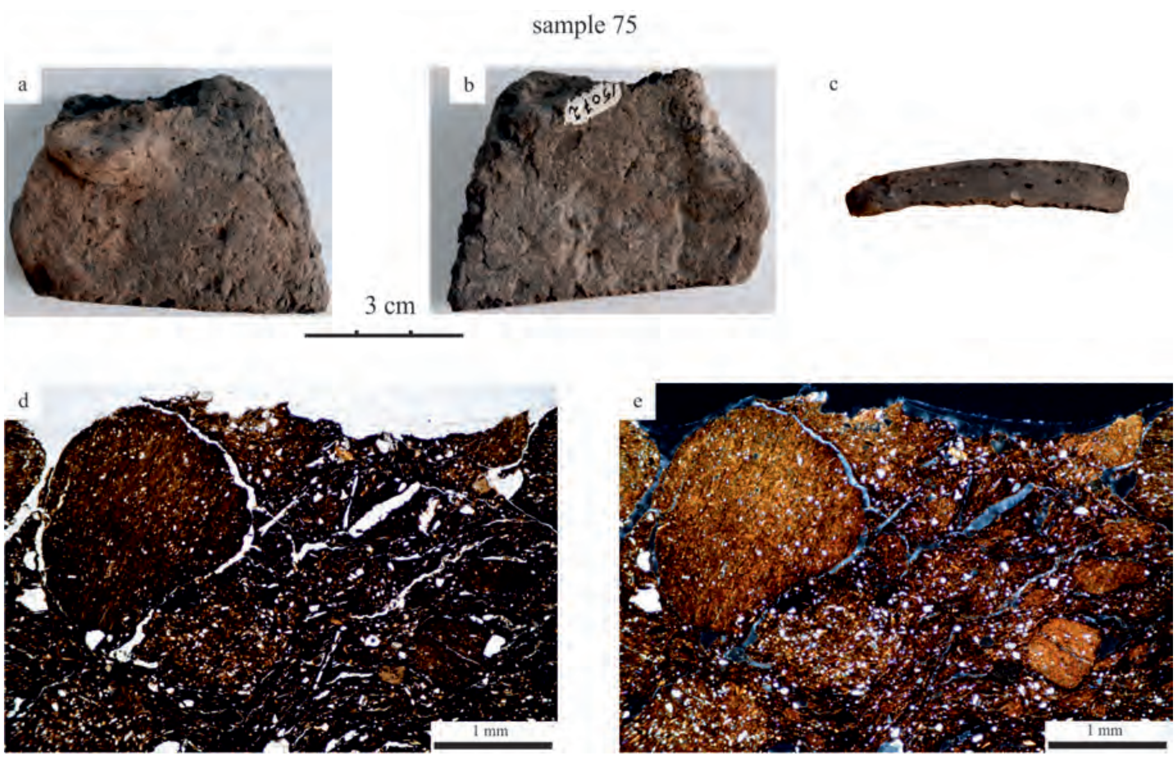

Fig. 15. Sample 75, coarse ceramics, Olteni; a, b – photographs of the analyzed sample of pottery; c – a fresh section of the pottery; d, e – photomicrographs of a thin section with numerous clay pellets and slit; d – PPL, e – XPL

Ryc. 15. Próbka 75, naczynie grubościenne, stanowisko Olteni; a, b – fotografia analizowanego fragmentu ceramiki; c – przełam fragmentu; d, e – mikrofotografia cienkiego szlifu, w którym widoczne są liczne grudki nie rozmieszanej gliny oraz okruchy skały mułkowej; d – 1N; e – NX

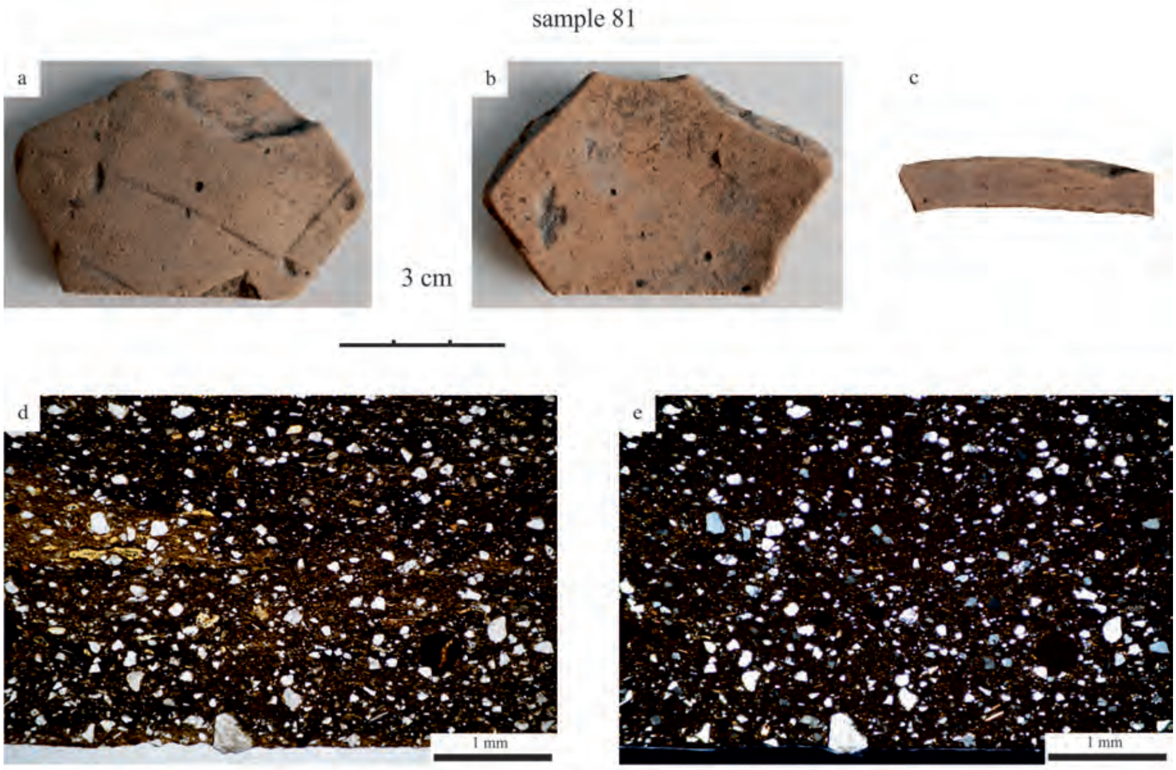

Fig. 16. Sample 81, fine ceramics, Preutești-Ciritei; a, b – photographs of the analyzed sample of pottery; c – a fresh section of the pottery; d, e – photomicrographs of a thin section with thicker grains and a poorly mixed ceramic body with no organic admixture d – PPL, e – XPL

Ryc. 16. Próbka 81, naczynie cienkościenne, stanowisko Preutești-Ciritei; a, b – fotografia analizowanego fragmentu ceramiki; c – przełam fragmentu; d, e – mikrofotografia cienkiego szlifu, w którym widoczne są grubsze ziarna krystaliczne, masa ceramiczna jest słabo wymieszana; d – 1N; e – NX

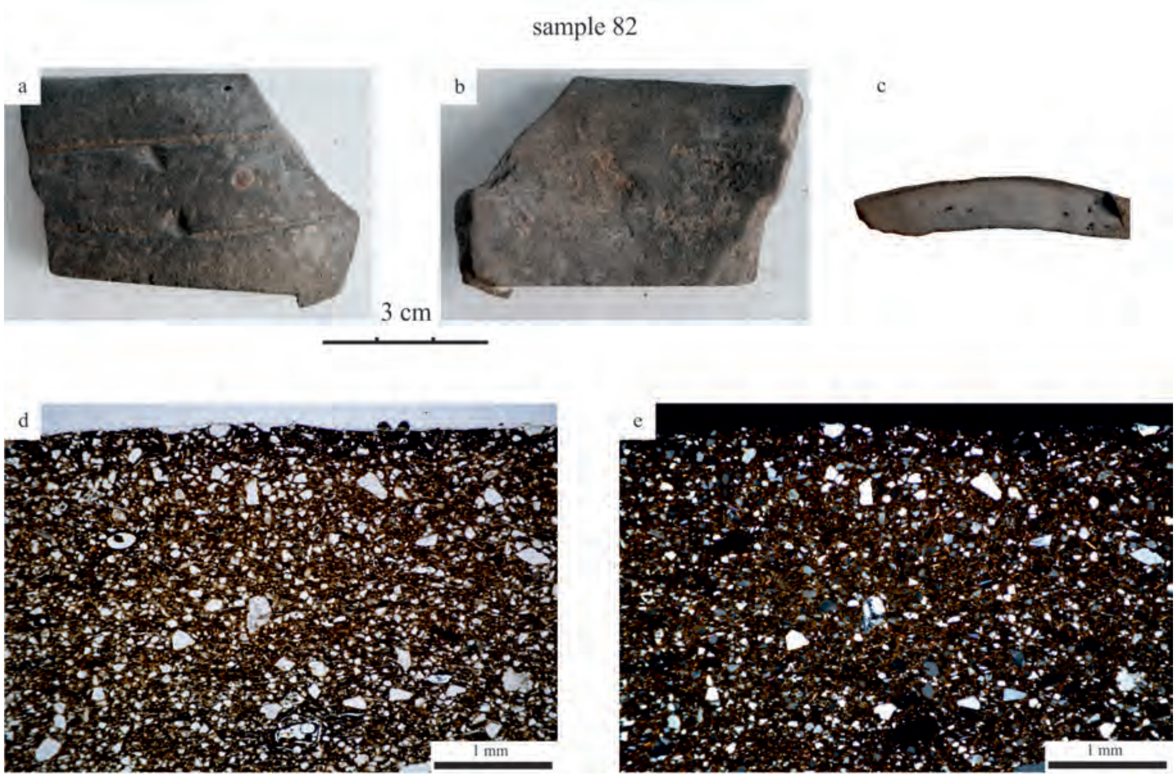

Fig. 17. Sample 82, fine ceramics, Preutești-Ciritei; a, b – photographs of the analyzed sample of pottery; c – a fresh section of the pottery; d, e – photomicrographs of a thin section with thicker grains and a ceramic body with no organic admixture; d – PPL, e – XPL

Ryc. 17. Próbka 82, naczynie cienkościenne, stanowisko Preutești-Ciritei; a, b – fotografia analizowanego fragmentu ceramiki; c – przełam fragmentu; d, e – mikrofotografia cienkiego szlifu, w którym widoczne są grubsze ziarna krystaliczne; d – 1N; e – NX

<u>Intentional temper</u>: plant material, mineral? – angular sand grains.
<u>Atmosphere and temperature of firing</u>: groundmass has the properties of reducing to oxidising firing: both surfaces are slightly oxidized and the core is dark grey; the approximate temperature of firing was 700–750°C.
<u>Comments</u>: ceramic paste is moderately mixed, porous, with a significant admixture of organic material (1.9%).
PG: Isa 2, clay with carbonates, including fine particles of micrite and bioclasts.
FT: Ia, coarse-grained with organic temper.

Sample 73 (Fig. 11), thick-walled ceramics
<u>Matrix</u> (d<0.05 mm): brown in PPL, brown-orange in XPL; optical active, consisting of clayey groundmass with an admixture of fine micrite (60.3%), silty fraction (12.2%) and micaceous minerals (1.8%). Flakes of muscovite are not altered. Concentrations (up to 0.1 mm) of iron oxides or hydroxides are rare.
<u>Inclusion</u> (d>0.05 mm), (8.4%): the mineralogical composition includes moderately sorted angular to sub-angular grains of quartz (5.4%), feldspars (1.5%) and opaque (0.3%). The grains do not exceed 0.15 mm; most of them range from 0.05 to 0.1 mm and only few (on slide) have 0.1–0.2 mm. Carbonate components, mainly dispersed fine micrite particles (approx. 0.05 mm) and angular calcite grains (approx. 0.05–0.13 mm), are common (0.9%). The clay contains visible bioclasts (relics of Foraminifera?). Clay clast saturated with iron oxides and hydroxides has been identified in the paste. The clay also includes very infrequent rutile grains.
<u>Lithoclasts</u>: absent.
<u>Secondary</u>: numerous carbonates in voids created by the destruction of plant material.
<u>Intentional temper</u>: plant material (4.2%).
<u>Atmosphere and temperature of firing</u>: groundmass has the properties of reducing to oxidising firing: both surfaces are slightly oxidized and the core is dark grey; the approximate temperature of firing was 700–750°C.
<u>Comments</u>: well mixed and fine-grained with a very small amount of bigger (>0.1 mm) grains. The clay paste is very similar to that of sample 74.
PG: Isa 2, clay with carbonates, including fine particles of micrite and bioclasts.
FT: Ia with some properties of IIc (fine-grained), homogenous, with a small amount of bigger grains, porous (9.2%), with a significant amount of plant admixture.

Sample 74 (Fig. 28), thick-walled ceramics
<u>Matrix</u> (d<0.05 mm): dark brown in PPL, not uniformly colored: dark brown and yellow, in XPL; optical active, consisting of clayey groundmass with an admixture of fine micrite (66.7%), silty fraction (10.6%) and micaceous minerals (1.4%). Flakes of muscovite tend to be partly altered. Concentrations(up to 0.1 mm) of iron oxides or hydroxides are rare.
<u>Inclusion</u> (d>0.05 mm), (18.3%): the mineralogical composition includes moderately sorted angular to sub-angular grains of quartz (5%), feldspars (3.1%) and opaque (1.4%). The grains do not exceed 0.15 mm; most of them range from 0.05 to 0.1 mm, and only few (on slide) from 0.1 to 0.15 mm. Carbonate components, mainly dispersed fine micrite particles (>0.05 mm; bigger ones are very rare), are common (8.6%), whereas calcite grains are extremely rare. The clay contains visible bioclasts (small shell fragments and relics of Foraminifera?).
<u>Lithoclasts</u>: absent.
<u>Secondary</u>: numerous carbonates in voids created by the destruction of plant material.
<u>Intentional temper</u>: plant material (2%).
<u>Atmosphere and temperature of firing</u>: groundmass has the properties of reducing to oxidising firing: both surfaces are slightly oxidized and the core is dark grey; the approximate temperature of firing was 750–800°C.
<u>Comments</u>: well mixed, fine-grained with a very small amount of bigger (>0.1 mm) grains. Close to the surface, there are intensive secondary crystallizations of carbonates, always located in voids created by the destruction of plant material.
PG: Isa 2, clay with carbonates, including fine particles of micrite and bioclasts.
FT: IIc, fine-grained, homogenous with a small amount of bigger grains; numerous voids created by the destruction of plant material are filled with secondary carbonates; a significant amount of plant admixture.

Site Olteni, (Bodoc commune, Covasna county) (N=4) 75–78
Sample 75 (Fig. 15), thick-walled ceramics
<u>Matrix</u> (d<0.05 mm): dark orange in PPL, dark orange in XPL; optical inactive, consisting of clayey groundmass saturated with iron oxides and hydroxides (46.5%), silty fraction (7.9%), micaceous minerals (1.1%) and very infrequent heavy minerals. Flakes of muscovite tend to be partly altered. Concentrations (up to 0.1 mm) of iron oxides or hydroxides are rare.
<u>Inclusion</u> (d>0.05 mm), (18.3%): the mineralogical composition includes poorly sorted angular to sub-angular grains of quartz (4.2%), feldspars (2.5%) and opaque (2.3%). The maximum grain size does not exceed 1.5 mm. Most grains range from 0.05 to 0.1 mm, few per cent are bigger (0.1–0.5 mm), and only isolated grains (on slide) are bigger than 1 mm. The paste also contains angular grains of amphiboles (probably hornblende), flakes of muscovite and biotite, and infrequent grains of heavy minerals.
<u>Lithoclasts</u>: rounded claystone, sometimes intensively saturated by iron oxides and hydroxides, mudstone with a higher content of mica flakes (max. >2 mm) and angular sandstone with iron cement (max. >1 mm) are common, while angular fragments of volcanic rock (approx. 0.2 mm) and fragments of plutonic rock (approx. 0.2–0.5 mm) are infrequent.
<u>Secondary</u>: absent.
<u>Intentional temper</u>: plant material (4.5%) and fragments of sedimentary rock.
<u>Atmosphere and temperature of firing</u>: groundmass has the properties of reducing to oxidising firing: both surfaces are slightly oxidized and the core is dark grey; the approximate temperature of firing was 750°C.
<u>Comments</u>: heterogeneous, poorly mixed, with sedimentary rock being probably an intentional admixture.
PG: Olt 1, fragments of sedimentary rock (claystone and sandstone) dominating, few fragments of igneous (volcanic and plutonic) rock, mafic minerals.
FT: Ib, coarse-grained with fragments of sedimentary rock and a plant admixture.

Sample 76 (Fig. 12), thick-walled ceramics
Matrix (d<0.05 mm): dark brown in PPL, brown-orange in XPL; optical active, consisting of clayey groundmass (55.7%), silty fraction (14%), micaceous minerals (0.9%) and infrequent heavy minerals. Flakes of muscovite tend to be partly altered. Concentrations (up to 0.1 mm) of iron oxides or hydroxides are rare.
Inclusion (d>0.05 mm), (15.9%): the mineralogical composition includes poorly sorted angular to sub-rounded grains of quartz (9.7%), feldspars, also plagioclases (1.7%), amphiboles (up to 0.3 mm), muscovite (up to 0.2 mm), biotite, heavy minerals and opaque (0.3%). Titano-magnetite minerals have been identified with the use of SEM-EDS.
Lithoclasts: sub-rounded grains of volcanic rock (max. 0.7 mm), infrequent rounded fragments of sedimentary rock (mudstone and claystone), very infrequent metamorphic mica schist grains.
Secondary: absent.
Intentional temper: plant material (4.3%).
Atmosphere and temperature of firing: groundmass has the properties of reducing to oxidising firing: both surfaces are slightly oxidized and the core is dark grey; the approximate temperature of firing was 750–800°C.
Comments: ceramic paste includes areas of clay with no organic temper, possibly the primary raw material. It is characterized by the same petrographic content and grain size distribution, with frequent quartz, feldspars, micaceous minerals, amphiboles and volcanic rock fragments.
PG: Olt 2, fragments of volcanic rock, mafic minerals, heavy minerals.
FT: Ia, coarse-grained, poorly mixed with a great amount of organic temper, porous (voids created by the destruction of plant material 7.7%).

Sample 77 (Fig. 19), thin-walled ceramics
Matrix (d<0.05 mm): brown in PPL, brown-yellow in XPL; optical active, consisting of clayey micaceous groundmass (55.7%), silty fraction (20%), micaceous minerals (9.8%) and concentrations (1.8%) of iron oxides or hydroxides. Heavy minerals are rare. Flakes of muscovite tend to be partly altered.
Inclusion (d>0.05 mm), (7.6%): the mineralogical composition includes moderately sorted angular to sub-angular grains of quartz (3.3%), feldspars (1.8%), thin flakes of muscovite (up to 0.5 mm), biotite (up to 0.1 mm), heavy minerals and opaque (0.4%). Amphiboles (up to 0.13 mm) are very rare; their content cannot be measured by the method used here.
Lithoclasts: sub-rounded grains of volcanic rock consisting of very fine-grained matrix with phenocrystals (max. 0.6 mm), infrequent rounded fragments of sedimentary rock (claystone), very infrequent fragments of plutonic rock consisting of quartz, feldspars and mica minerals, probably granite.
Secondary: absent.
Intentional temper: absent.
Atmosphere and temperature of firing: groundmass has the properties of reducing firing: both surfaces and the core are dark grey; the approximate temperature of firing was 750–800°C.
Comments: very homogenous, uniform and compact (voids 1.4%) ceramic paste, well prepared. The raw material may have been deprived of thicker grains.
PG: Olt 2, fragments of volcanic rock, mafic minerals, heavy minerals.
FT: IIa, homogeneous, compact with no organic admixture.

Sample 78 (Fig. 20), thin-walled ceramics
Matrix (d<0.05 mm): light brown in PPL, gray-yellow in XPL; optical active, consisting of clayey groundmass (57.6%), silty fraction (11.8%), micaceous minerals (mostly fine biotite flakes, 7%), concentrations of iron oxides or hydroxides and opaque. Heavy minerals are rare. Flakes of mica tend to be partly altered.
Inclusion (d>0.05 mm), (15.1%): the mineralogical composition includes moderately sorted angular to sub-angular grains of quartz (few grains of polycrystalline quartz, 8.6%), feldspars (5%), thin flakes of muscovite (up to 0.15 mm), biotite (up to 0.2 mm) and opaque (1%). Heavy minerals (including rutile) and amphiboles (up to 0.07 mm) are very rare; their content cannot be measured by the method used here. Most grains range from 0.05 to 0.1 mm; rougly a few per cent are bigger than 0.1 mm, with the maximum of 0.3 mm.
Lithoclasts: infrequent rounded claystone saturated with iron oxides and hydroxides (up to 0.7 mm).
Secondary: absent.
Intentional temper: one fragment of a plant.
Atmosphere and temperature of firing: groundmass has the properties of reducing to oxidising firing: both surfaces are slightly oxidized and the core is light grey; the approximate temperature of firing was 750–800°C.
Comments: the ceramic paste is very homogenous and uniform with parallel structure, compact (voids 1.5%), well prepared. The raw material may have been deprived of thicker grains. One well rounded grain of a different raw material has been identified.
PG: Olt 3, fine-grained with no fragments of volcanic rock.
FT: IIa, homogeneous, compact with no organic admixture.

Site Mihoveni, (Șcheia commune, Suceava county) (N=2) 79–80
Sample 79 (Fig. 21), thin-walled ceramics
Matrix (d<0.05 mm): small opaque dots (0.01 mm) in the light yellow clay body in PPL, black in XPL; optical active, consisting of clayey groundmass (68.7%), silty fraction (10.3%), micaceous minerals (mostly fine muscovite flakes, 0.6%), concentrations of iron oxides or hydroxides and opaque (1.6%). Heavy minerals are rare. Flakes of mica tend to be partly altered.
Inclusion (d>0.05 mm), (17.6%): the mineralogical composition includes moderately sorted angular to sub-angular grains of quartz (12.8%), feldspars (3.5%), thin flakes of muscovite (up to 0.15 mm), biotite (up to 0.1 mm) and opaque (up to 0.07 mm). Heavy minerals, including rutile, are very rare, one sub-rounded grain of flint (0.4 mm) has been identified; the content cannot be measured by the method used here. Most grains range from 0.05 to 0.15 mm; only few reach the size of approx. 0.2 mm.
Lithoclasts: infrequent rounded claystone consisting of the same clay as the surrounding matrix (up to 0.7 mm), very infrequent mica schist (up to 0.25 mm).
Secondary: absent.
Intentional temper: absent.
Atmosphere and temperature of firing: groundmass has the properties of reducing to oxidising firing: both surfaces are slightly oxidized and the core is light grey; the approximate temperature of firing was 850°C; the beginnings of the vitrification process.
Comments: ceramic paste is very homogenous and uniform, compact (voids is 0.3%) with semi-parallel structure, well

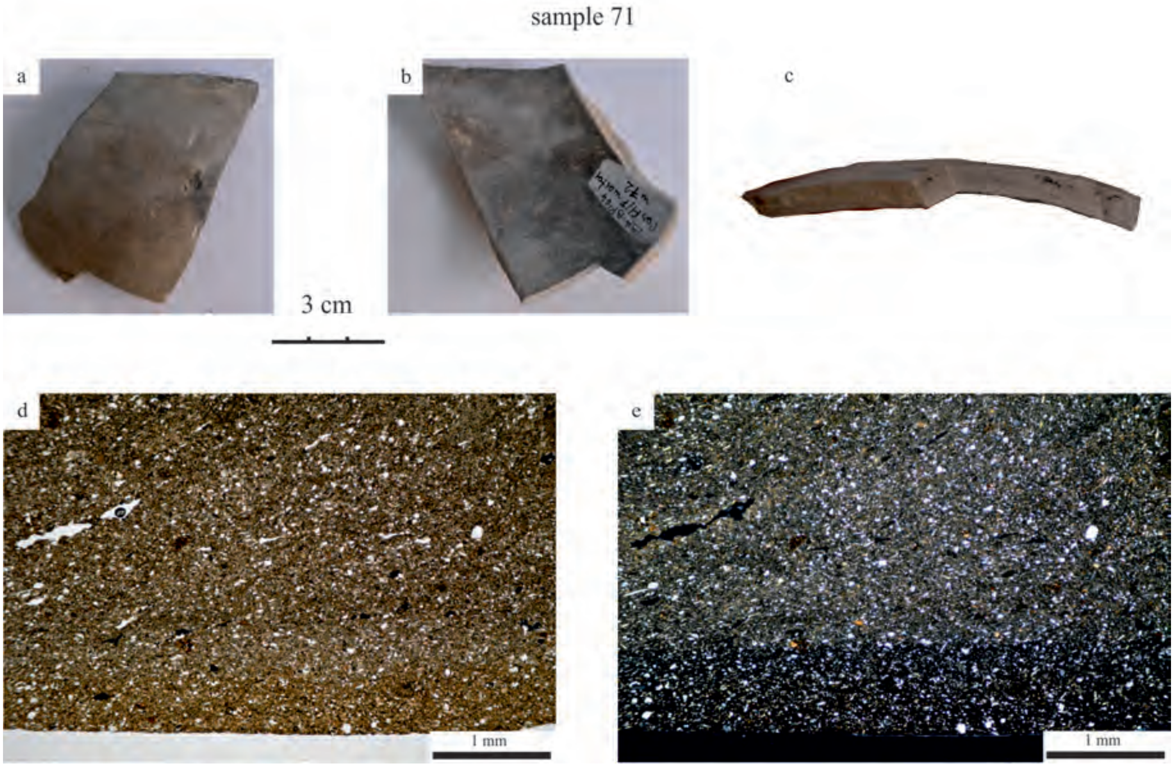

Fig. 18. Sample 71, fine ceramics, Isaiia; a, b – photographs of the analyzed sample of pottery; c – a fresh section of the pottery; d, e – photomicrographs of a thin section with a fine-grained, homogeneous, compact ceramic body; d – PPL, e – XPL

Ryc. 18. Próbka 71, naczynie cienkościenne, stanowisko Isaiia; a, b – fotografia analizowanego fragmentu ceramiki; c – przełam fragmentu; d, e – mikrofotografia cienkiego szlifu, masa ceramiczna jest drobnoziarnista, jednorodna i zwarta; d – 1N; e – NX

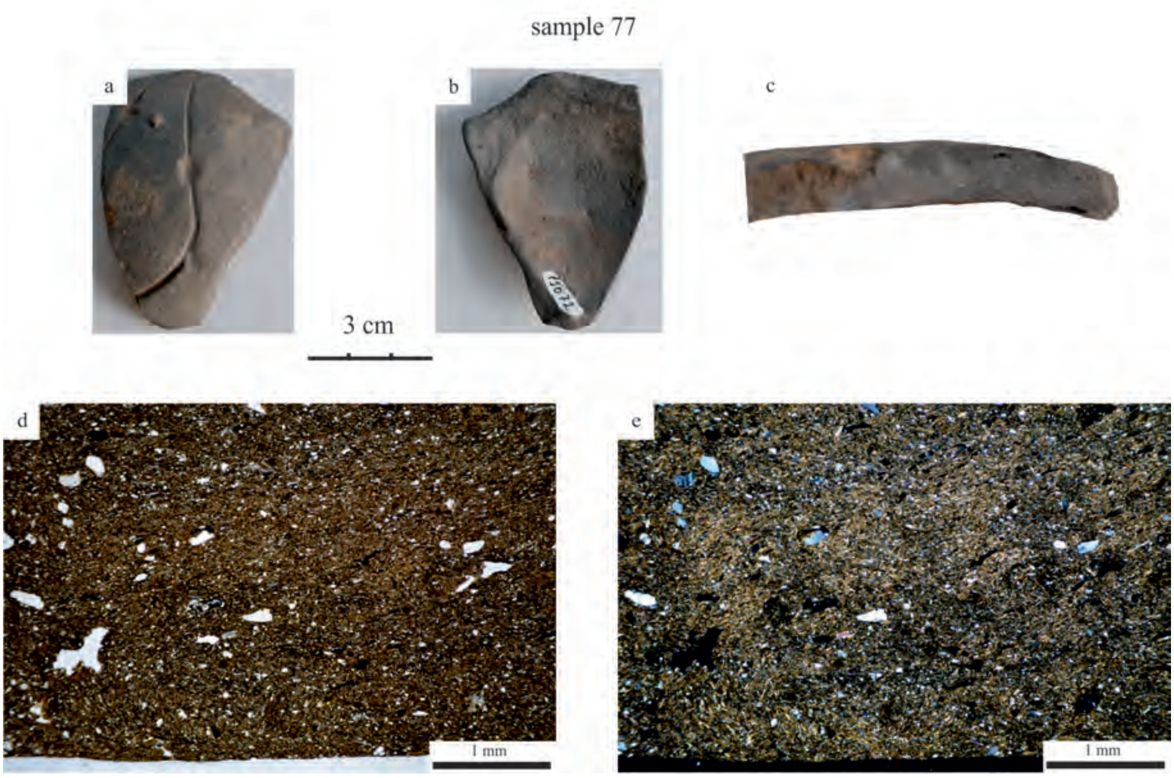

Fig. 19. Sample 77, fine ceramics, Olteni; a, b – photographs of the analyzed sample of pottery; c – a fresh section of the pottery; d, e – photomicrographs of a thin section with a fine-grained, homogeneous ceramic body with a small amount of coarser grains and with no organic admixture; d – PPL, e – XPL

Ryc. 19. Próbka 77, naczynie cienkościenne, stanowisko Olteni; a, b – fotografia analizowanego fragmentu ceramiki; c – przełam fragmentu; d, e – mikrofotografia cienkiego szlifu, masa ceramiczna jest drobnoziarnista, jednorodna z niewielką zawartością grubszych ziaren; d – 1N; e – NX sample 78

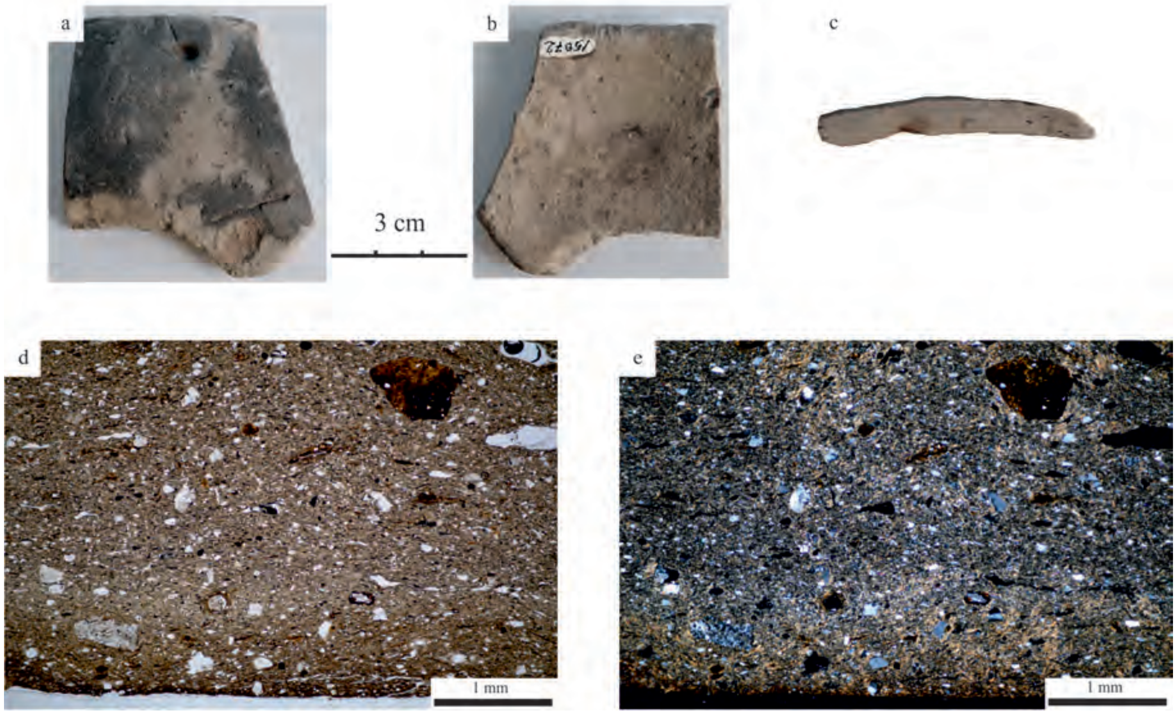

Fig. 20. Sample 78, fine ceramics, Olteni; a, b – photographs of the analyzed sample of pottery; c – a fresh section of the pottery; d, e – photomicrographs of a thin section with a fine-grained, homogeneous ceramic body with a small amount of coarser grains and with no organic admixture; d – PPL, e – XPL

Ryc. 20. Próbka 78, naczynie cienkościenne, stanowisko Olteni; a, b – fotografia analizowanego fragmentu ceramiki; c – przełam fragmentu; d, e – mikrofotografia cienkiego szlifu, masa ceramiczna jest drobnoziarnista, jednorodna z niewielką zawartością grubszych ziaren; d – 1N; e – NX

sample 79

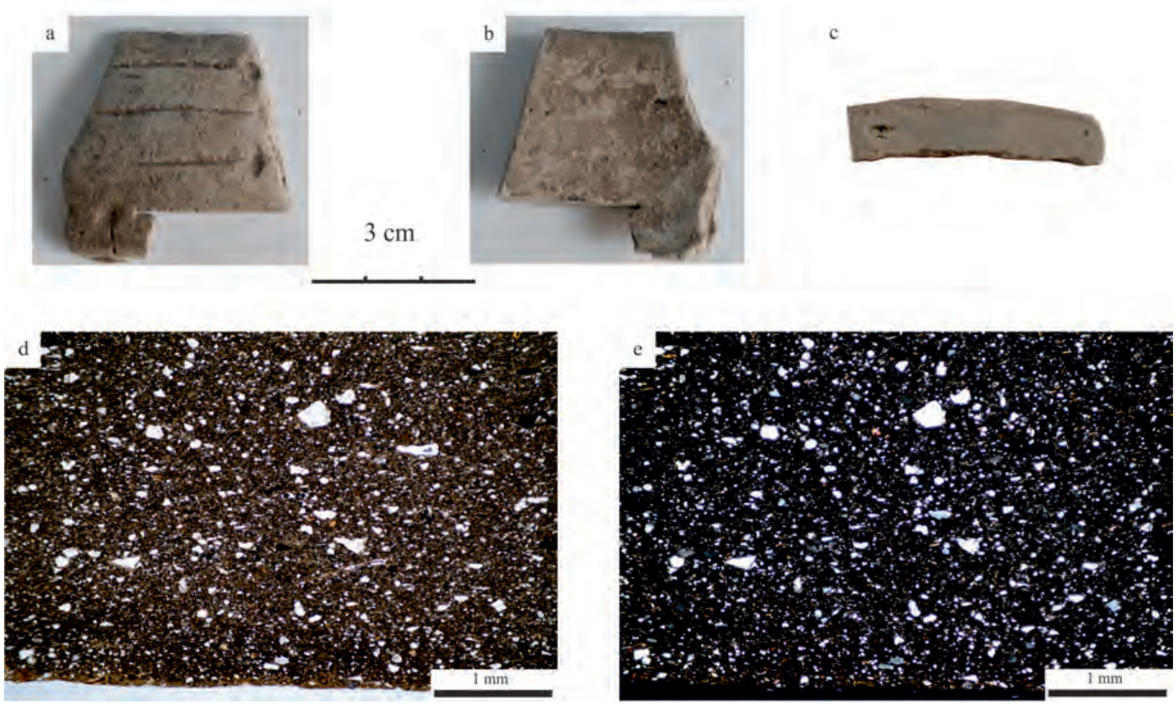

Fig. 21. Sample 79, fine ceramics, Mihoveni; a, b – photographs of the analyzed sample of pottery; c – a fresh section of the pottery; d, e – photomicrographs of a thin section with a fine-grained, homogeneous ceramic body with a small amount of coarser grains and with no organic admixture; d – PPL, e – XPL

Ryc. 21. Próbka 79, naczynie cienkościenne, stanowisko Mihoveni; a, b – fotografia analizowanego fragmentu ceramiki; c – przełam fragmentu; d, e – mikrofotografia cienkiego szlifu, masa ceramiczna jest drobnoziarnista, jednorodna z niewielką zawartością grubszych ziaren; d – 1N; e – NX

prepared. The raw material may have been deprived of thicker grains.
PG: Mih 1, fine-grained clay, moderately sorted, with dominant angular to sub-angular grains of quartz and feldspars.
FT: IIa, homogeneous, compact with no organic admixture.

Sample 80 (Fig. 29), thick-walled ceramics
Matrix (d<0.05 mm): brown in PPL, dark gray-yellow in XPL; optical active, consisting of clayey micaceous groundmass (53.7%), silty fraction (16.3%), micaceous minerals (mostly fine muscovite flakes, 3.4%), concentrations of iron oxides or hydroxides, and opaque (1.2%). Heavy minerals are rare. Flakes of mica tend to be partly altered.
Inclusion (d>0.05 mm), (12.8%): the mineralogical composition includes moderately sorted angular to sub-angular grains of quartz (9%), feldspars (2.9%), thin flakes of muscovite and biotite (up to 0.15 mm), and opaque (up to 0.05 mm). Heavy minerals, including rutile, are very rare and there are few sub-rounded flint grains (0.1 mm); their content cannot be measured by the method used here. Most grains range from 0.05 to 0.15 mm. Only few grains reach the size of approx. 0.2 mm.
Lithoclasts: absent.
Secondary: absent.
Intentional temper: abundant plant material.
Atmosphere and temperature of firing: groundmass has the properties of reducing to oxidising firing: the external surfaces are oxidized and the core is grey; the approximate temperature of firing was 800–850°C.
Comments: ceramic paste is homogenous and uniform with chaotic structure, porous (voids 8%), well prepared and well mixed. The raw material may have been deprived of thicker grains.
PG: Mih 1, fine-grained clay, moderately sorted with dominant angular to sub-angular grains of quartz and feldspars.
FT: IIc, homogeneous, uniform, porous with an organic admixture.

Site Preutești-Ciritei, (Preutești commune, Suceava county) (N=2) 81–82
Sample 81 (Fig. 16), thin-walled ceramics
Matrix (d<0.05 mm): brown-orange in PPL, very dark orange in XPL; optical active, consisting of clayey groundmass (70.5%), and small amounts of silty fraction (2.3%) and of micaceous minerals (0.3%). Concentrations of iron oxides or hydroxides and opaque are common. Heavy minerals are rare. Flakes of mica tend to be partly altered.
Inclusion (d>0.05 mm), (20.1%): the mineralogical composition includes moderately sorted angular to sub-angular grains of monocrystalline quartz (13.3%), feldspars (4.9%), thin flakes of muscovite and biotite (up to 0.15 mm), and opaque (up to 0.05 mm). Heavy minerals are very rare and there are few sub-angular flint or chalcedony grains (0.1–0.25 mm); their content cannot be measured by the method used here. Most grains range from 0.05 to 0.2 mm. The maximum grain size is 0.3 mm.
Lithoclasts: rare sub-angular fragments of igneous rock and sub-rounded fragments of claystone (saturated with iron oxides and hydroxides).
Secondary: iron oxides and hydroxides, usually in voids.
Intentional temper: sand?
Atmosphere and temperature of firing: groundmass has the properties of oxidising firing: the surfaces and the core are orange; the approximate temperature of firing was 850°C.
Comments: ceramic paste, containing very few grains of silty fraction, is characterized by the equal dispersion of grains of sand (0.05–0.2 mm) in the clay. The ceramic paste is compact with parallel structure (voids 2.3%).
PG: Pre 1, a small amount of silty fraction and micaceous minerals, coarse fraction consisting of quartz and feldspars.
FT: Ic, coarse-grained with no organic temper.

Sample 82 (Fig. 17), thin-walled ceramics
Matrix (d<0.05 mm): brown in PPL, brown-orange in XPL; optical active, consisting of clayey groundmass (50.4%) with a small amount of silty fraction (8%) and of micaceous minerals (2.1%). Concentrations of iron oxides or hydroxides and opaque are common. Heavy minerals are rare. Flakes of mica tend to be partly altered.
Inclusion (d>0.05 mm), (36.1%): the mineralogical composition includes sorted angular to sub-rounded grains of monocrystalline and sometimes polycrystalline quartz (24.5%), feldspars (7.2%), thin flakes of muscovite and biotite (up to 0.2 mm), and opaque (up to 0.07 mm). Heavy minerals are very rare; their content cannot be measured by the method used here. Most grains range from 0.05 to 0.2 mm. The maximum grain size is 0.4 mm.
Lithoclasts: infrequent sub-angular fragments of igneous or metamorphic rock.
Secondary: absent.
Intentional temper: sand?
Atmosphere and temperature of firing: groundmass has the properties of reducing firing: the surfaces and the core are dark; the approximate temperature of firing was 800°C.
Comments: ceramic paste, containing few grains of silty fraction, is characterized by grains of sand (0.05–0.3 mm) dispersed equally in the clay. The paste is homogeneous, with parallel structure, well prepared and compact (voids 2.8%).
PG: Pre 1, a small amount of silty fraction and micaceous minerals; well sorted coarse fraction consisting of quartz and feldspars.
FT: Ic, coarse-grained with no organic temper.

Site Traian-Dealul Fântânilor, (Zănești commune, Neamț county) (N=5) 83–87
Sample 83 (Fig. 31), thin-walled ceramics?
Matrix (d<0.05 mm): brown in PPL, dark brown in XPL; optical active, consisting of clayey micaceous groundmass (52%) and a small amount of silty fraction (7%). Heavy minerals are rare.
Inclusion (d>0.05 mm), (12.1%): the mineralogical composition includes sorted angular to sub-rounded grains of monocrystalline, sometimes polycrystalline quartz (7%), feldspars (3%), thin flakes of muscovite and biotite (up to 0.2 mm), and opaque (up to 0.07 mm). Heavy minerals are very rare. Most grains ranges from 0.05 to 0.12 mm. The maximum grain size is 0.53 mm.
Lithoclasts: few elongated rounded grains of micrite (max. 0.5 mm), infrequent sub-angular fragments of igneous or metamorphic rock.
Secondary: secondary calcite and iron oxides or hydroxides in voids.
Intentional temper: grog temper (12.6%), very infrequent organic fragments distributed unevenly in the clay (mostly empty spaces).

Atmosphere and temperature of firing: groundmass has the properties of reducing to oxidising firing: the surfaces are oxidized and the core is grey; the approximate temperature of firing was 850°C.
Comments:
PG: Tra 1a, fine-grained, well sorted with micrite and fragments of metamorphic or igneous rock.
FT: IId, fine-grained with grog temper and with trace amounts of organic material.

Sample 84 (Fig. 22), thin-walled ceramics
Matrix (d<0.05 mm): dark gray in PPL, black in XPL; optical inactive in part, consisting of clayey groundmass (81.1%), and small amounts of silty fraction (6.5%) and of micaceous minerals (2.7%); concentrations of iron oxides or hydroxides and opaque are common. Very fine particles of carbonates, distributed within the clay, are visible in some areas of the clayey mass. Heavy minerals are rare. Flakes of mica tend to be partly altered.
Inclusion (d>0.05 mm), (6.1%): the mineralogical composition includes sorted angular to sub-rounded grains of monocrystalline quartz (3%), feldspars (1.2%), thin flakes of muscovite or biotite (up to 0.2 mm), and opaque (up to 0.1 mm). Heavy minerals are very rare (0.3%). No crystalline inclusion exceeds 0.15 mm.
Lithoclasts: few elongated rounded grains of micrite (max. 0.7 mm).
Secondary: absent.
Intentional temper: absent.
Atmosphere and temperature of firing: groundmass has the properties of reducing firing: the surfaces and the core are grey; the approximate temperature of firing was >850°C.
Comments: ceramic paste, containing a very small amount of grains of silty fraction, has also a very small amount of coarse inclusion. The paste is homogeneous, with parallel structure, well prepared and compact (voids 0.6%).
PG: Tra 1b, very fine-grained, well sorted with lithoclasts (micrite).
FT: IIa, homogeneous, compact with no organic admixture.

Sample 85 (Fig. 30), thin-walled ceramics
Matrix (d<0.05 mm): light brown in PPL, dark gray-yellow in XPL; optical active, consisting of clayey micaceous groundmass (58.2%), a significant amount of silty fraction (16.1%) and micaceous minerals (3.5%). Concentrations of iron oxides or hydroxides and opaque are common. Heavy minerals are rare. Flakes of mica tend to be partly altered.
Inclusion (d>0.05 mm), (13.3%): the mineralogical composition includes moderately sorted angular to sub-rounded grains of monocrystalline quartz (6.9%), feldspars (4%), thin flakes of muscovite and biotite (up to 0.15 mm), and opaque (up to 0.06 mm). Angular grains of heavy minerals are very rare (0.3%). Crystalline inclusions are approx. 0.25–0.3 mm in diameter and do not exceed 0.8 mm (one grain).
Lithoclasts: few sub-angular to sub-rounded fragments of metamorphic rock (up to 0.3 mm), usually fine-grained mica schist, and rounded clay clasts similar to the clay matrix (approx. 0.5 mm). Clay clasts saturated with iron compounds are smaller, approx. 0.2 mm. The clay contains one bigger (0.8 mm) sub-rounded fragment of sedimentary rock composed of fine (0.02–0.1 mm) grains of quartz, feldspars, mica and opaque minerals.
Secondary: iron oxides and hydroxides.
Intentional temper: a small amount of plant admixture (1.7%).
Atmosphere and temperature of firing: groundmass has the properties of reducing firing: the surfaces and the core are grey; the approximate temperature of firing was 750°C.
Comments: ceramic paste has strong parallel structure visible in the arrangement of mineral flakes and elongated voids. The paste contains bigger crystalline grains and clasts of unmixed clay. Due to the destruction of organic material, few voids have been recorded (2.9%).
PG: Tra 2, clayey-micaceous groundmass, sorted metamorphic rock grains, no carbonates.
FT: IIc with some properties of Ib (coarse grains), moderately sorted with a small amount of plant admixture, medium mixed, rather compact.

Sample 86 (Fig. 13), thick-walled ceramics
Matrix (d<0.05 mm): brown in PPL, dark brown in XPL; optical active, consisting of clayey micaceous groundmass (52.3%), a significant amount of silty fraction (10.5%) and micaceous minerals (1.5%); iron oxide or hydroxide concentrations and grains, and opaque minerals are not common. Heavy minerals are rare. Flakes of mica tend to be partly altered.
Inclusion (d>0.05 mm), (24.6%): the mineralogical composition includes poorly sorted angular to sub-rounded grains of monocrystalline quartz (13.2%), feldspars (9%), thin flakes of muscovite and biotite (up to 0.1 mm) and opaque (up to 0.06 mm). Angular grains of heavy minerals are very rare (0.3%). Crystalline inclusions have the diameter of approx. 0.1–0.2 mm and they do not exceed 0.4 mm (one grain).
Lithoclasts: few sub-angular to sub-rounded fragments of metamorphic rock (up to 0.4 mm); some grains are identified as fine-grained schist and mica schist. Clay clasts saturated with iron compounds are small, approx. 0.1 mm.
Secondary: very infrequent iron oxides and hydroxides in voids created by the destruction of plant material.
Intentional temper: a small amount of plant admixture (1.8%).
Atmosphere and temperature of firing: groundmass has the properties of reducing firing: the surfaces and the core are grey; the approximate temperature of firing was 750°C.
Comments: ceramic paste has chaotic structure. It contains bigger crystalline grains. Due to the destruction of organic material, a significant number of voids has been recorded (8.4%).
PG: Tra 2, clayey-micaceous groundmass, sorted metamorphic rock grains, no carbonates.
FT: Ia, coarse-grained, poorly mixed, porous (voids 8.4%) with organic temper.

Sample 87 (Fig. 23), thin-walled ceramics
Matrix (d<0.05 mm): light brown in PPL, dark gray-yellow in XPL; optical active, consisting of clayey micaceous groundmass (60%), a significant amount of silty fraction (20%), and micaceous minerals (3.2%); concentrations and grains of iron oxides or hydroxides and opaque minerals are uncommon. Heavy minerals are rare. Flakes of mica tend to be partly altered. Layers of very fine-grained carbonate clay with no clastic material are visible in some places.

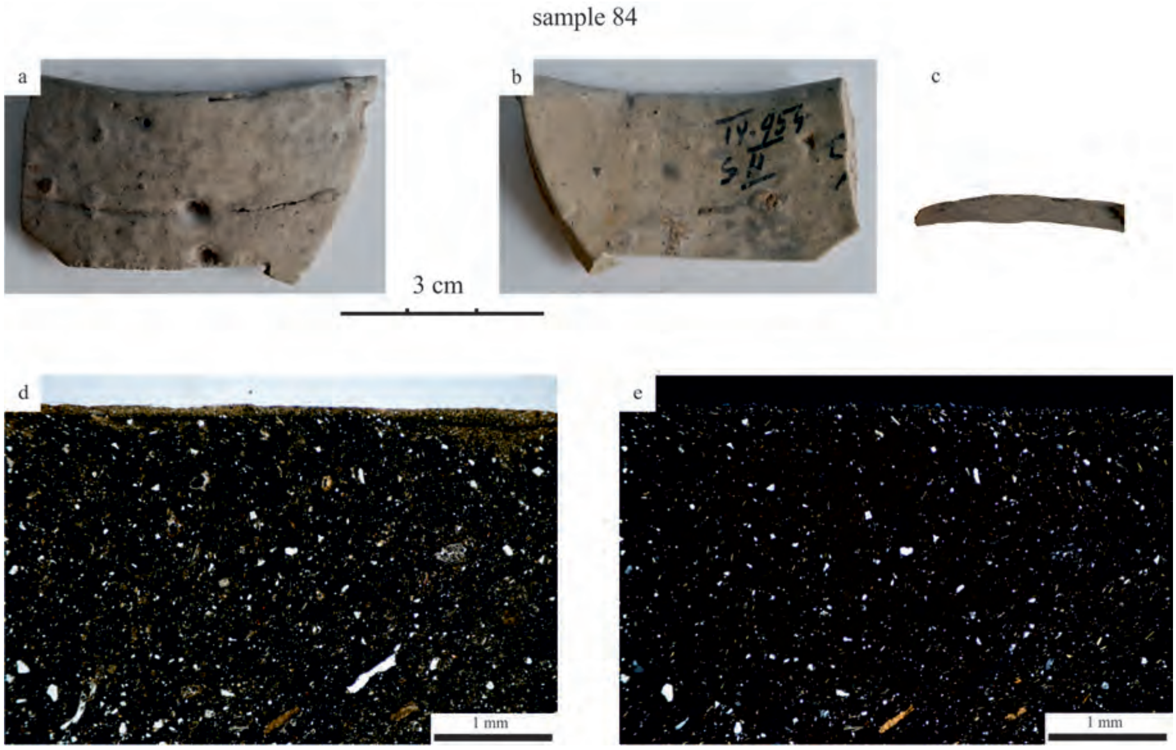

Fig. 22. Sample 84, fine ceramics, Traian-Dealul Fântânilor; a, b – photographs of the analyzed sample of pottery; c – a fresh section of the pottery; d, e – photomicrographs of a thin section with a fine-grained, homogeneous, compact ceramic body after strong firing, with no organic admixture; d – PPL, e – XPL

Ryc. 22. Próbka 84, naczynie cienkościenne, stanowisko Traian-Dealul Fântânilor; a, b – fotografia analizowanego fragmentu ceramiki; c – przełam fragmentu; d, e – mikrofotografia cienkiego szlifu, masa ceramiczna jest drobnoziarnista, jednorodna, zwarta, silnie wypalona; d – 1N; e – NX

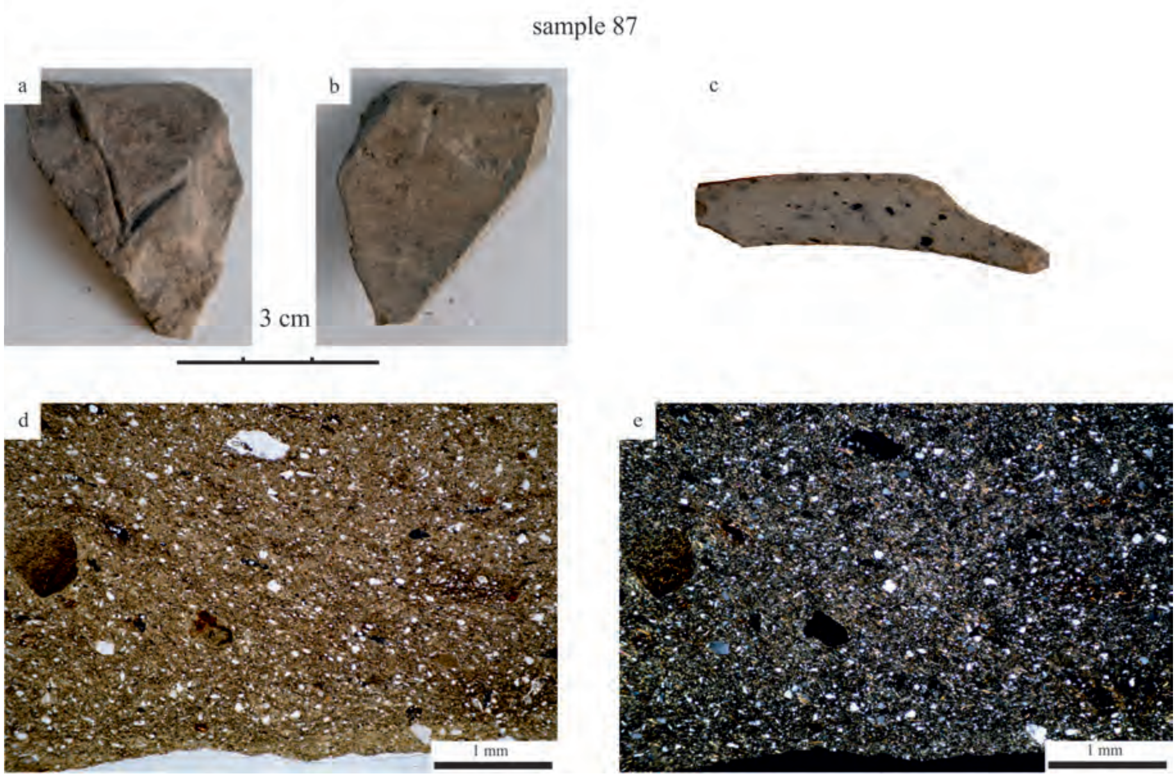

Fig. 23. Sample 87, fine ceramics, Traian-Dealul Fântânilor; a, b – photographs of the analyzed sample of pottery; c – a fresh section of the pottery; d, e – photomicrographs of a thin section with a fine-grained, homogeneous, compact ceramic body with no organic admixture; d – PPL, e – XPL

Ryc. 23. Próbka 87, naczynie cienkościenne, stanowisko Traian-Dealul Fântânilor; a, b – fotografia analizowanego fragmentu ceramiki; c – przełam fragmentu; d, e – mikrofotografia cienkiego szlifu, masa ceramiczna jest drobnoziarnista, jednorodna, zwarta; d – 1N; e – NX

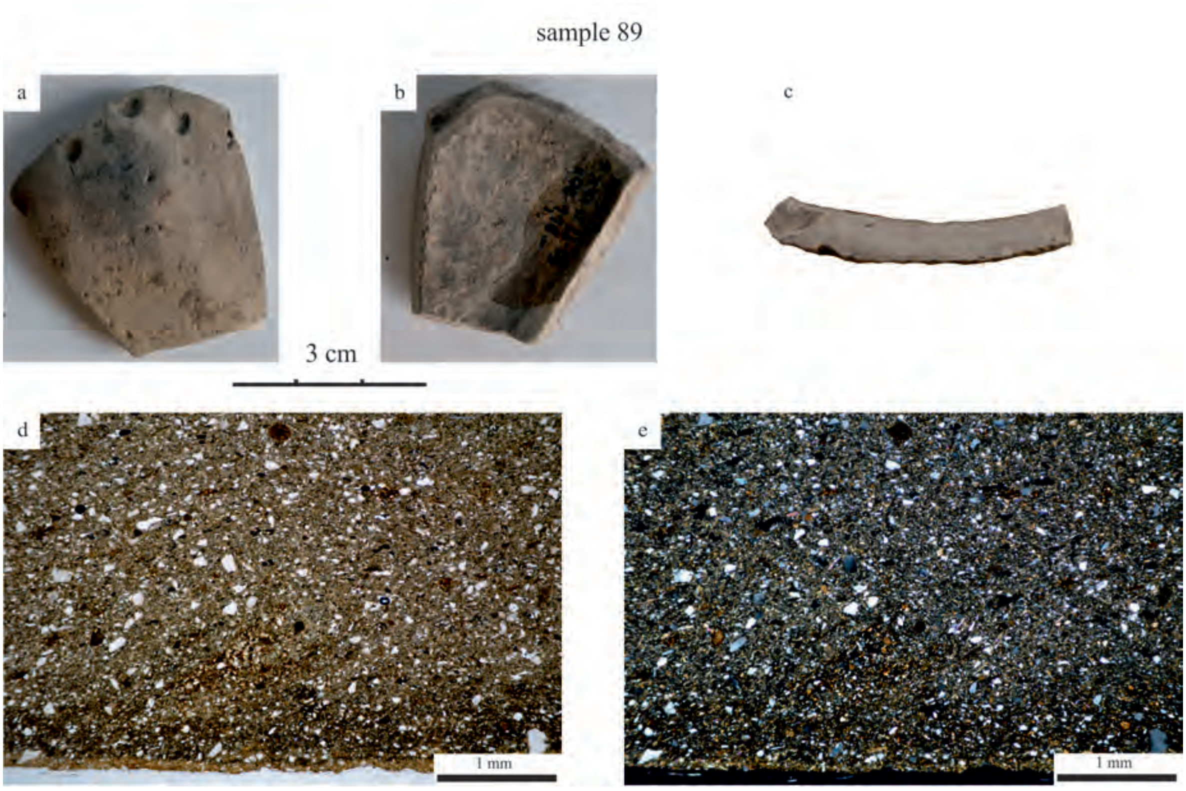

Fig. 24. Sample 89, fine ceramics, Târpeşti; a, b – photographs of the analyzed sample of pottery; c – a fresh section of the pottery; d, e – photomicrographs of a thin section with a fine-grained, homogeneous, compact ceramic body with no organic admixture; d – PPL, e – XPL

Ryc. 24. Próbka 89, naczynie cienkościenne, stanowisko Târpeşti; a, b – fotografia analizowanego fragmentu ceramiki; c – przełam fragmentu; d, e – mikrofotografia cienkiego szlifu, masa ceramiczna jest drobnoziarnista, jednorodna, zwarta; d – 1N; e – NX

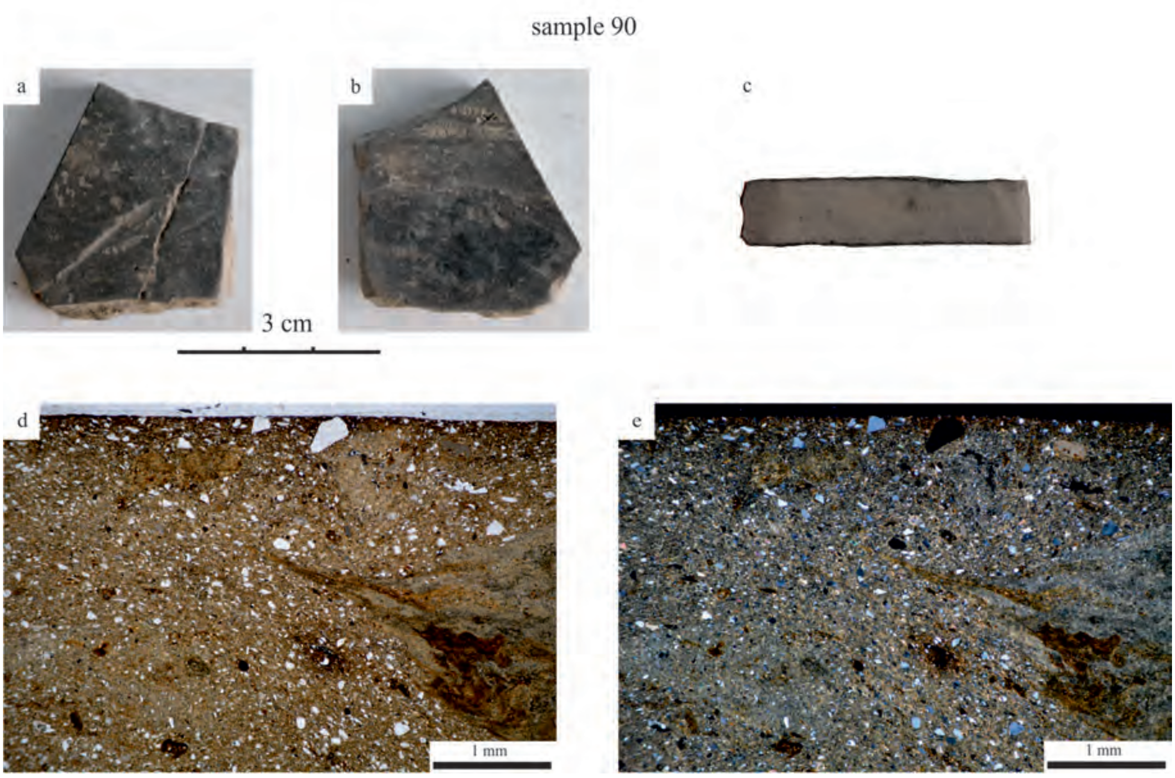

Fig. 25. Sample 90, fine ceramics, Târpeşti; a, b – photographs of the analyzed sample of pottery; c – a fresh section of the pottery; d, e – photomicrographs of a thin section with a fine-grained, homogeneous, compact ceramic body with no organic admixture; worse production of the clay mass is visible; d – PPL, e – XPL

Ryc. 25. Próbka 90, naczynie cienkościenne, stanowisko Târpeşti; a, b – fotografia analizowanego fragmentu ceramiki; c – przełam fragmentu; d, e – mikrofotografia cienkiego szlifu, masa ceramiczna jest drobnoziarnista, jednorodna, zwarta, widoczne jest gorsze wyrobienie masy; d – 1N; e – NX

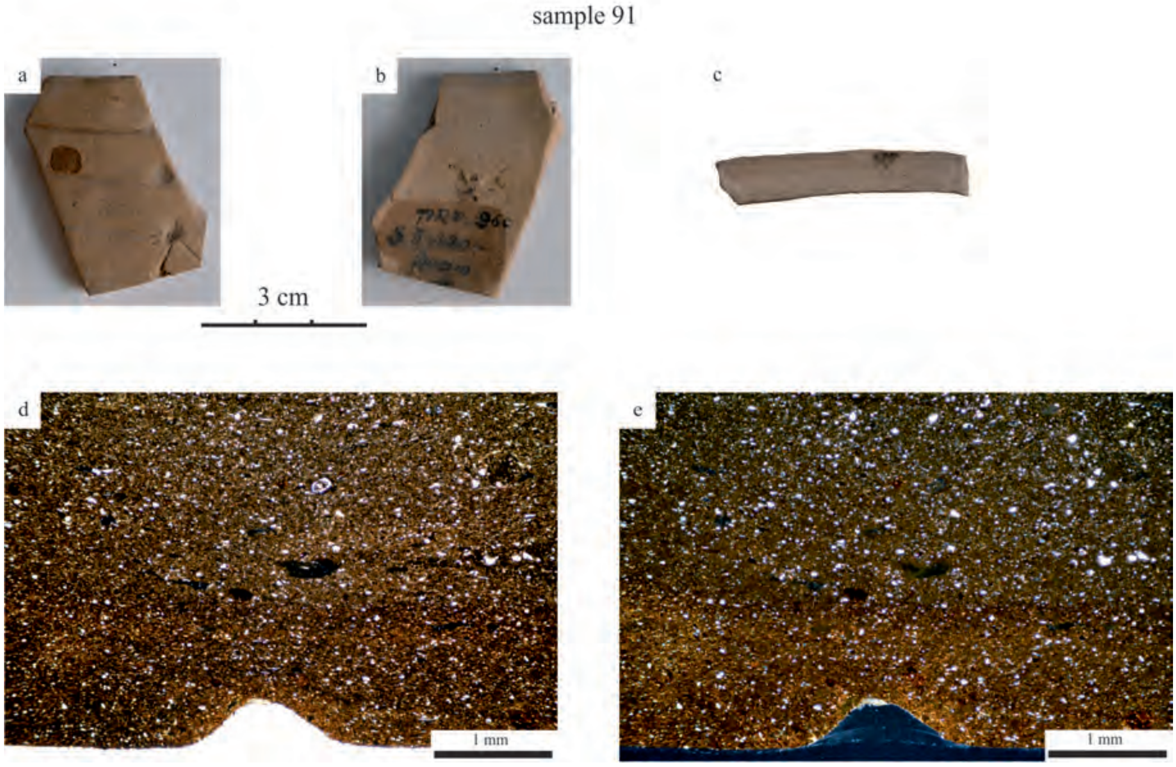

Fig. 26. Sample 91, fine ceramics, Târpeşti; a, b – photographs of the analyzed sample of pottery; c – a fresh section of the pottery; d, e – photomicrographs of a thin section with a fine-grained, homogeneous, compact ceramic body with no organic admixture; d – PPL, e – XPL

Ryc. 26. Próbka 91, naczynie cienkościenne, stanowisko Târpeşti; a, b – fotografia analizowanego fragmentu ceramiki; c – przełam fragmentu; d, e – mikrofotografia cienkiego szlifu, masa ceramiczna jest drobnoziarnista, jednorodna, zwarta; d – 1N; e – NX

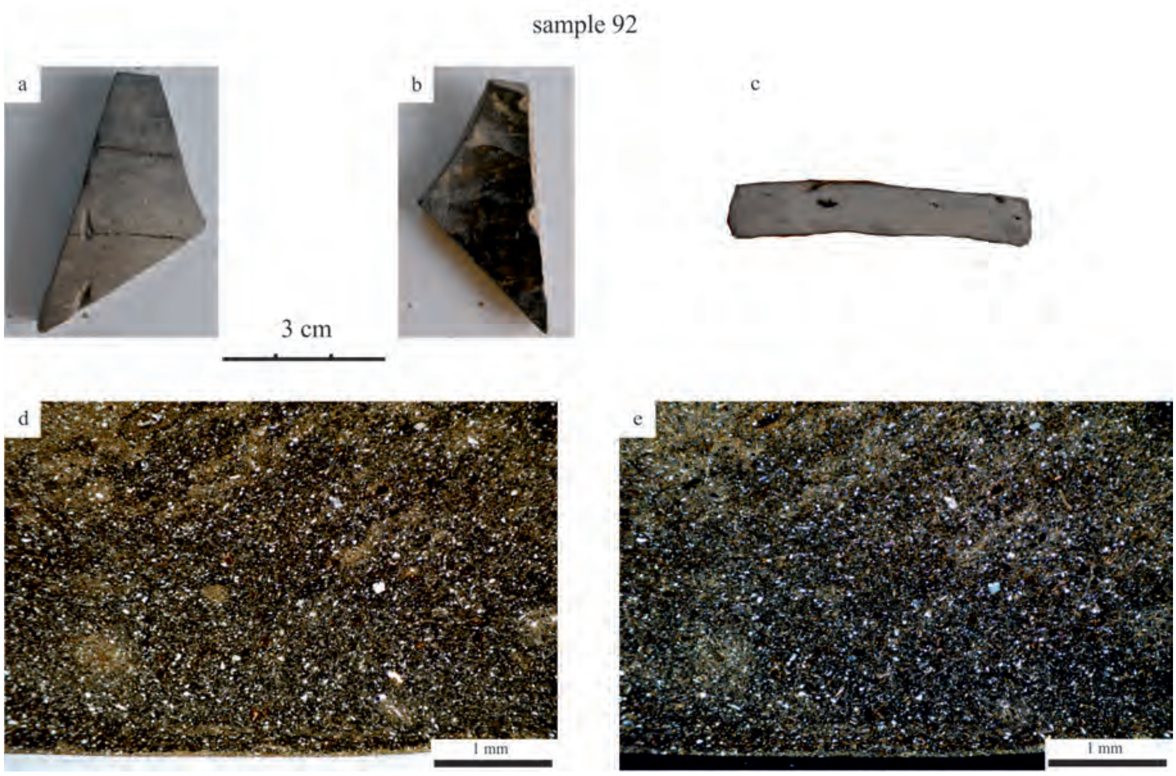

Fig. 27. Sample 92, fine ceramics, Târpeşti; a, b – photographs of the analyzed sample of pottery; c – a fresh section of the pottery; d, e – photomicrographs of a thin section with a fine-grained, homogeneous, compact ceramic body with no organic admixture; d – PPL, e – XPL

Ryc. 27. Próbka 92, naczynie cienkościenne, stanowisko Târpeşti; a, b – fotografia analizowanego fragmentu ceramiki; c – przełam fragmentu; d, e – mikrofotografia cienkiego szlifu, masa ceramiczna jest drobnoziarnista, jednorodna, zwarta; d – 1N; e – NX

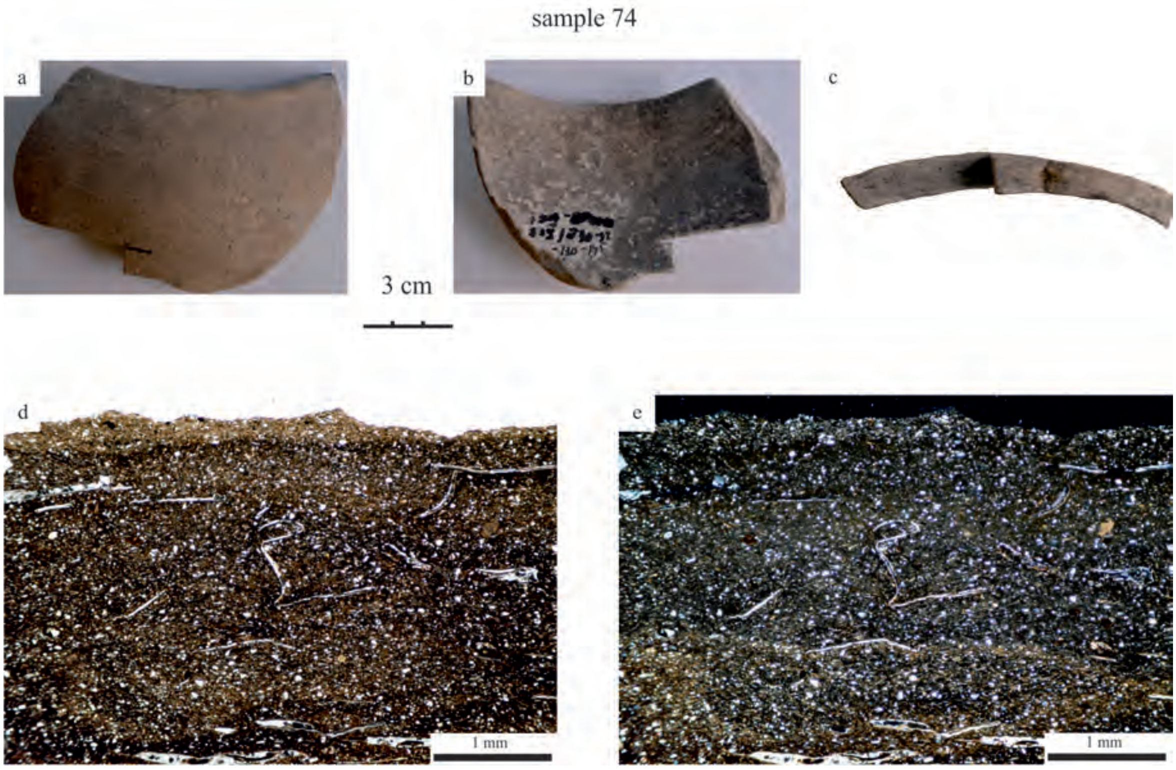

Fig. 28. Sample 74, fine ceramics, Isaiia; a, b – photographs of the analyzed sample of pottery; c – a fresh section of the pottery; d, e – photomicrographs of a thin section with a fine-grained, homogeneous, compact ceramic body with thin plant tissue; secondary carbonates are visible in voids; d – PPL, e – XPL

Ryc. 28. Próbka 74, naczynie cienkościenne, stanowisko Isaiia; a, b – fotografia analizowanego fragmentu ceramiki; c – przełam fragmentu; d, e – mikrofotografia cienkiego szlifu, masa ceramiczna jest drobnoziarnista, jednorodna, zwarta, widoczne są drobne fragmenty organiczne i wtórne węglany w pustkach; d – 1N; e – NX

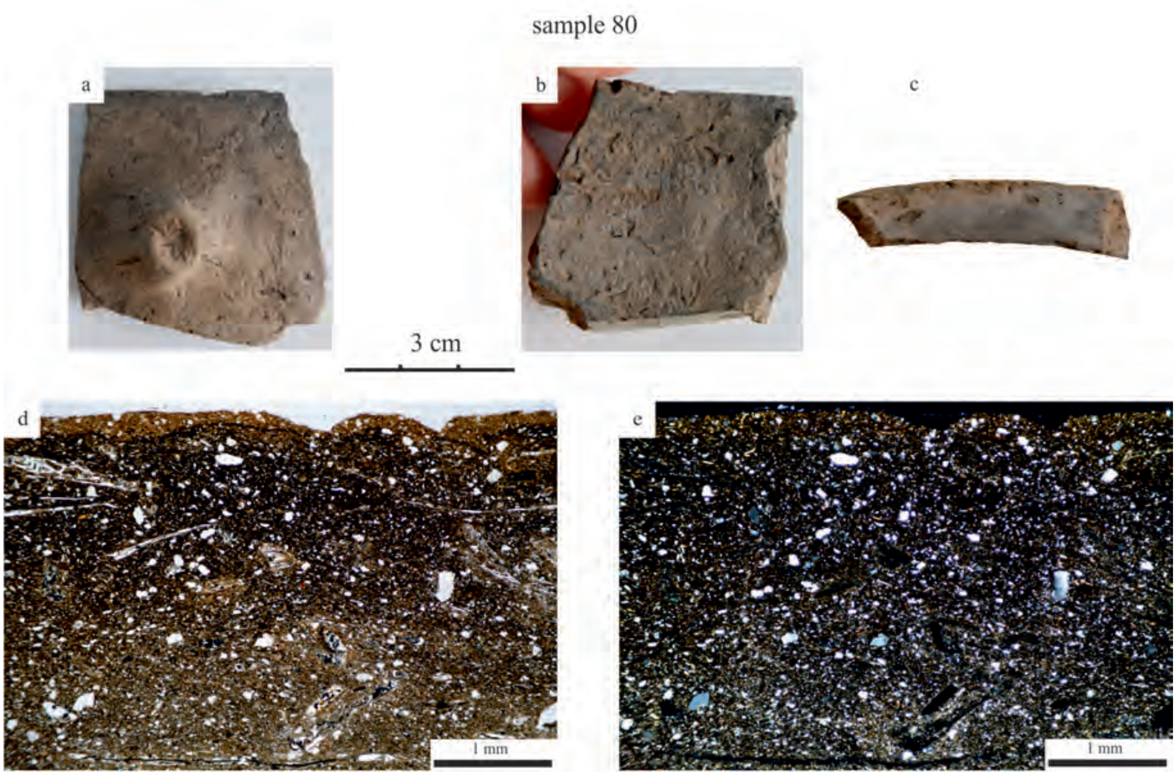

Fig. 29. Sample 80, coarse ceramics, Mihoveni; a, b – photographs of the analyzed sample of pottery; c – a fresh section of the pottery; d, e – photomicrographs of a thin section with a fine-grained, homogeneous, compact ceramic body with a small amount of coarser grains and an organic admixture; d – PPL, e – XPL

Ryc. 29. Próbka 80, naczynie cienkościenne, stanowisko Mihoveni; a, b – fotografia analizowanego fragmentu ceramiki; c – przełam fragmentu; d, e – mikrofotografia cienkiego szlifu, masa ceramiczna jest drobnoziarnista, jednorodna, zwarta, widoczne są drobne fragmenty organiczne i niewielka ilość grubszych ziaren; d – 1N; e – NX

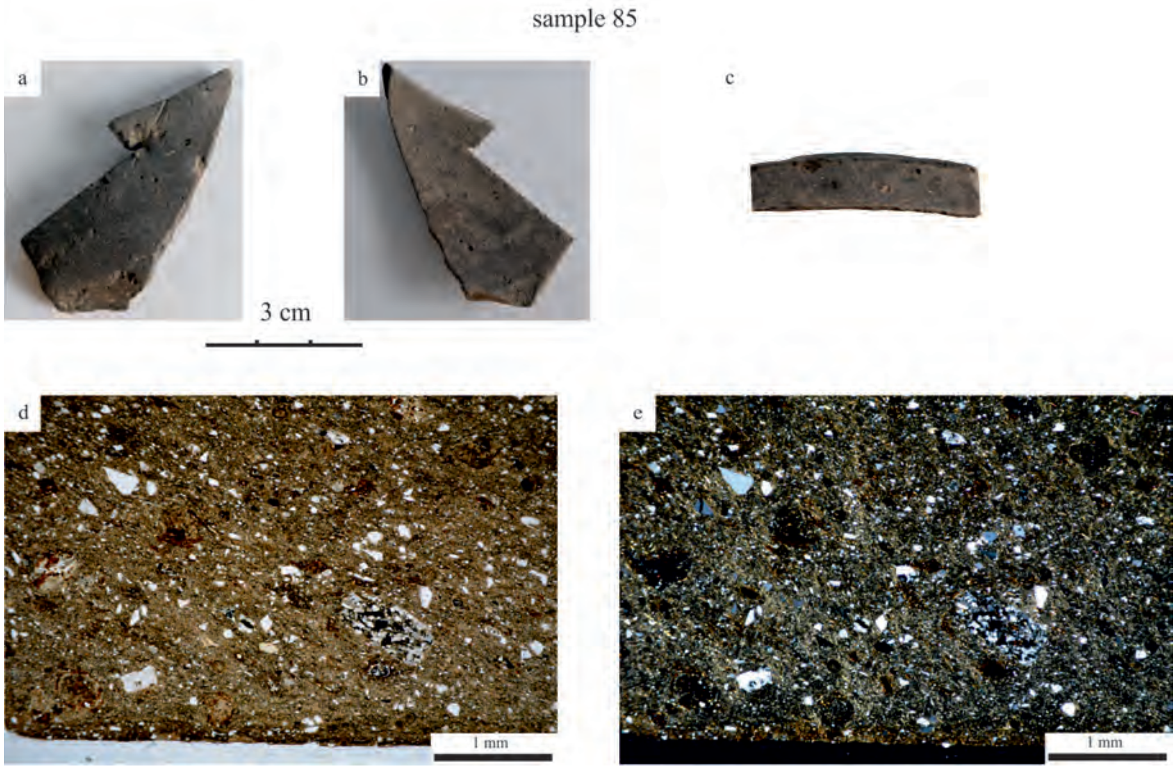

Fig. 30. Sample 85, fine ceramics, Traian-Dealul Fântânilor; a, b – photographs of the analyzed sample of pottery; c – a fresh section of the pottery; d, e – photomicrographs of a thin section with a fine-grained, homogeneous, compact ceramic body with a small amount of coarser grains and an organic admixture; d – PPL, e – XPL

Ryc. 30. Próbka 85, naczynie cienkościenne, stanowisko Traian-Dealul Fântânilor; a, b – fotografia analizowanego fragmentu ceramiki; c – przełam fragmentu; d, e – mikrofotografia cienkiego szlifu, masa ceramiczna jest drobnoziarnista, jednorodna, zwarta, widoczne są drobne fragmenty organiczne i niewielka ilość grubszych ziaren; d – 1N; e – NX

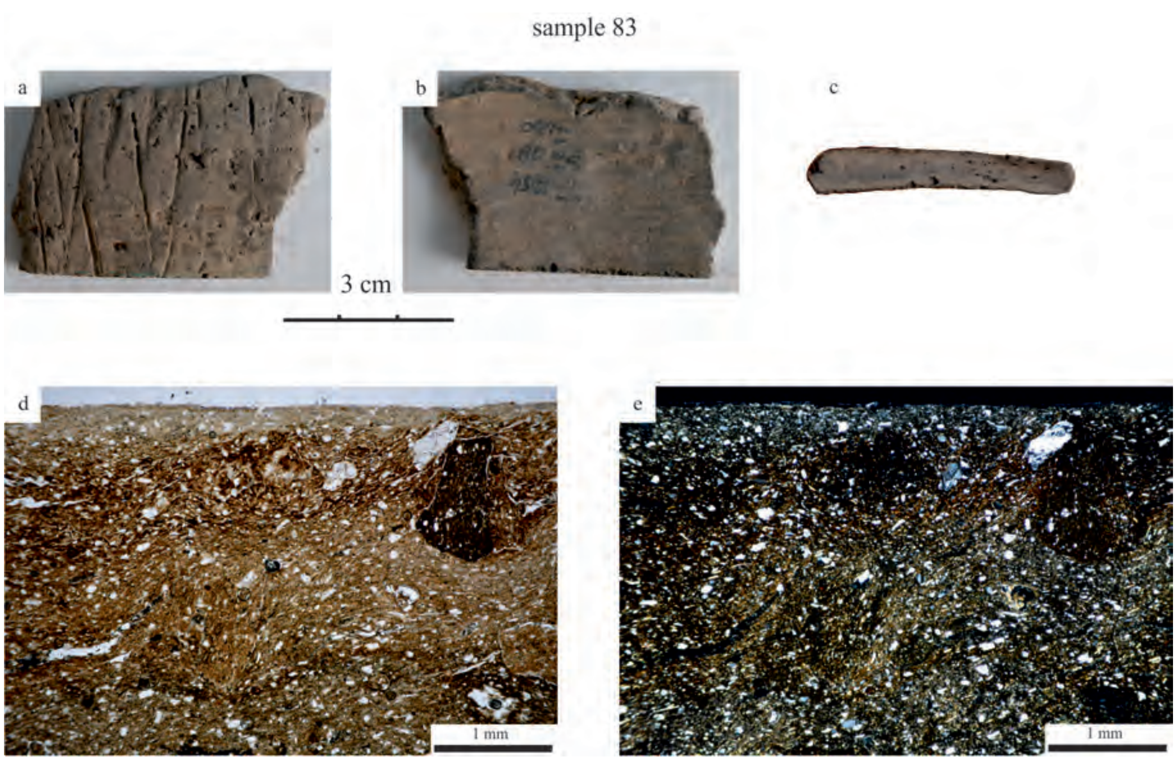

Fig. 31. Sample 83, fine ceramics, Traian-Dealul Fântânilor; a, b – photographs of the analyzed sample of pottery; c – a fresh section of the pottery; d, e – photomicrographs of a thin section with a fine-grained, heterogeneous ceramic body with a grog admixture; d – PPL, e – XPL

Ryc. 31. Próbka 83, naczynie cienkościenne, stanowisko Traian-Dealul Fântânilor; a, b – fotografia analizowanego fragmentu ceramiki; c – przełam fragmentu; d, e – mikrofotografia cienkiego szlifu, masa ceramiczna jest drobnoziarnista, niejednorodna z domieszką szamotu; d – 1N; e – NX

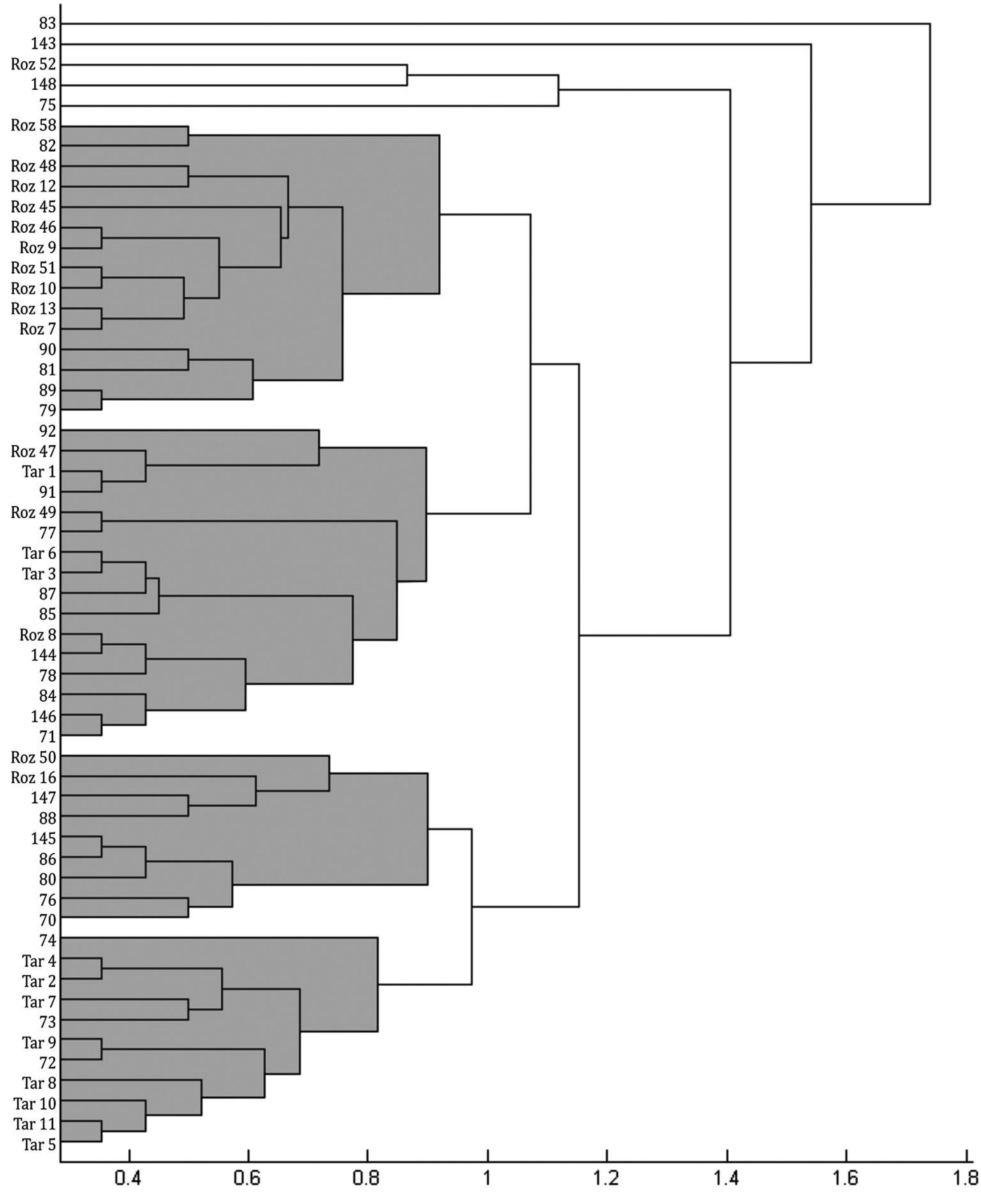

Fig. 32. Cluster hierarchical analysis of the LBK pottery samples from Małopolska (Tar, Roz), the Republic of Moldova (samples 143–148) and eastern Romania (samples 70–92)

Ryc. 32. Analiza skupień ceramiki KCWR z Małopolski (Tar, Roz), Mołdawii (próbki 143–148) i wschodniej Rumunii (próbki 70–92)

Inclusion (d>0.05 mm), (13.3%): the mineralogical composition includes well sorted angular to sub-rounded grains of monocrystalline and sometimes polycrystalline quartz (7%), feldspars (3.8%), thin flakes of muscovite or biotite (up to 0.1 mm), and opaque (up to 0.06 mm). Angular grains of heavy minerals are rare (0.6%). Crystalline inclusions have the diameter of approx. 0.1–0.2 mm and they do not exceed 0.4 mm (one grain). Angular flint fragments are very rare (a few grains).

Lithoclasts: infrequent lithoclasts which consist of polycrystalline quartz, too small for more accurate identification (<0.1 mm), small (<0.1 mm) rounded particles of micrite, and clay clasts (up to 0.5 mm).

Secondary: absent.

Intentional temper: a small amount of plant admixture (few fragments) and many voids created by the destruction of plant material.

Atmosphere and temperature of firing: groundmass has the properties of reducing to oxidising firing: the surfaces are oxidized and the core is grey; the approximate temperature of firing was 850°C.
Comments: ceramic paste has parallel structure visible in the arrangement of mineral flakes and elongated voids. The clay paste includes visible layers of very fine-grained carbonate clay. The ceramic body is compact (voids 0.3%).
PG: Tra 3, fine-grained, well sorted clay with no lithoclasts and with layers of carbonate clay.
FT: IIa with some properties of Ia (organic temper), fine-grained, compact with a very small admixture of plant material, moderately mixed.

Site Târpești, (Petricani commune, Neamț county) (N=5) 88–92
Sample 88 (Fig. 14), thick-walled ceramics
Matrix (d<0.05 mm): brown-orange in PPL, orange-yellow-gray in XPL; optical active, consisting of clayey groundmass (55.3), a significant amount of silty fraction (14%), and micaceous minerals (1.2%); concentrations and grains of iron oxides or hydroxides and opaque minerals are uncommon. Heavy minerals are rare. Flakes of mica tend to be partly altered.
Inclusion (d>0.05 mm), (22.5%): the mineralogical composition includes poorly sorted angular to sub-rounded grains of monocrystalline or polycrystalline quartz (13.5%), feldspars (4.3%), thin flakes of muscovite or biotite (up to 0.15 mm), and opaque (up to 0.1 mm). Angular grains of heavy minerals, e.g. rutile, are rare. Crystalline inclusions have the diameter of approx. 0.1–0.4 mm and do not exceed 0.7 mm (one grain). There are isolated grains of thermally altered glauconite and small grains (approx. 0.07 mm) of chalcedony and flint. The inclusions are distributed equally in the clay.
Lithoclasts: elongated sub-angular to sub-round fragments of metamorphic rock (mica schist), approx. 0.1–0.2 mm, angular and sub-angular fragments of igneous rock consisting of quartz, feldspars and mica (up to 0.7 mm).
Secondary: absent.
Intentional temper: plant admixture (3.5%) and probably sand.
Atmosphere and temperature of firing: groundmass has the properties of reducing to oxidising firing: the surfaces are oxidized and the core is grey; the approximate temperature of firing was 750°C.
Comments: ceramic paste has parallel structure visible in the arrangement of mineral flakes and elongated voids. The body is compact, but with a few voids (2.6%) created by the destruction of organic material.
PG: Tarp 1, metamorphic rock, a small amount of mica flakes.
FT: Ia, coarse-grained, well mixed with an organic admixture.

Sample 89 (Fig. 24), thin-walled ceramics
Matrix: light brown with elongated opaque spots (approx. 0.01–0.03 mm) in PPL, dark grey with yellow spots (approx. 0.02–0.05 mm) in XPL; optical active, consists of clayey-carbonate groundmass (39.2%), silty fraction (19.1%) and micaceous minerals (3%). Small (approx. 0.05 mm) iron oxide or hydroxide concentrations and mica flakes are rare.
Inclusion (34.5%): the mineralogical composition includes moderately sorted angular to sub-rounded grains of quartz (13.6%), feldspars (3.7%) and opaque (0.8%). Grains do not exceed 0.25 mm; most of them ranges from 0.1 to 0.2 mm. Carbonate components, mainly dispersed fine micrite particles (approx. 0.05–0.1 mm) and calcite grains (approx. 0.1 mm), are common (14.4%). Some micrite inclusions are bigger (up to 1.8 mm). There are bioclasts (shells – one fragment is approx. 2 mm in diameter) and small grains of chalcedony discernible in the clay.
Lithoclasts: rounded fragments of micrite limestone (0.5–1.8 mm), a fragment of metamorphic rock (0.4 mm), very infrequent grains of claystone.
Secondary: absent.
Intentional temper: absent.
Atmosphere and temperature of firing: groundmass has the properties of reducing to oxidising firing: the external surfaces are slightly oxidized and the core is light grey; the approximate temperature of firing was 800–850°C.
Comments: all inclusions are distributed equally in the clay, the ceramic body is homogeneous and compact (voids 1.3%).
PG: Tarp 2, fine-grained, moderately sorted carbonate mud with rare bioclasts.
FT: IIa, homogeneous, well mixed with no organic admixture and with a compact ceramic body (voids 1.3%).

Sample 90 (Fig. 25), thin-walled ceramics
Matrix: light brown in PPL, yellow-gray in XPL; optical active, consisting of clayey-carbonate groundmass (60.7%), silty fraction (14.3%), and micaceous minerals (1.6%). Small (approx. 0.05 mm) concentrations of iron oxides or hydroxides are rare.
Inclusion (17.2%): the mineralogical composition includes moderately sorted angular to sub-rounded grains of quartz (7.5%), feldspars (2.2%) and opaque. Grains do not exceed 0.25 mm; most of them ranges from 0.1 to 0.15 mm. Carbonate components, mainly dispersed fine micrite particles (approx. 0.05–0.1 mm) or calcite grains (approx. 0.1 mm), are common (6.5%). Some micrite inclusions are bigger, up to 0.4 mm. Bioclasts (relicts of plankton and shells) are visible in the clay.
Lithoclasts: rounded fragments of micrite limestone (0.05–0.4 mm), very infrequent claystone grains.
Secondary: absent.
Intentional temper: a few voids created by the destruction of plant material.
Atmosphere and temperature of firing: groundmass has the properties of oxidising firing: the external surfaces are dark grey and the core is light grey; the approximate temperature of firing was 750°C.
Comments: poorly mixed, some areas of clay without clastic material, compact.
PG: Tarp 2, fine-grained, moderately sorted carbonate mud with infrequent bioclasts.
FT: IIa with some properties of Ib (worse mixing), homogeneous, moderately mixed, with no organic temper and with a compact ceramic body (voids 1.9%).

Sample 91 (Fig. 26), thin-walled ceramics
Matrix: dark brown in PPL, dark orange in XPL; optical active, consists of clayey groundmass (79.4%), silty fraction (8.7%) and a small amount of micaceous minerals (0.9%). Small (approx. 0.05 mm) concentrations of iron oxides and hydroxides are common.

Inclusion (5.1%): the mineralogical composition includes well sorted sub-angular to sub-rounded grains of quartz (2.8%), feldspars (1.4%) and opaque. Grains range from 0.05 to 0.1 mm.
Lithoclasts: rounded fragments of claystone (natural components of the clay).
Secondary: absent.
Intentional temper: absent.
Atmosphere and temperature of firing: groundmass has the properties of oxidising firing: the external surfaces and the core are orange; the approximate temperature of firing was 750–800°C.
Comments: the ceramic body saturated with iron oxides and hydroxides, compact.
PG: Tarp 3, pure, homogeneous clay with very infrequent clastic material.
FT: IIa, homogeneous, well mixed, with no organic admixture and with a compact ceramic body (voids 0.9%).

Sample 92 (Fig. 27), thin-walled ceramics
Matrix: the color of the ceramic body is uneven: light brown or light brown with a large amount of small black spots in PPL, yellow-gray in XPL; optical active, consisting of clayey-carbonate groundmass (60.4%), silty fraction (20.2%), a small amount of micaceous minerals (1.6%), opaque (0.6%) and heavy minerals (0.6%). There are small (approx. 0.05 mm) concentrations of iron oxides or hydroxides.
Inclusion (5.1%): the mineralogical composition includes well sorted angular to sub-angular grains of quartz (3.8%), feldspar (2.2%) and opaque. There are also irregular concentrations of iron oxides or hydroxides (approx. 0.05–0.1 mm) and calcite grains. Grains do not exceed 0.1 mm. Bioclasts (fragments of shells) are very rare.
Lithoclasts: frequent small inclusions of micrite and marl.
Secondary: absent.
Intentional temper: absent.
Atmosphere and temperature of firing: groundmass has the properties of oxidising firing: the external surfaces and the core are orange; the approximate temperature of firing was 750°C.
Comments: compact.
PG: Tarp 2, fine-grained, well sorted carbonate mud with infrequent bioclasts.
FT: IIa, homogeneous, well mixed, with no organic admixture and with a compact ceramic body (voids 1.6%).

DISCUSSION.
THE ORIGINS AND CHRONOLOGY OF THE LBK CERAMICS IN EASTERN ROMANIA

The issues of relative chronology and LBK genesis in eastern Romania and neighboring areas of the Republic of Moldova and Ukraine have been discussed many times. They were mainly focused on the level of research on the typology and style of ceramics. Our article considers these problems only in the aspect of ceramics technology.

The LBK spread to Małopolska and the Western Volhynian Upland in Ukraine in its pre-music-note (I) phase (M. Dębiec 2015). The earliest LBK groups migrated to south-eastern Poland from south-western Slovakia and Moravia through the Moravian Gate.

In the music-note phase (II), the LBK population gradually increased, reaching its peak in the Želiezovce phase (III). During the LBK evolution, the inner rhythm of cultural change was the same almost throughout Małopolska and in south-western Slovakia. Its development was different, however, in the Dniester basin (in Ukraine, eastern Romania and the Republic of Moldova), where assemblages representing the music-note (II) phase are the only documented LBK pottery and where no ceramic materials from the Želiezovce phase (III) have been found to date (J.K. Kozłowski 1985).

The LBK ceramics from eastern Romania and from the Republic of Moldova differ considerably from the ceramics of the late Starčevo-Criş culture, of the Pişcolţ group within the ALPC and of the post-Linear Iclod group in north-western Romania (cf. S. Kadrow, A. Rauba-Bukowska 2017a, Table 2; S. Kadrow, A. Rauba-Bukowska 2017b, Table 29.1). However, the technology of that pottery is reminiscent of the LBK ceramic assemblages at Targowisko 10–11 (phases I and II; cf. A. Rauba-Bukowska 2014) and Rozbórz 42 (phase III).

CONCLUSIONS

The LBK ceramic assemblages from Małopolska, eastern Romania and the Republic of Moldova have been subjected to hierarchical cluster analysis (Fig. 32) with the use of the MatLab programme. Eight properties have been examined: the content of silty fraction, coarser clastic material, clay clasts, micaceous minerals (muscovite, biotite) and, as an intentional admixture, the presence of rounded grains, of larger angular rock fragments and of grog. Those properties describe both the choice of the appropriate raw material and the admixture added to the clay. The quantities of the minerals have been divided into four categories: 1) absence; 2) a small amount; 3) an average amount; 4) a large amount. The resulting dendrogram (Fig. 32) illustrates the close affinity of those ceramic assemblages.

The dendrogram corroborates the widely accepted thesis that eastern Romania, the Republic of Moldova and the adjacent parts of Ukraine (the Dniester basin) were settled by the LBK population from Małopolska at the beginning of phase II (cf. J.K. Kozłowski 1985; O.V. Larina 1999; O.V. Larina, V.A. Dergachev 2017, pp. 9–22). The ceramics from the eastern areas show no stylistic features of the Želiezovce phase (III). Consequently, some researchers (e.g. O.V. Larina 1999) conclude that LBK settlement in the Siret, the Prut and the Dniester basins was limited to phase II of the LBK. Since those areas have provided no ceramics with the technology related closely to phase II of the LBK in Małopolska, the culture seems to have lasted much longer, even though no traces of the Želiezovce style have been recorded (J.K. Kozłowski 1985).

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Technologia ceramiki kultury ceramiki wstęgowej rytej we wschodniej Rumunii

Streszczenie

Artykuł przedstawia wybrane aspekty technologii produkcji ceramiki kultury ceramiki wstęgowej rytej (KCWR) we wschodniej Rumunii. Autorzy koncentrują się na mineralogicznych i petrograficznych kompozycjach mas ceramicznych używanych do produkcji ceramiki. Są to pierwsze analizy tego typu dotyczące ceramiki KCWR z omawianego obszaru. W skrótowej, tabelarycznej formie zostały już one opublikowane (S. Kadrow, A. Rauba-Bukowska 2017a, tabela 1–2). Niniejszy artykuł udostępnia te analizy szczegółowo z uwzględnieniem kompletnego opisu badanych próbek, zastosowanych metod i uzyskanych rezultatów. Odnosi się też do wyników analogicznych badań próbek ceramiki z terenu Republiki Mołdawii (S. Kadrow, A. Rauba-Bukowska, S. Țerna 2017). Wszystkie wymienione analizy zostały zrealizowane w ramach grantu NCN 2013/09/B/HS3/03334.

Pomimo tego, że stanowiska KCWR odkrywano w Rumunii już w okresie międzywojennym, to kultura ta do dzisiaj pozostaje poza głównym sektorem zainteresowań badaczy z tego kraju. Materiały KCWR pochodzą ze stanowisk wielokulturowych, których eksploratorzy skupiali się głównie na pozostałościach kultury Precucuteni. Jedna z nielicznych prac syntetycznych poświęcona jest chronologii względnej KCWR we wschodniej Rumunii (J. Braungart 2014, s. 9–42).

Analizom poddano 23 próbki ceramiki z pięciu stanowisk KCWR z dorzecza Prutu i Seretu (Mołdawia) oraz jednego stanowiska z Siedmiogrodu (ryc. 1). Są to następujące stanowiska: Olteni – „piaskownia", stan. B (Siedmogród) oraz Mihoveni – „Cahla Morii", Târpești – „Râpa lui Bodai", Traian – „Dealul Fântânilor", Isaiia – „Balta Popii" i stanowisko Preutești (ryc. 2–6).

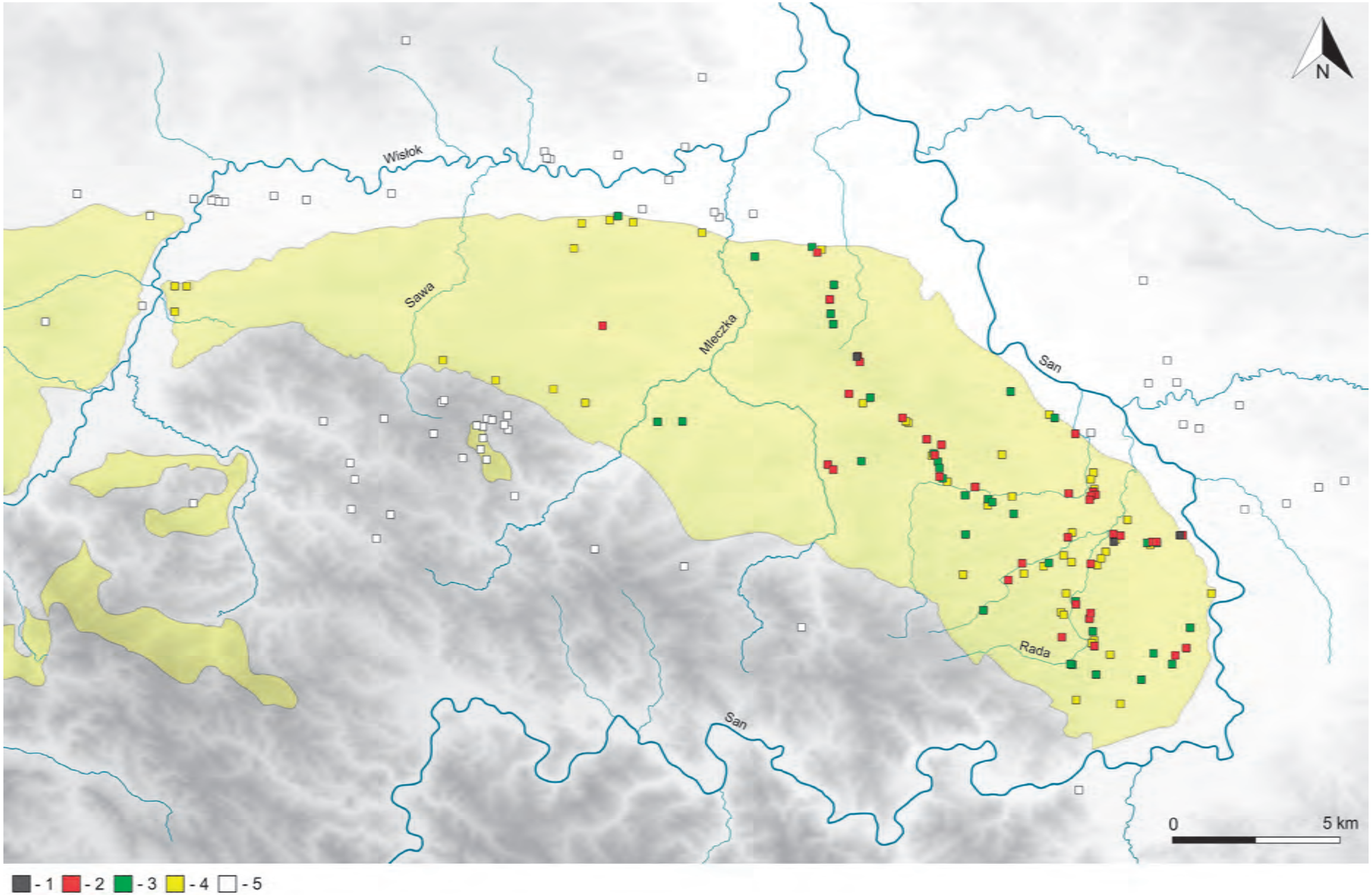
Z wszystkich próbek ceramicznych wykonano cienkie szlify do obserwacji pod mikroskopem polaryzacyjnym Nikon Eclipse LV100N POL. Za pomocą punktowej, ilościowej analizy mikroskopowej określono procentowy udział takich składników jak: minerały ilaste, kwarc, skalenie potasowe, plagioklazy, muskowit, biotyt, minerały ciężkie, ziarna skał osadowych, magmowych i metamorficznych, szamot i materiał organiczny. Dodatkowo wykonano analizę granulometryczną, polegającą na pomiarze średnicy ziaren w przedziałach: 0,002–0,02 mm, 0,02–0,05 mm, 0,05–0,1 mm, 0,1–0,2 mm, 0,2–0,5 mm, 0,5–1 mm, 1–2 mm i ∅ > 2 mm. Analizy statystyczne wykonano przy użyciu program MATLAB R2007b.

W trakcie rozwoju KCWR rytm wewnętrznych przemian w Małopolsce był podobny do południowo-zachodniej Słowacji. Jednak na terenach położonych na wschód od łuku Karpat ewolucja ta przebiegała inaczej. Wszystkie tamtejsze zespoły ceramiczne reprezentują tylko fazę nutową (II). Nie zanotowano tam klasycznych materiałów fazy żeliezowskiej (III; por. J.K. Kozłowski 1985).

Ceramika KCWR ze wschodniej Rumunii i z sąsiedniej Republiki Mołdawii pod względem technologicznym różni się od ceramiki późnej fazy kultury Starčevo-Criş, od ceramiki grupy Pişcolt kultury wschodniej ceramiki linearnej oraz od ceramiki postlinearnej grupy Iclod (wszystkie z terenu północno-zachodniej Rumunii; por. S. Kadrow, A. Rauba-Bukowska 2017a, tabela 2; S. Kadrow, A. Rauba-Bukowska 2017b, tabela 29.1). Jednakże przypomina ona ceramikę KCWR z I i II fazy tej kultury na stan. 10-11 w Targowisku oraz z fazy III w Rozborzu na stan. 42 (A. Rauba-Bukowska 2014).

Technologiczne cechy ceramiki KCWR z Małopolski oraz ze wschodniej Rumunii i z Republiki Mołdawii poddano hierarchicznej analizie klusterowej (ryc. 32). W rezultacie można stwierdzić bliskie podobieństwo ceramiki z wyżej wymienionych obszarów. Dendrogram potwierdza tezę, że obszary na wschód od łuku Karpat zostały zasiedlone przez ludność KCWR zamieszkującą Małopolskę, od początku fazy nutowej J.K. Kozłowski 1985; O.V. Larina 1999; O.V. Larina, V.A. Dergachev 2017, s. 9–22).

Bliskie podobieństwa części ceramiki KCWR ze wschodniej Rumunii do zespołów żeliezowskich z Małopolski, pomimo braku powiązań stylistycznych, świadczą, że jej rozwój na wschód od Karpat nie ograniczał się tylko do fazy nutowej (II), lecz kontynuował się także współcześnie do fazy żeliezowskiej (III; por. J.K. Kozłowski 1985).



Ryc. 2. Rodzaje stanowisk KPL na lessach Podgórza Strzyżowskiego i Doliny Dolnego Sanu: 1 – cmentarzyska; 2 – osady; 3 – punkty osadnicze; 4 – ślady osadnictwa; 5 – stanowiska położone w promieniu 10 km od badanego obszaru

Abb. 2. Arten der Fundstellen der Trichterbecherkultur auf den Lössgebieten von Podgórze Strzyżowskie und im unteren San-Tal: 1 – Gräberfelder; 2 – Siedlungen; 3 – Siedlungspunkte; 4 – Siedlungsspuren; 5 – Fundstellen im Umkreis von 10 km von dem erforschten Gebiet