THE COMBINATION OF DIFFERENT MODELING TECHNIQUES TO ARCHAEOLOGICAL VESSELS, DATA TRASOLOGICAL EXPERIMENTAL AND ETHNOGRAPHIC

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Abstract. The study of technological methods of manufacturing ceramic materials is considered by the example of the Maikop culture in the North Caucasus and the data of ethnography. As an example the experimental simulation of round-the Maikop culture vessels, made by several methods. Trasological study of the structure of the test pieces of ceramics in the fracture showed that it is possible to determine the area of joints tapes. External and internal ceramic surface smoothed, but you can define a manual molding of thin lines multidirectional polishing. Manual molding can also be defined and some fragments of ceramics on its inner surface, to maintain the following bands modeling and smoothing the surface of joints by hand. Some fragments have a very dense homogeneous structure, which is formed as a result of receiving use knockout, using a wooden spatula or forging of vessel walls using stone tools on both sides. Some techniques for making vascular managed modeled by experiments. Research data on the manufacturing technique of ethnography round bottom flask showed that the modeling techniques such vessels much more. The paper presents the archaeological, ethnographic and experimental data on manufacturing as the flat-bottomed and round bottom flask using a technique manual molding, punch and forging (forging the walls of stone tools from both sides). Recently, using the technique of punch it was carried out a series of experiments on modeling the round bottom flask. Trasological study technology of round bottomed flask with two knockout techniques, not previously considered.

Keywords: archeology; a comprehensive study of ceramics; ethnographic studies of modeling ceramics; pottery trasological analysis; experimental modeling; hand-molded ceramics; machinery manufacturing round bottom flask.

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ОСНОВНЫЕ ХАРАКТЕРИСТИКИ ТЕХНОЛОГИИ ПРОИЗВОДСТВА КЕРАМИКИ РАННЕГО НЕОЛИТА РОССИИ

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Аннотация. Керамика появилась на южной территории современной России примерно в то же время, как на юге Европы, примерно 6000 cal BC. В то время как гончарство вместе с доместикацией животных и растений было привнесено на юг Европы с юго-западной Азии, ранненеолитическая керамическая традиция образовалась локально охотниками и собирателями или была заимствована у других представителей доземледельческого общества Северной Евразии. В данной статье анализируются 4 фрагмента сосудов из четырех разных регионов из центра и юга России, используются методы, которые применялись ранее в двух крупномасштабных исследовательских программах по ранненеолитической керамики из Адриатики и центральной части Балканского полуострова. Четыре сосуда были изготовлены с различными отощителями, но все они – слабого обжига. Несмотря на то, что фрагменты могут представлять разные технологические традиции для южно-европейского гончарства, общее техническое состояние сосудов охотников-собирателей было развито не менее, чем керамика периода раннего земледелия.

Ключевые слова: ранний неолит в России; технология изготовления керамики; оптическая микроскопия; растровая электронная микроскопия; шамот; отощители.

Introduction

Pottery has often been equated to cultural groups, in particular in prehistoric archaeology (e.g. Childe 1929). Pottery is often the best studied, most recognisable and most distinctive evidence of early Neolithic societies in Europe. We tend to attribute specific styles, surface treatments and shapes to a specific community, defining cultural groups and changes on the basis of variations in shapes, styles, etc.

Ceramics appeared in southern Russia at about the same time as in southern-Europe, at ca. 6000 cal BC (Piezonka 2015), but the first potters in the two regions relied on very different subsistence strategies. In eastern Europe, early Neolithic pottery was probably developed locally by hunter-gatherers, or derived from other pre-agricultural societies further to the east. In the Balkans and Mediterranean Europe, however, pottery was adopted concurrently with farming, in what appears to have been a process of population expansion and movement. Mesolithic subsistence economies in eastern Europe were based on exploiting wild resources, particularly fish – just as in the Mesolithic of the Iron Gates region of the central Balkans – but unlike in the Balkans, the adoption of pottery seems to have reinforced existing subsistence economies.

This divergence in subsistence economies was probably accompanied by differences in settlement patterns, with higher densities of presumably sedentary farmers in early Neolithic southern Europe and dispersed and highly mobile foragers in eastern Europe. Such differences could be associated with fundamental differences in pottery technology. In lithic technology, the degree of diversification increases with sedentism, while more expedient technology might be expected for mobile communities; pottery production might follow a similar pattern. We might expect a clearly defined chaîne operatoire in sedentary societies, with better planning of raw material procurement (clay, temper, fuel), more investment in equipment and training, and production on a larger scale.

In this paper I will compare the technology of early farmers and hunter-gatherers who used pottery, focusing on whether people planned raw material procurement carefully or just used what was readily available, and noting the significance of any differences between pottery technology among hunter-gatherers and farmers. We know that pottery-making is not a very complex technology, and it could therefore have been reinvented more than once. It may have been easier to learn how to make pottery from someone who already produced it, and in this way we would expect the same techniques to be transmitted from one individual to another. As there are various solutions to the common technical problem of making functional pottery, however, we might expect more variability in pottery technology if it has been invented independently more than once.

Methods and sampling

For this paper, four potsherds from four early Neolithic Russian sites located in very different regions were considered (Figure 1): one sample from Cherkasskaya III in the upper Don valley (sample CHK01), one from Imerka VIII in the Oka valley, east of Ryazan (IMK01), one from Varfolomeevskaya in the middle Volga valley (VAR01) and one from Zamostje 2 in the upper Volga (ZAM01). The samples are macroscopically very different from each other, as ZAM01 is plain without decoration, VAR01 has wavy heavily incised lines, IMK01 has two lines of (pinched?) impressions, and CHK01 has some grooved motifs (Figure 2).

The Russian samples were analysed in polished thin sections using two complementary techniques, optical microscopy with a polarising microscope and by variable pressure Scanning Electron Microscopy with Energy Dispersive Spectrometry (SEM-EDX), to enable comparison of the chemical signatures of the different plastic and non-plastic inclusions identified by optical microscopy (Spataro 2002, chapter 2; 2011a). The SEM-EDX was used to study the microstructure of the ceramics, which is very important to understand some technical choices (e.g. firing temperature; see Tite and Maniatis 1975) and to identify the chemical composition of the fabrics and in particular of the clay matrix, as coarse inclusions (i.e. clay pellets and chamotte) are present in some samples. The SEM-EDX analyses were carried out at 20 kV and 40 Pa. Two SEM elemental maps were also carried out to identify the chemical distribution of specific elements in samples IMK01 and ZAM01. Principal Component Analysis (PCA) were also carried out on the correlation matrix of the SEM-EDX results, using the software Past 3.04 (Hammer et al. 2001).

The results of archaeometric analyses of these samples are then compared to the general results from the early Neolithic pottery of the central Balkans, and the Adriatic region, from which altogether almost 1,000 samples were studied by optical microscopy and SEM-EDX (see below). Macroscopically, one of the main differences between the Russian potsherds and the south and south-eastern European material is that the former display food residues on the surfaces, in contrast to the south-eastern European pots. which on the whole do not present food crusts. These samples were in fact chosen for food residue analyses.

Optical microscopy in thin section

The four early Neolithic Russian potsherds have very different fabrics. Three were tempered respectively with shell, chamotte and sand (the latter probably also with plant matter), whereas one sample (IMK01) was probably not tempered.

Sample CHK01 from Cherkasskaya III has a very dark brown fabric, with very abundant quartz sand (>40%; mainly 0.1×0.15 mm, but there are also some coarse and rounded or sub-rounded quartz inclusions; very fine quartz inclusions are also present with a size of 0.03×0.02 mm; Figure 3 left), some plagioclase, occasional pyroxene, opaques, rutile and iron oxide. There are elongated voids most probably left by the burning of organic matter, in a few instances charred remains are still visible (Figure 3 right). A carbon layer is visible on one of the surfaces of the sherd.

Sample IMK01 from Imerka VIII has a red and non-calcareous fabric, with abundant and poorly-sorted quartz (20%; size range between 0.3×0.2 and 0.03×0.02 mm), some fine muscovite, some plagioclase, zirconium, ilmenite, opaques, iron oxides, and very abundant iron-rich clay pellets of different sizes (ca. 0.2-1.0 mm diameter), mainly containing quartz inclusions (Figure 4 left and right). Some carbonised food residue is visible on the surface.

Sample VAR01 from Varfolomeevskaya has a fabric which is brown on one of the surfaces of the sherd and reddish in the interior, some scattered, mainly fine quartz inclusions, with very few coarse quartz inclusions (>5%: up to 0.9×0.6 mm), occasional clay pellets (some do not contain inclusions and some include quartz and mica lamellae), occasional very fine lithic inclusions, abundant and poorly-sorted shell fragments, up to 10 mm long (see Figure 5 left). A carbon layer (food residue) is visible on one surface of the sherd (Figure 5 right).

Sample ZAM01 from Zamostje 2 has a reddish, mainly non-calcareous and slightly micaceous fabric, with some moderately well-sorted quartz sand (>15%; between 0.02×0.03 mm and 0.5×0.8 mm), very fine muscovite, K-feldspar, occasional quartzite, opaques, a fine bone fragment, very fine pyroxene, occasional calcareous fine fragments, iron oxides, and abundant chamotte fragments (<15%; size range between 0.04×0.05

and 0.6×1.5 mm) with variations in their contents (some contain feldspar and one possibly biotite), suggesting that the chamotte was derived from more than one pot (Figure 6 left and right).

SEM-EDX microscopy and analysis

The differences in mineral inclusions identified by optical microscopy are also reflected in the SEM microscopic analysis and EDX results (Table 1). Four bulk analyses at 100x (each covering ca. 1.5×1.1 mm) were carried out for CHK01 and VAR01, whereas to obtain more reliable results, multiple analyses were carried out for samples ZAM01 and IMK01, as they contained respectively chamotte and clay pellets, whose composition was very different to that of the overall matrix (Tables 1 and 2).

The clay matrix of sample CHK01 contains very fine quartz inclusions, and it was very heavily tempered with coarse sand, which makes it very rich in silica (>80%), hence the contents of the other oxides are much lower than in the other sherds (see Table 1). This sample, which was probably also tempered with plant matter, contains very few organic remains. This disappearance of the organics, together with the clay filaments sticking to the quartz crystals, and some starting to vitrify, indicates a relatively high firing temperature.

Sample IMK01 contains a high percentage of clay pellets, which are particularly iron-rich (ca. 22% FeO; see Table 1), richer in calcium oxide and poorer in silica than the clay surrounding them (Table 1 and Figure 7). At high magnification it is possible to note that there is sintering of the clay but no vitrification, although in some areas some clay filaments are beginning to form, suggesting that the firing temperature was generally lower than 800°C.

Sample VAR01 was heavily tempered with shells and this is reflected in the high percentage of calcium oxide; it also contains higher soda than the other pots, whereas the other oxides are lower than in the chamotte-tempered sample from Zamostje II (Table 1). The fabric microstructure shows sintering of the clay, but the microstructural features of the shells suggest a firing temperature of only 650–750°C (Maritan et al. 2007). Traces of food residues are visible on the edges of the sample, but also penetrating the sherd (see Figure 8).

Sample ZAM01 contains abundant chamotte temper, which comes from more than one type of ceramic fabric, and some of the chamotte fragments themselves include other chamotte pieces (chamotte in chamotte). As observed with the polarised microscope, a few chamotte fragments are vitrified (Figure 9) and therefore more highly-fired than the clay matrix of the sample analysed in thin section (Figure 10), indicating that some of the pots from which the chamotte is derived were more highly-fired at a temperature which reached ca. 850°C.

Given the abundance of chamotte in sample ZAM01, seven bulk analyses were first carried out on the chamotte and eight on the matrix (160x) (Table 2). The matrix was also analysed with three bulk analyses at 100x (each giving sample areas of ca.1.5×1.1 mm; Table 1). The chemical results confirm that the chamotte added during the ceramic manufacture was made of different raw materials to that used for the ZAM01 matrix, as it is generally higher in alumina, potash, and slightly higher in iron oxide, whereas the clay used for the matrix of the sherd is richer in magnesia and calcium oxide (see Tables 2 and 1). These two oxides are related to the clay itself and not to the inclusions of the matrix.

In the voids between chamotte and clay there are recurrent iron sulphide pellets (FeS2) which are post-depositional formations.

The SEM-EDX results were studied using Principal Component Analysis (PCA), to see whether any clustering based on chemical composition reflects the fabric subdivision based on mineralogy. Figure 11 shows the results of PCA when all the results were considered together, including those from the clay pellets in sample IMK01 and the chamotte in sample ZAM01. It is interesting that the chamotte (black diamonds) clusters with results from the clay matrix of the Zamostje sherd (black dots), indicating no great differences in their chemical composition. On the other hand, the clay pellets from sample IMK01 (green diamonds) are chemically very different to the pottery matrix (green dots), as they are very iron-rich.

Figure 12 shows the high variability in the chemical composition of the chamotte fragments, which are mainly positive on Factors 1 and 2, whereas the bulk analyses of the clay matrix are mainly negative on the same factors. This reinforces the idea that the recycled pottery came from ceramics which were made with different raw materials.

Elemental maps

Elemental maps were generated for samples ZAM01 (Figure 14a-f) and IMK01 (Figure 15a-h), to identify the elemental distribution of the chamotte and clay pellets. The chamotte fragments in the Zamostje 2 sample are slightly richer in aluminium (Figure 14b); magnesium is higher in the matrix (except for one; Figure 14c); calcium (Figure 14d), potassium (Figure 14e) and silicon (Figure 14f) are generally more concentrated in the matrix and less abundant in the chamotte (see also Tables 1 and 2). The clay pellets in the Imerka VIII sample (Figure 15a-h) have lower contents of aluminium (Figure 15a) and silicon (Figure 15b), but they are richer in calcium (Figure 15d) and much richer in iron (Figure 15g), whereas sodium is similarly distributed between the pellets and the clay matrix (Figure 15e, Table 1).

Results and discussion

Major different between the four sites in terms of technology.

There is a lot of variation in pottery technology between the four Russian settlements. The clays were worked adding a variety of tempering materials, and one sherd was probably not tempered (IMK01). The last sample is very interesting as it is particularly rich in iron-rich clay pellets, which might have been part of the raw clay material used to make the vase. If so, this would imply that the clay was not worked prior to making the pot itself. On the basis of comparisons between the thin sections of soil samples containing clay pellets and the ceramics analysed from the central Balkans, the clay pellets in the Imerka sample seem to be naturally present in the paste of the potsherd. However, in this sample they are particularly numerous. They are very rich in iron and contain lower amounts of alumina and calcium than the clay matrix of the pot. It would be very difficult to prove whether dry clay pellets were deliberately added to the clay during the manufacturing process.

All the other samples show a clear selection of tempering agents, which might have been locally available and part of formulas culturally transmitted within the community.

At Cherkasskaya III, the vessel was heavily tempered with coarse quartz sand (and probably also plant matter, although this may have been naturally present in the original raw clay); a similar pattern was identified at the early Neolithic site of Rakushechnyi Yar in the lower Don River basin, from which three sherds were analysed in thin section and by X-Ray microtomography (Kulkova and Kulkov 2015). These sherds were tempered with aleurites (Kulkova and Kulkov 2015, 7) and also included abundant plant matter, identified as Stuckenia pectinata (syn. Potamogeton pectinatus). These sherds were fired between 650 and 800 °C (Kulkova and Kulkov 2015, 9).

In the case of Zamostje 2, the chamotte hints at previous traditions, as it is chemically distinctively different from the clay source used for the pottery matrix and it includes grog-in-grog (Table 1), and could be derived from pottery made at another site. Although the Zamostje 2 sherd I have analysed is rather fine, there is coarser material at this site, as Marianna Kulkova has reported (unpubl. report). She analysed by optical microscopy in thin section five undecorated ceramic fragments from the same phase as sample ZAM01, and identified four fabric groups, three of which contained variable amounts of chamotte temper (15–25%) and sand temper, and in one case the fine sand is comparable to that in ZAM01. In general, sample ZAM01 includes finer chamotte fragments than those in the sherds analysed by Kulkova, comprising no more than 15% of the fabric.

As expected, given the geographical distance between sites and the mineralogical differences identified in thin section by optical microscopy, the chemical analyses show that very different raw materials were exploited. The clays used were mainly non-calcareous, although the Zamostje sample was made with a clay richer in calcium oxide (Table 1), and the clay used to make the Imerka sherd was full of iron-rich clay pellets.

Although the firing temperature was generally low, there are some variations. In some of the sherds there is sintering of the clay, i.e., the clay is sticking to the quartz inclusions, and some clay filaments have started to vitrify (e.g. CHK01), suggesting a slightly higher firing temperature, reaching 800 °C or slightly more, probably for a short period of time. To reinforce this observation, very few charred remains are left, the others having burnt out of the clay.

In contrast, the IMK01 and VAR01 sherds were not very highly fired, with temperatures not exceeding 700-750°C. In particular, in the Varfolomeevskaya sample the shells have largely intact internal structures, suggesting a maximum temperature of 750 °C, and probably less (see Maritan et al. 2007). The Zamostje 2 sample is particularly interesting, as it was not very highly fired, as there are no clay filaments starting to vitrify, but it contains chamotte fragments from vessels which were fired at up to 850°C.

Comparison between early Neolithic pottery in Russia and south-eastern Europe.

Like the early Neolithic Russian samples, pottery produced contemporaneously in the central Balkans and in the Adriatic region was also heavily tempered. Temper seems to be the main choice of the early Neolithic societies of both these areas (Spataro 2009a), and it is recurrent from the earliest to the latest phases, with the only exception of fine painted ware, which was probably used as a prestige item (Spataro 2009b).

The use and quantity of temper might be based on perceived functional advantages during the forming and firing of pottery. For example, shell temper, a carbonate temper, indicates a low firing temperature, as carbonate decomposes into lime at 600–800 °C (see Feathers and Peacock 2008, 290). Platy shells “with large surface-to-volume ratio” can be added to improve the workability of the clay (Feathers 2006). Although it is hard to process, chamotte adds strength and has lower or comparable thermal expansion properties to the clay matrix (see Rice 1987, Table 14.1). However, it does not provide obvious functional advantages over sand temper (Tite et al. 2001). Finally, organic matter increases the porosity of pots and makes the pot easier to manufacture and more permeable (for more details see Schiffer and Skibo 1987).

Tempering agents help the potter/s to work the raw materials (see Rye 1976), but their choices is not always linked to functional reasons; in some cases it seems to reflect a more cultural choice. Chaff temper, used for most of the early Neolithic pottery production in Serbia, Slavonia and Romania (Spataro 2011b), was most probably not used for its functional advantages, as other options were available (e.g. sand/rock fragments from the Carpathian basin) but as it was a recipe embedded in the society and transmitted from one generation to the following, as other decorative features of the pottery (Spataro and Meadows 2013).

Along the Croatian coastline and the Dalmatian islands, the early, middle and late Neolithic communities manufactured their pottery always adding crushed calcite, probably because it was easily and locally available. Despite changes in style, shape and surface treatments, the potters used the same recipe to manufacture ceramics throughout a period of a thousand years (Spataro 2002; 2009a). Along the eastern Italian coastline, the potters used flint and granite rock fragments in central Italy, whereas volcanic sand was used in south-eastern Italy.

The fact that pottery was heavily tempered in Russia as well, despite the differences in the subsistence economy, raises the question whether the vessels were formed in the same way. Some tempers were used in both areas, such as sand and organic and grog temper. We might predict that if a larger sample of pottery were analysed at each site, the hunter-gatherer assemblages might be more diverse in terms of technology and raw materials, because pottery must have been made in smaller batches (e.g. only when an old pot was broken beyond repair).

Sand and (possibly) organic temper were used by both Starčevo and Russian potters, but the Russian potters used more abundant quartz sand and less plant matter than the Starčevo potters. Plant temper is uncommon in the early Neolithic Adriatic region. Two aspects in the Russian sherds have no parallel in the Balkans and the Adriatic early Neolithic pottery: the sherd from Imerka VIII (IMK01) contains very abundant iron-rich clay pellets, and the sherd from Varfolomeevskaya (VAR01) was shell-tempered.

Finally, chamotte, which seems to have been common at Zamostje 2 (see also Kulkova unpubl.), was also used to make earlier generations of pots, as shown by the grog-in-grog (chamotte fragments containing inclusions of chamotte), which demonstrates that this technique was well-established. Of course, it is not possible to say whether the previous pottery, from which the grog fragments were derived, dated to just a few years or months before the analysed sherd was manufactured.

Chamotte was used at the Middle Adriatic Impressed Ware site of Maddalena di Muccia in the interior of the Marche region, in central-eastern Italy (Spataro 2002, 144-151). Chamotte is very rare in the Starčevo culture, perhaps only occurring accidentally (as very few fragments were identified in very few specimens), but it is commonplace in the succeeding Vinča period (Kaiser et al. 1986; Tringham et al. 1992; Spataro 2014).

Another aspect which these three Neolithic cultures have in common is the relatively low firing temperatures, as shown by the lack of vitrification of the fabrics and the well-preserved shells. The temperature achieved suggests that a kiln was not required, and that probably a bonfire was used for the firing. High firing temperatures are testified for the first time in the Balkans at the beginning of the middle Neolithic, with the Vinča culture (Kaiser et al. 1986; Spataro 2014). In conclusion, the early Neolithic Russian pottery was no less sophisticated, and probably more diverse, than the early Neolithic pottery I have studied from south and south-eastern Europe.

Despite the very different temper types used by the hunter-gatherers to make their pots, they were all used for cooking or preparing food, given the abundant burnt food crusts. This is a very important aspect, as one of the intriguing questions related to the early Neolithic pottery of the south-eastern European farmers is whether the potters used a specific paste to manufacture a vessel for a specific use (e.g. cooking). So far, from the analyses of almost 1,000 pots, no correlation has been found between vessel shape and fabric (e.g. Spataro 2011), and unfortunately food residues were not found on these pots. However, the four Russian pots, manufactured with shell, grog or sand temper, were all used for cooking. Thus coarse wares and cooking practices may be interconnected. This is an important topic for future research, as changes in cooking practices may explain the adoption of pottery production by hunter-gatherer societies.

Table 1 – SEM-EDX compositional results of the four potsherds analysed with average (blue rows) and standard deviation (white rows). Results are reported as normalised % oxides. The analyses of samples VAR01 and CHK01 was carried out on the fabric (matrix and non-plastic inclusions). The analyses of sample IMK01 werecarried out on the fabric (including the abundant clay pellets), only on the matrix (excluding the very iron rich pellets), and the clay pellets. Matrix and chamotte were analysed for sample ZAM01 matrix at 100x (ca.1.5×1.1 mm).

Sample	Notes		Na2O	MgO	Al2O3	SiO2	K2O	CaO	TiO2	MnO	FeO
VAR01	Fabric	mean	1.3	2.8	15.1	54.3	2.3	17.7	0.7	0.1	5.7
		s.d.	0.1	0.2	1.2	5.1	0.2	7	0.1	0	0.4
CHK01	Fabric	mean	0.3	0.9	9.2	83.7	0.9	0.9	0.5	0	3.6
		s.d.	0	0.1	1.5	2.5	0.1	0.1	0.1	0	0.5
IMK01		mean	1	1.2	13.7	69.9	2	2.5	0.8	0.1	8.8
		s.d.	0.1	0.1	0.6	1.5	0.1	0.2	0	0	0.9
		mean	1	1.2	13	57.4	2	3.2	0.7	0.3	21.4
		s.d.	0.1	0.1	1.4	5.6	0.4	0.6	0.1	0.3	5.5
		mean	1	1.1	14.3	71.3	2.2	2.4	0.7	0	7
		s.d.	0.1	0.1	0.4	1.2	0.1	0.2	0.1	0	0.6
ZAM01		mean	0.7	4.5	17.4	61.4	3.2	5.9	0.9	0.1	5.9
		s.d.	0.1	1	0.6	2.4	0.1	2.1	0.1	0	0.3
		mean	0.8	3.4	16	64.9	3.1	5.3	0.9	0.1	5.7
		s.d.	0.1	0.2	0.5	2.2	0.2	1	0.1	0	0.5

Table 2 – ZAM01: SEM-EDX compositional results of seven bulk analyses on different chamotte fragments analysed (160x) with average (blue rows) and standard deviation (white rows). Results are reported as normalised % oxides.

	Sp3	Sp4	Sp5	Sp16	Sp17	Sp18	Sp19
Na2O	0.7	0.6	0.7	0.8	0.9	0.8	0.9
MgO	2.9	4.1	2.5	2.5	2.5	2.5	2.9
Al2O3	20.7	21.1	18.0	18.9	18.4	17.8	20.3
SiO2	60.3	58.2	66.6	65.2	66.1	65.2	62.1
K2O	3.9	4.6	3.6	3.4	3.1	3.4	4.3
CaO	3.5	3.5	1.8	1.7	2.4	2.6	2.3
TiO2	0.9	1.0	1.1	0.9	1.2	1.0	1.1
MnO	0.1	0.1	0.1	0.1	0.0	0.0	0.1
FeO	6.9	7.0	5.6	6.7	5.5	6.7	6.2

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REFERENCES

1. Childe V. G. The Danube in Prehistory. Oxford, Clarendon Press, 1929.
2. Piezonka H. Jäger, Fischer, Töpfer: Wildbeutergruppen mit früher Keramik in Nordosteuropa im 6. und 5. Jahrtausend v. Chr. Deutsches Archäologisches Institut, Archäologie in Eurasien Band 30. Bonn: Habelt Verlag, 2015.
3. Spataro M. The First Farming Communities of the Adriatic: Pottery Production and Circulation in the Early and Middle Neolithic. Società per la Preistoria e Protostoria della Regione Friuli-Venezia Giulia, Quaderno 9. Trieste, 2002.
4. Spataro M. A Comparison of Chemical and Petrographic Analyses of Neolithic Pottery from South-Eastern Europe. Journal of Archaeological Science, 38, 2 (2011): 2011. P. 255–269
5. Tite M.S. and Y. Maniatis. Examination of ancient pottery using scanning electron microscope. Nature 257 (5222): 1975. P. 122–123.
6. Maritan L., Mazzoli C. and Freestone I. Modelling changes in mollusc shell internal microstructure during firing: implications for temperature estimation in shell-bearing pottery. Archaeometry 49(3), 2007. P.529-541.
7. Hammer Ø., Harper D.A.T. and Ryan P.D. PAST: Palaeontological Statistics software for education and data analysis. Palaeontologia Electronica 4(1): 2001. 9pp.
8. Kreiter
9. Kulkova M.A. and Kulkov, A.M. Investigations of early Neolithic ceramics from eastern Europe by X-Ray microtomography and petrography. Microscopy and Analysis, 17, 2015. P.7-10.
10. Kulkova M. unpubl. report. Petrographic analysis of ceramic fragments of the site Zamostje 2 (in Russian). 2013.
11. Spataro M. Cultural diversities: the Early Neolithic in the Adriatic region and Central Balkans. A Pottery perspective. In Gheorghiu D. (ed.) Early Farmers, Late Foragers, and Ceramic Traditions: On the Beginning of Pottery in the Near East and Europe, (Chapter 4): 63–86. Cambridge Scholars Publishing, Newcastle upon Tyne, 2009.
12. Spataro M. The first specialised potters of the Adriatic region: the makers of Neolithic figulina ware. In Forenbaher, S. (ed) A Connecting Sea: Maritime Interaction in Adriatic Prehistory: 59–72. BAR International Series 2037, Oxford. 2009b.
13. Feathers J.K. and Peacock E. Origins and spread of shell-tempered ceramics in the eastern woodlands: conceptual and methodological frameworks for analysis. Southeastern Archaeology 27 (2), (Winter 2008), 2008. P. 286–293.
14. Feathers J.K. Explaining Shell-Tempered Pottery in Prehistoric Eastern North America. Journal of Archaeological Method and Theory 13, 2006. P. 89–133.
15. Rice P.M. Pottery Analysis A Sourcebook. The University of Chicago Press, Chicago and London. 1987.
16. Tite M.S, Kilikoglou V and Vekinis G. Review article. Strength, toughness and thermal shock resistance of ancient ceramics, and their influence on technological choice. Archaeometry 43(3): 2001. P. 301–324.
17. Schiffer M.B. and Skibo J.M. Theory and Experiment in the Study of Technological Change. Current Anthropology, 28(5): 1987. P. 595–609.
18. Rye O.S. Keeping Your Temper under Control: Material and the Manufacture of Papuan Pottery. Archaeology and Physical Anthropology in Oceania 11: 1976. P. 106–137.
19. Spataro M. Technological uniformity? Early Neolithic ceramics, vessels, cult objects, net weights and daub production in Romania. In Luca, S.A. and Suciu, C. (eds.) The First Neolithic Sites in Central/South-East European Transect: 37–45. BAR, International Series,

Oxford. 2011.

20. Spataro M. and Meadows J. Bringing pottery to life: ceramic temper as a cultural identity. Batovicev Zbornik. Diadora, 26/27: 2013. P. 59–75.

21. Kaiser T., Franklin U.M. and Vitali V. Pyrotechnology and pottery in the Late Neolithic of the Balkans. In: Olin JS, Blackman MJ (eds) Proceedings of the 24th International Archaeometry Symposium, 85–94. Smithsonian Institution Press, Washington, 1986.

22. Tringham R, Brukner B, Kaiser T, Borojević K, Bukvić L, Šteli P, Russell, N, Stevanović M, and Voytek, B. Excavations at Opovo, 1985–1987: socioeconomic change in the Balkan Neolithic. Journal of Field Archaeology 19(3): 1992. P. 351–386.

23. Spataro M. Continuity and change in pottery manufacture between the early and middle Neolithic of Romania. Archaeological and Anthropological Sciences 6(2), 2014. P. 175–197.

FIGURE CAPTIONS

Figure 1 – Eastern and southern Europe, showing the location of sites and cultures mentioned in the text.

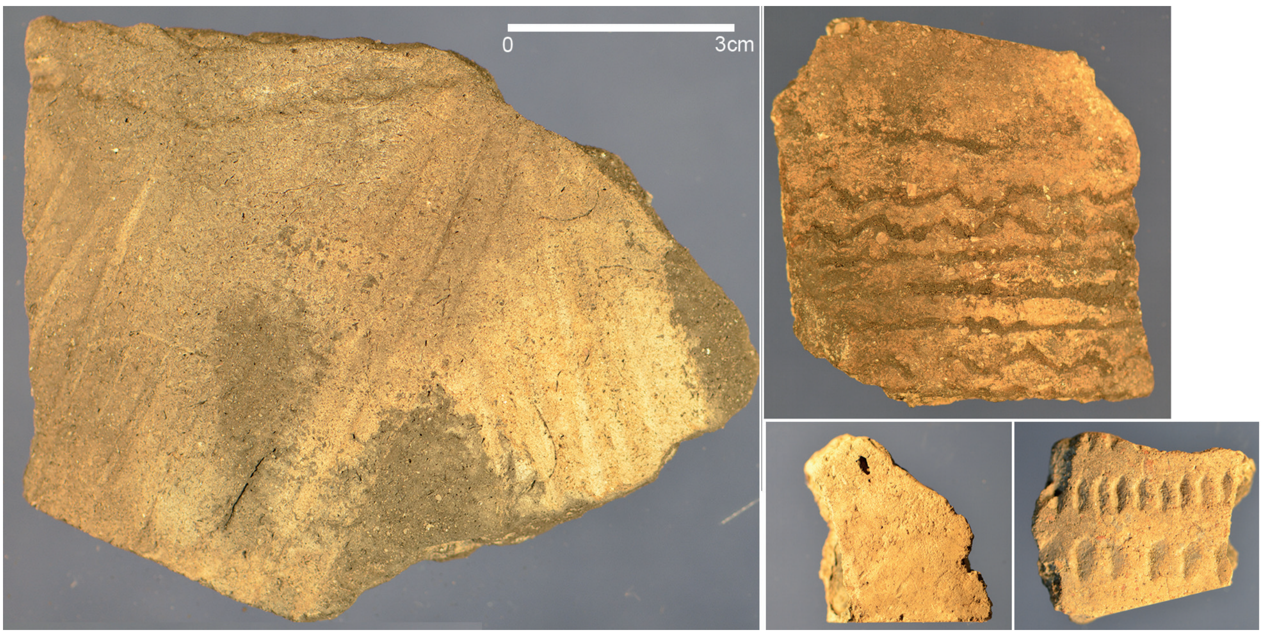

Figure 2 – The four early Neolithic Russian potsherds analysed. Clockwise from top: CHK01, ZAM01, IMK01, and VAR01 (photographs by J. Meadows).

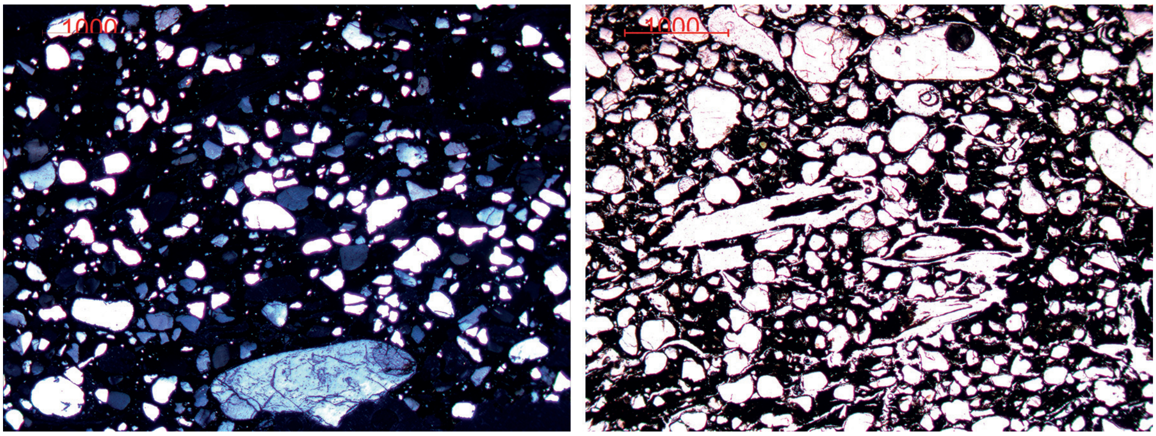

Figure 3 – Microphotographs of thin section of sample CHK01: left) showing the abundant sand-temper (cross polarised light, XPL), and right, showing charred plant remains in the fabric (note dense dark [plant] matter in the holes; plane polarised light, PPL; photographs by the author).

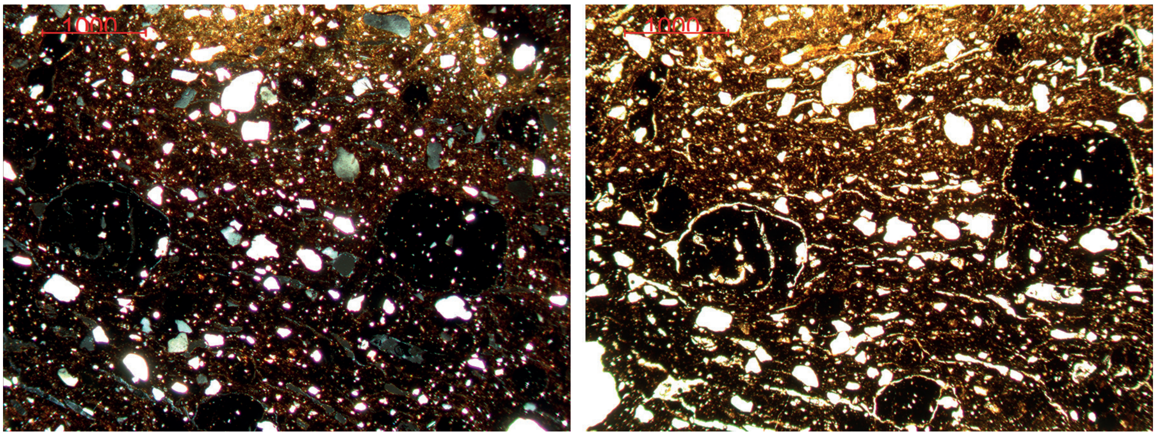

Figure 4 – Microphotographs of thin section of sample IMK01: left) showing abundant clay pellets and quartz sand (XPL), and right, showing the fabric and clay pellets in PPL (photographs by the author).

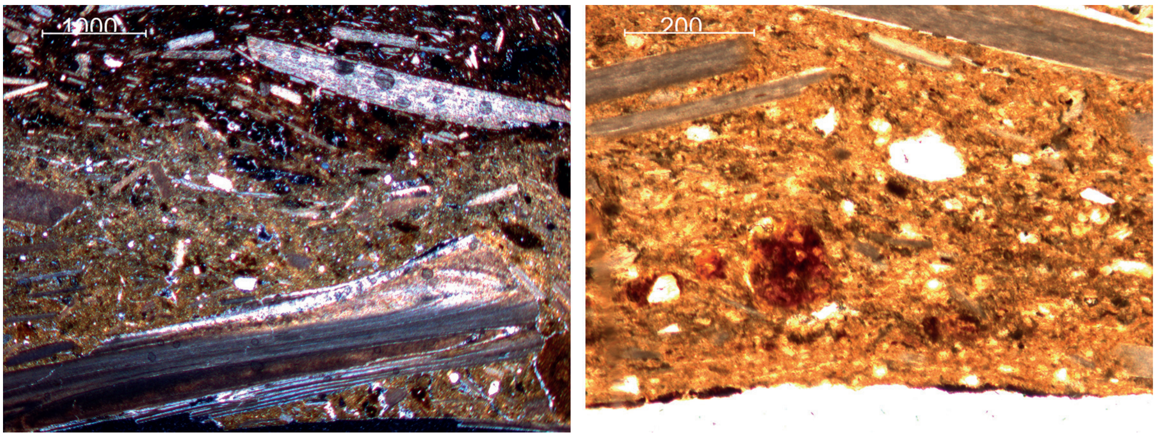

Figure 5 – Microphotographs of thin section of sample VAR01: left, showing abundant shell temper with different sizes (XPL), and right, showing the fabric in PPL with shells in the fabric and food residue along the surface (darker dense strip; photographs by the author).

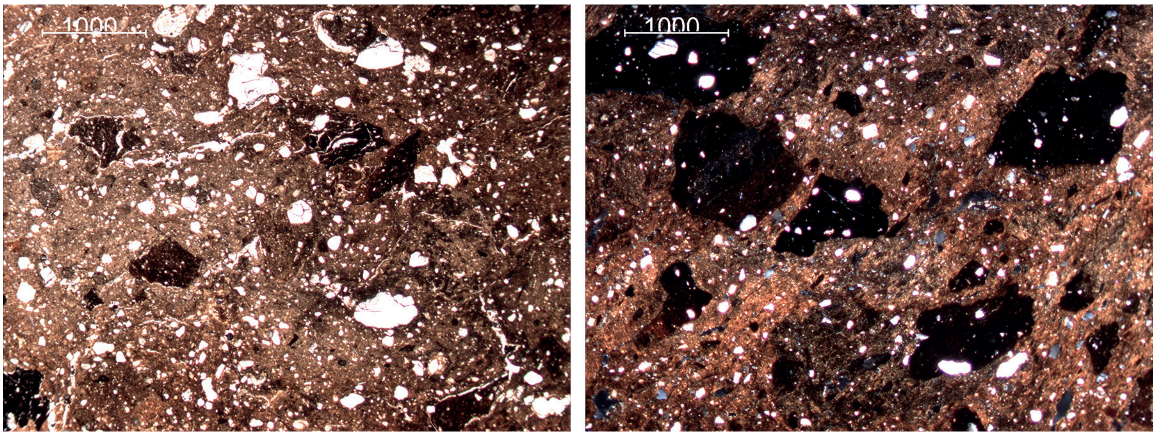

Figure 6 – Microphotographs of thin section of sample ZAM01: left, showing abundant chamotte temper (XPL), and another area in PPL (photographs by the author).

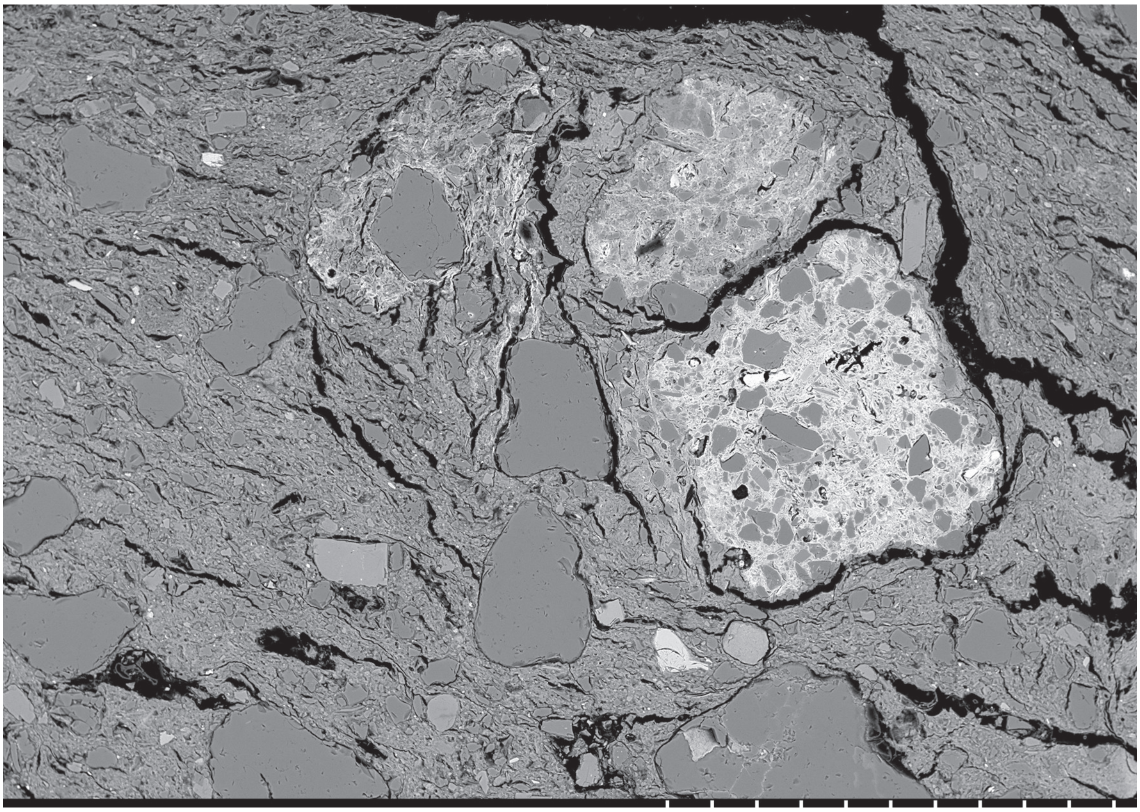

Figure 7 – Imerka VIII, sample IMK01: SEM image showing three iron-rich clay pellets in the fabric. Scale bar in 50-micron divisions.

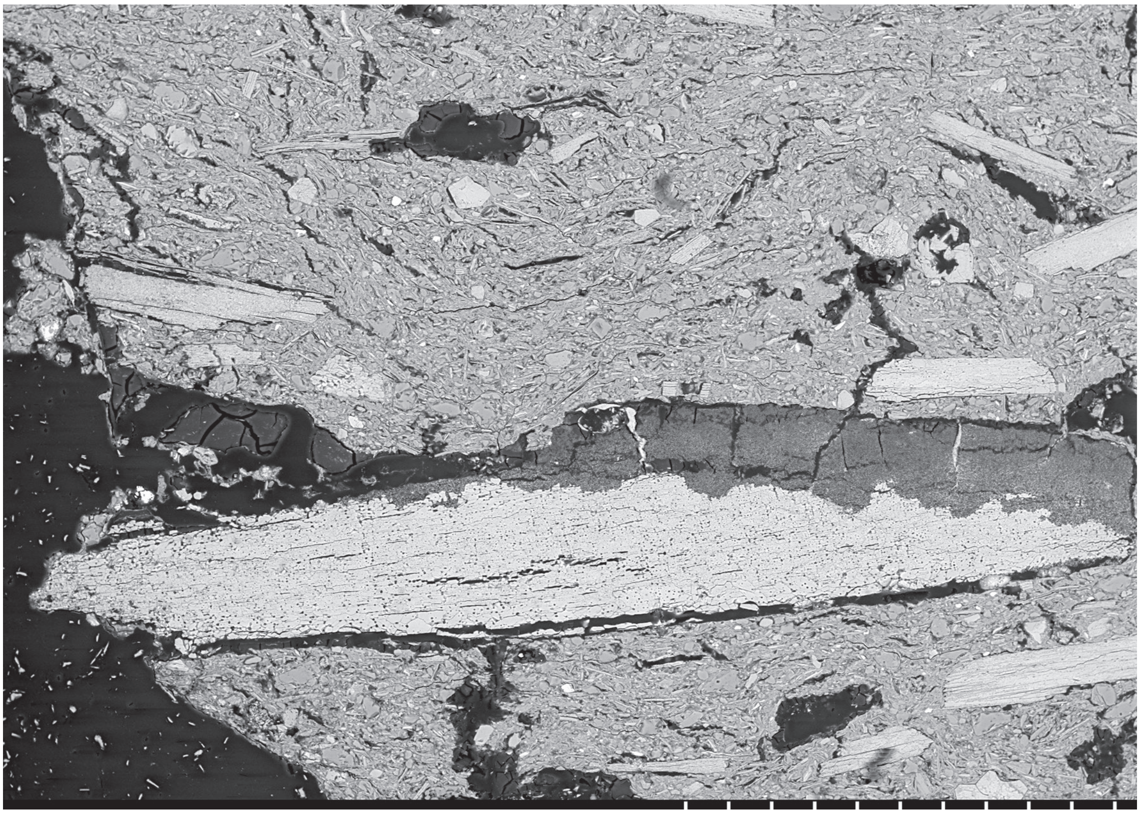

Figure 8 – SEM image of sample VAR01 showing traces of carbon residue on the edge, infilling the crack and interacting with the shell temper. Scale bar in 40-micron divisions.

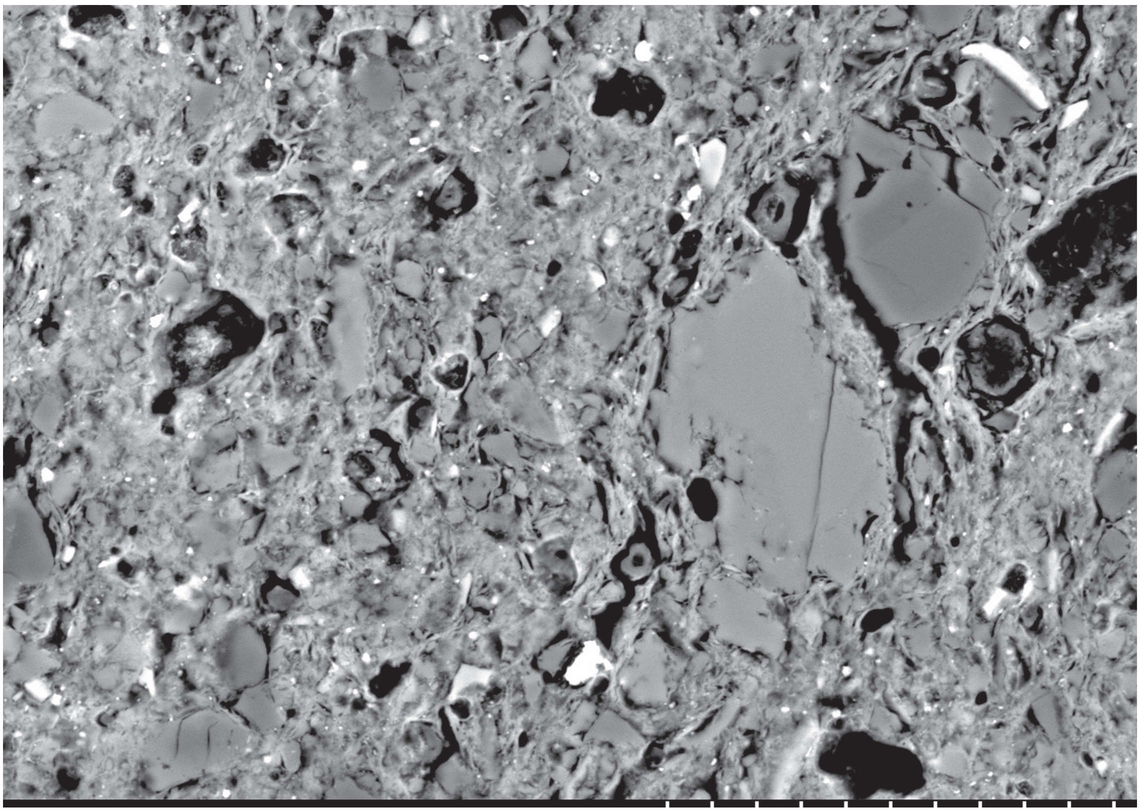

Figure 9 – SEM image of sample ZAM01 showing chamotte temper at high magnification, with some vitrification of the clay particles. Scale bar in 5-micron divisions.

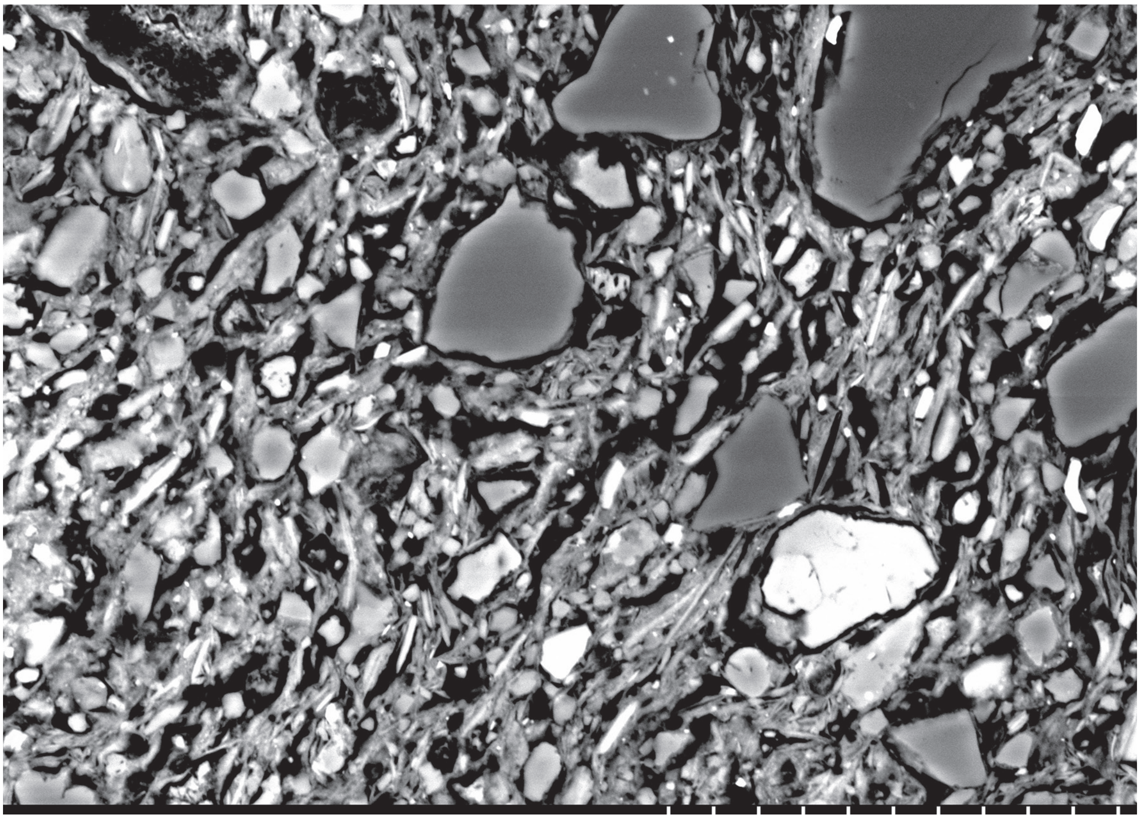

Figure 10 – SEM back-scattered image of sample ZAM01 showing the clay matrix at high magnification with no vitrification of the clay particles. Scale bar in 5-micron divisions.

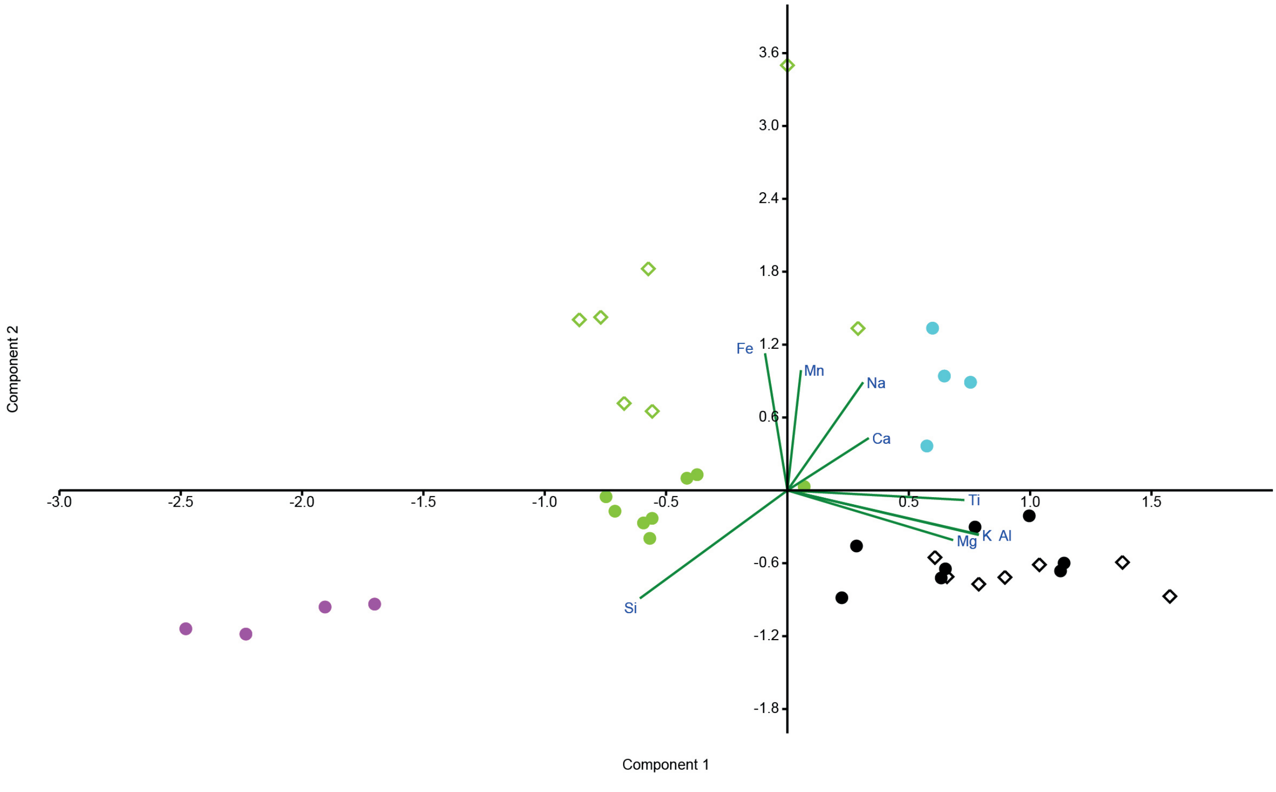

Figure 11 – PCA plot, components 1 and 2, of all SEM-EDX compositional data from the early Neolithic Russian pots from Cherkasskaya III (sample CHK01, pink), Imerka VIII (IMK01, green; diamonds represent clay pellet inclusions), Varfolomeevskaya (VAR01, turquoise) and Zamostje 2 (ZAM01, black; diamonds represent chamotte inclusions). Each symbol represents one of the at least four bulk analyses performed for each sherd (see Tables 1 and 2 for details).

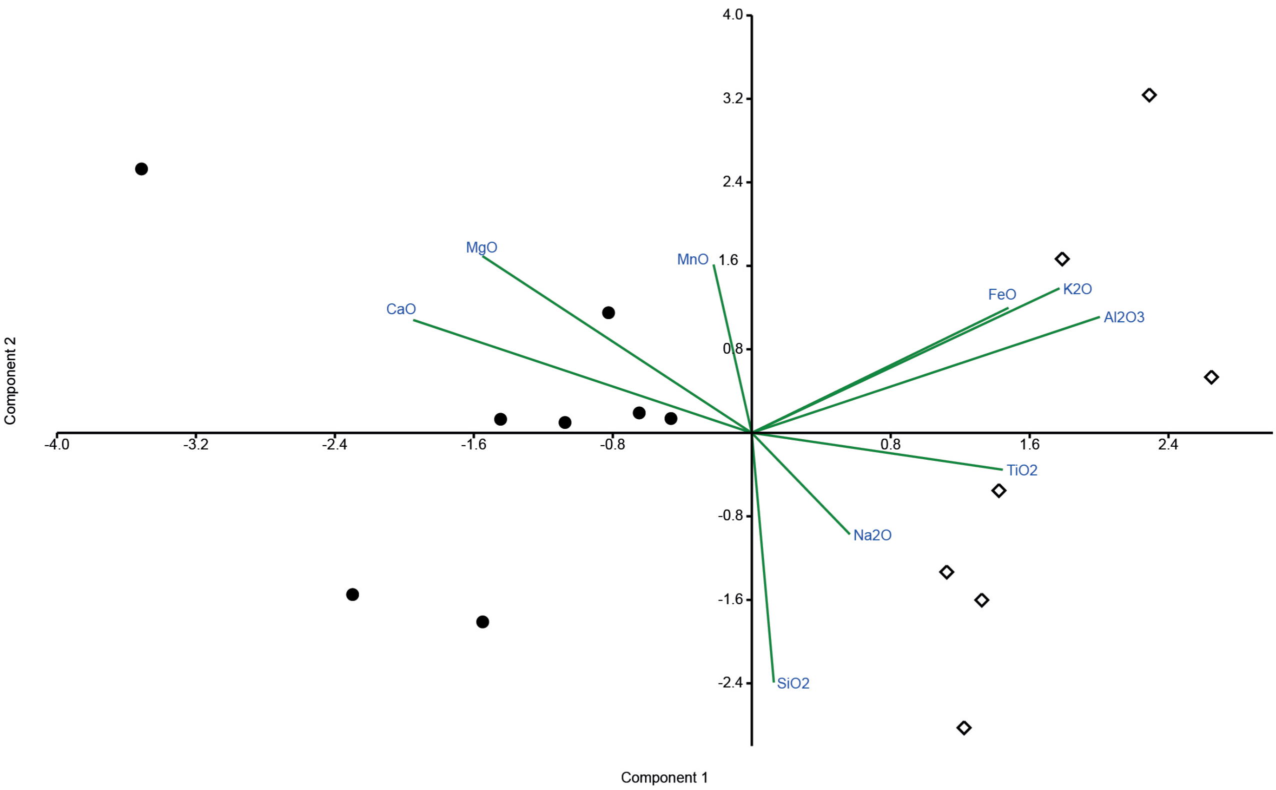

Figure 12 – PCA plot, components 1 and 2, of all SEM-EDX compositional data from the early Neolithic Russian pot from Zamostje 2 (ZAM01). Each symbol represents one of the bulk analyses of the pottery matrix (black dots) and chamotte inclusions (diamonds) (see Tables 1 and 2 for details).

FIRST IMPRESSIONS OF EARLY NEOLITHIC RUSSIAN POTTERY TECHNOLOGY

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Abstract. Ceramics appeared in southern Russia at about the same time as in southern Europe, at ca. 6000 cal BC, but whilst pottery was introduced into southern Europe, together with plant and animal domesticates, from southwest Asia, early Neolithic pottery in eastern Europe was probably developed locally by hunter-gatherers, or derived from other pre-agricultural societies in northern Eurasia. In this paper, four sherds from four different regions of central and southern Russia are analysed using the same methods previously employed in two large-scale research programmes on early Neolithic pottery from the Adriatic and the central Balkans. The four pots were made with different tempering agents and were generally low-fired, but while they may represent different technological traditions to the southern European pottery, the overall technical quality of the hunter-gatherer pottery is no less developed than that of the early farmers.

Keywords: early Neolithic Russia; ceramic technology; optical microscopy; Scanning Electron Microscopy; chamotte; tempering agents.