Plastic raw materials in Neolithic pottery production[1]

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ABSTRACT – *The paper is dedicated to the investigation of various natural silts as the most ancient type of raw material used in pottery production. The authors describe the specific features of the composition of plain and mountain silts, and discover the same features in ancient ceramics from different regions in Russia. It can be concluded that silts were the earliest raw material used, a tradition that faded away during the evolution of pottery production.*

IZVLEČEK – *V članku predstavljamo raziskave različnih vrst naravnega mulja, ki predstavlja najstarejšo vrsto surovine za proizvodnjo lončenine. Opisujemo specifične značilnosti sestave mulja, dosegljivega tako v ravnini kot v gorah, ter jih primerjamo z najstarejšo lončenino iz različnih regij v Rusiji. Sklepamo, da predstavlja naravni mulj najzgodnejšo vrsto surovine za izdelavo keramike, in da se je ta tradicija proizvodnje lončenine sčasoma izgubila.*

KEY WORDS – *natural silt; raw material; ceramics; pottery traditions*

Introduction

The raw materials used in pottery production can be formed into various shapes after damping, and can preserve their shape after drying. Three main kinds of raw materials are used in pottery production: mineral-organic (such as silt), organic (such as dung), and mineral (such as various kinds of clay). Some results of the study of silt as a raw material for the production of pottery will be considered here. Attention will be paid primarily to two questions: first, whether silt was indeed used as a raw material in ancient pottery production; and second, what are the capacities of modern approaches in studying this type of raw material.

The main focus is on initial and early Neolithic pottery production in the Elshanska and Low Volga in the Volga Basin, the Rakushechnuy Yar culture in the Low Don basin, and in the Bug-and-Dnieper, Dnieper-and-Donetsk and Surskaya cultures in the forest-steppe and steppe zone of Eastern Europe.

Comparative studies of silts and ancient pottery

Little attention has been paid recently to plastic raw materials used by ancient potters. The opinion that potters used clays as their main plastic raw material almost everywhere since the Neolithic Period persists to this day among archaeologists. In the course of ancient pottery analysis in the last two decades some facts have come to light that obviously contradict this view. This was most evident during the testing of natural inclusions in the pottery paste of Neolithic ceramics in Eastern Europe (*Vasilyeva 1994*).

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The analysis of pottery from the Bug-and-Dniester, the Dnieper-and-Donetsk and the Low Volga cultures with a binocular microscope showed that the pottery contained various inclusions in addition to clay particles, which we classify here into six types:

❶ Many plant prints from earth, water and underwater origin, including long prints (up to 5cm long) of narrow tangled plants (Fig. 1a, 1b) were identified as filamentous algae (*Department of Botany at Samara State Pedagogical University, personal communication*).

❷ Pieces of up to 0.5cm of sharp and more often round-edged mollusc shells were discovered in the pottery. Shell fragments of *Limnaea staglnalis* and *Planorbis planorbis*, bivalve molluscs that occupy rivers and lake shores have been discovered in Low Volga Neolithic pottery (*P. Y. Yasyuk, Department of Zoology at Samara State Pedagogical University, personal communication*).

❸ Whole shells (up to 0.6cm long) of the small volute of Valvata piscinalis (Fig. 2) were present in the pottery. These species occupy the shoreline area of rivers, lakes and ponds, clean soil or aquatic plants.

❹ Single scale (Fig. 3), vertebrae (Fig. 4), and rib prints of fish and their remains were also identified in the pottery.

❺ Round pieces of fine clay about 1–2mm in diameter are present.

❻ Various kinds and proportion of sand with grains smaller than 1mm were distributed non-uniformly in the pottery samples.

The natural inclusions in Elshanska pottery have a different composition. The following inclusions could be identified in the paste: (i) large amounts of sand (32–35% according to the data obtained by X-ray diffraction), including fine sand (less than 0.5mm) and often grey and black sand also; (ii) small amounts of plant prints, plant tissue (detritus), and sometimes long narrow plants (tangles); (iii) single pieces of shell with round edges; and (iv) occasional fish scale and bone prints.

Our comparative studies of natural inclusions in various kinds of clays show that such organic materials are virtually absent from them. Therefore, we can conclude that ancient potters used various silts and

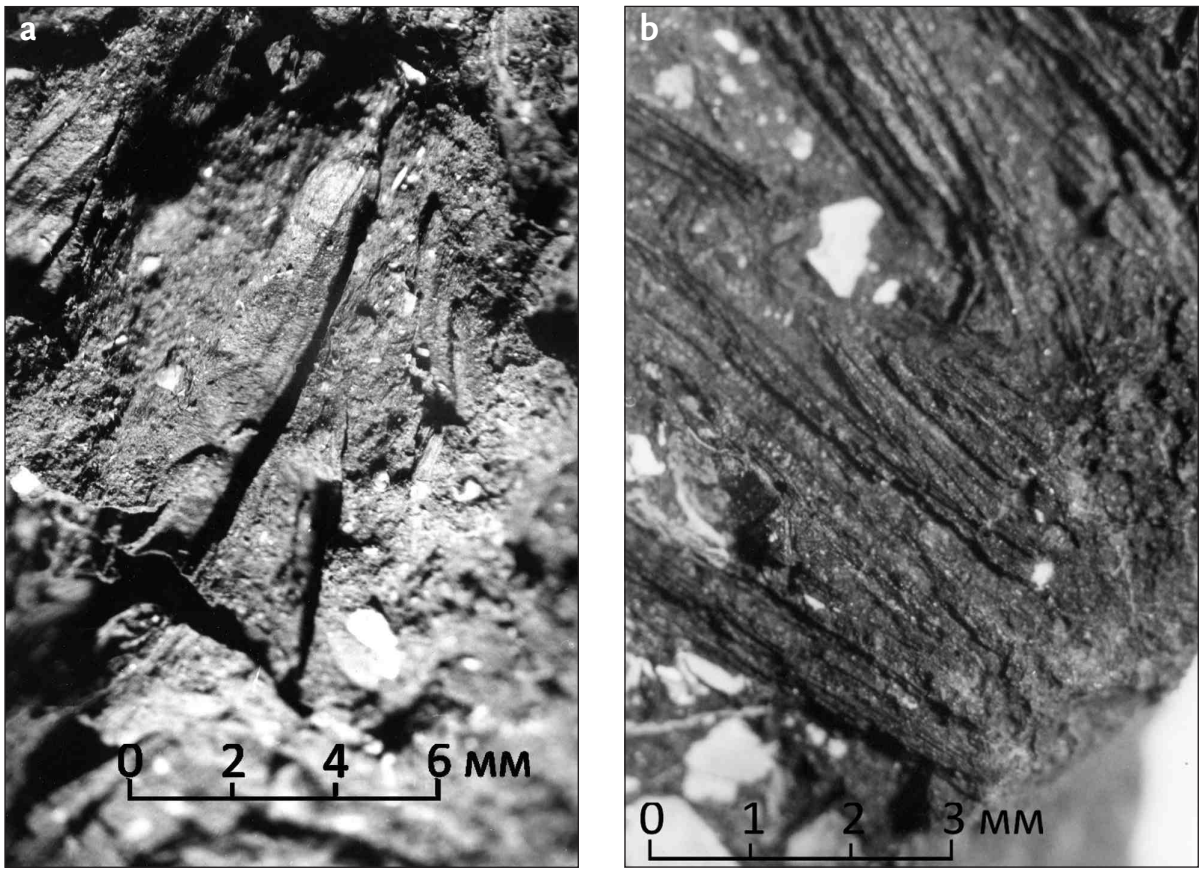

Fig. 1. Plant imprints in pottery paste (a Kair-Shak III settlement , b Tenteksor I settlement).

Fig. 2. Snail shell* Valvata piscinalis *in pottery paste. Kair-Shak III settlement.

sapropels as the main raw material for the production of pottery, not natural clays. The same characteristics of silt are described in the geological literature, where silt is defined as a fine-grained waterlogged precipitate of sedimentary rock. In natural conditions, it is fluid, becoming solid after drying. In terms of granulometric composition, most silt is pelite sedimentary rock. According to Klenova's classification, silt is sediment (soil) that contains approximately 30–50% of mineral particles smaller than 0.01mm (*Geological Dictionary 1978.284*). Silts are comprised of mineral and organic matter; the mineral component includes clay particles smaller than 0.01mm and sand-siltstone particles bigger than 0.01mm in size. The proportion of sand and siltstone particles varies and depends on how the silt originates. Evidently, this is the reason for the variation in the qualitative composition and proportions of sand in pottery from the same culture. Moreover, silt contains iron oxides, which appear as small red-brown coloured spots or small ironstone grains of marsh ore. Carbonates in the form of white inclusions that react with 10% hydrochloric acid, but sometimes also separated pebbles and big grits can also be found in the silt. The organic components of silt include floral and faunal remains. The plant particles are comprised of roots, footstalks and leaves of aquatic and subaquatic plants (Fig. 5), fragments of wood and bark, parts of inflorescence, footstalks, leaves, seeds and fragments of plants. Animal particles include small shells and molluscs, the chitin exoskeletons of insects, various grubs and worms, fish scales, bones and the like.

To determine whether silts were used in primitive pottery production, we performed special field and laboratory experiments over the course of a few years to study the composition and characteristics of various natural silts. The experiments involved: (i) silt collection in various rivers and lakes from shallow waters and at various depths; (ii) silt sieving with water; (iii) microscopic study of the qualitative composition of various silt fractions; (iv) the preparation of standard samples in special moulds, which were dried and fired at 450°C and 750°C. In addition, we made vessels from various kinds of dried, powdered, and dampened silts. The various silts were collected in shallow water from the River Ahtuba near the Kairshuck II site (Astrahansaya region), from bayou lakeshores, and the bottom of the Samara and Volga rivers (Samara region).

After washing finds with water in sieves, we obtained various fractions of silt in five different size ran-

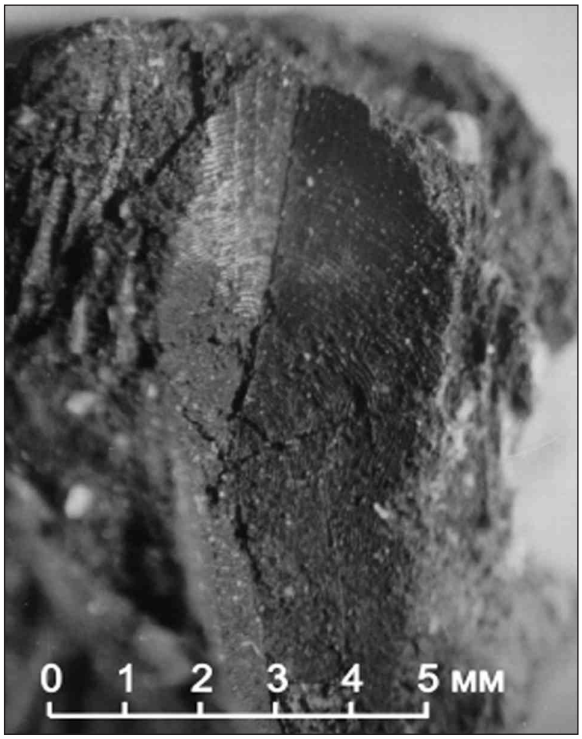

Fig. 3. Fish scale imprint in pottery paste. Kair-Shak III settlement.

ges: (i) more than 4 mm, (ii) 2–4mm, (iii) 1–2mm, (iv) 0.5–1mm, and (v) 0.25–0.5mm. The first fraction includes round pieces of fine clay, coarse and whole floral and faunal remains. The second fraction had the same composition, but the organic remains were somewhat destroyed and partly decayed. The third fraction consists of small round particles of fine clay, various coloured sand, some of which was partly sharp-cornered, various plant particles (such as pieces of wood and bark, algae, scapes and long leaves of aquatic plants, clots of blue-green transparent and plain algae, seeds and fragments of empty glumes, and a quantity of indeterminate floral pieces), and faunal remains (whole snails and shell fragments, pieces of chitin from insect exoskeletons, fish scales and grubs). The fourth fraction was largely the same. The fifth fraction included a great deal of sand, very small pieces of fine clay and the smallest plant remains.

Part of the finest fraction of silt was dissolved in a large volume of water. As a result, a thin layer of very fine clay formed on the top; the lower layer consisted of sand, clay particles in the form of lenses and layers, very fine plant particles, and a considerable amount of red-brown spots (iron compounds). During this study, we discovered that their particular characteristics could be connected to their origin. Thus, the silts from shallow water in rivers and ponds inhabited by birds and animals included more glutinous mass that consisted of small decomposed plant particles and other organic matter such as bird feathers, footstalks, fish scale *etc*. Silts from the bottom of ponds usually include fish scale, sand and clay particles and some addition of small vegetation. This is why the overall composition of silts depends heavily on its local conditions.

The water of stagnant basins (such as lakes, ponds, bogs) contains large quantities of plankton, algae (Fig. 5), worms, molluscs, slugs, maxillopods, and blue-green algae rich in iron. In addition, there is a sizeable quantity of clay soil. All these bottom sediments generate a creamy deposit known as the pelogenous layer. Lower layers of black or grey sapropel contain almost no natural plant or animal remains. The sapropel layer is more homogeneous and dense than the upper pelogenous layer. Lamination is one of the main features of silt.

In the next stage of the experimental study, we made standard samples of silt (10cm long and 1cm^2 square) cleaned of coarse organic and mineral inclusions. The samples were dried for 2–3 days to eliminate surplus water, fired at 450°C and 750°C, and studied under a binocular microscope. The comparative analysis of the natural composition of standard samples and the Neolithic pottery revealed a close resemblance.

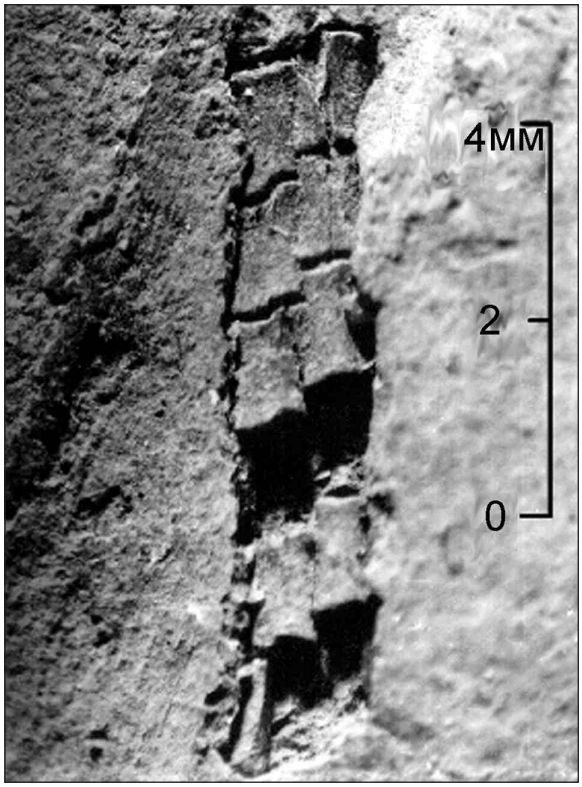

Fig. 4. Fish vertebras in pottery paste. Kair-Shak III settlement.

As a result of this study, we can establish a system of main attributes for the determination of natural silt as a raw material in pottery production:

❶ The presence of round insoluble pieces 1–2mm in size of fine high plastic clay in the pottery paste.

❷ Unequal distribution of plant remains and natural sand in pottery paste (which is typical of natural silts) and the presence of more compact clay parts due to difficulties in mixing the pottery paste.

❸ Significant variety of qualitative composition and proportions of natural sand in the pottery paste of a single vessel and in contemporary pottery. The composition of silts usually depends on the mineral and organic riverbank formation.

❹ Considerable amount of ferriferous inclusions.

❺ Plant prints in the silt raw material are narrow, flat, long (up to 5cm), and often twisted. They have

no traces of cutting by teeth, which are characteristic of dung remains.

❻ Presence of organic material of animal origin: fish bones and scales (Fig. 6), grubs, worms *etc*.

❼ Presence of shell pieces, mostly small and with rounded edges, in combination with medium-sized and larger pieces (up to 4mm). Complete snail and bivalve shells can also be present. Silt deposits with high amounts of broken and round shells are rare in nature, which is why the use of this kind of raw material reflects a special pottery tradition. It is possible that the tradition of adding high amounts of broken shells as temper to ceramic paste appeared and was distributed among the populations of the Srednestogovskaya, Khvalynskaya, Samarskaya cultures from the Eneolithic Period. For example, some of the Neolithic pottery includes small snail shells 5–7mm in size (at Kair-Shak III, Tenteksor I, Vishenki II).

❽ One of the special features of Neolithic pottery made from silt is the foliation of sherds. An experiment showed that the main reason for this is daubing of the mould with thin silt patches. This mode of vessel construction was discovered at settlements of the Low Volga culture. The walls of the vessels are approximately 1cm thick.

Fig. 5. Algae agglomeration in natural silt.

It is important to consider all attributes of silts in the study of ancient pottery, as individual attributes are not enough to qualify the raw material as silt. However, this does not mean that all pottery sherds will reveal fish scales or worm prints and so forth. But these individual attributes should be connected to other special features as discussed above.

Thus, as a result of comparative studies of natural silts and Neolithic pottery, we conclude that ancient potters used various silt raw materials (as well as natural clays) for their production of pottery. These differences are very important, since they reflect the various cultural traditions in pottery production that were characteristic of different cultural groups of ancient populations.

Pottery technology

For a better understanding of these facts, pottery technology should be considered as a source of historical information based on archaeological and ethnographical data. The history of pottery technology reflects general and concrete-historical evolution processes. The former have a unidirectional tendency in their evolution and develop in any pottery tradition. On the other hand, the latter appear in various regions and chronological periods: they could exist over one or several generations of potters and appear and vanish suddenly. Such processes always destroyed evolution, increasing or reducing its pace.

Now four types of general processes in pottery technology evolution are known: the first concerns the potters' skills of self-organisation; the second shows the evolution of potters' knowledge of raw materials; the third – in terms of the thermal treatment of vessels; and the fourth is connected to the different modes of pottery-making (*Bobrinsky 1999*). The selection of plastic raw materials is an indispensable technological task for potters during pottery production. These skills could be characterised in various (pre)historic situations as being highly stable or highly variable. These facts reflect the beginning of changes in the cultural material of native populations as the result of the arrival of foreign potters.

It is also necessary to remember that clay as a raw material can have one of four functions in pottery paste: (i) as a mineral temper (< 40% in volume) in combination with other plastic and non-plastic inclusions, (ii) as a special copulative raw material (40–60%) with other kinds of temper and/or natural inclusions, (iii) as the principal raw material (60–

90%), and (iv) as a single raw material (90–100%) in pottery paste (*Bobrinsky 1978; 1993*). Therefore, to determine the function of plastic raw materials, we need to know its proportion in pottery paste.

The latter three functions of clay are the most important, because different pottery industries existed on these bases in prehistoric and historical periods. All these functions of raw material are known in different regions (in Eastern Europe, in Siberia, in the Near and Far East, and in Central Asia), and therefore can be considered universal in the history of pottery technology.

In the comparative study of archaeological and ethnographical data, Bobrinsky discovered that potters' ideas about clay as a raw material developed in two directions – upwards and downwards. The duration of each direction lasted at least a few thousand years. The progress in both directions included three states of development – unformed, partly formed, and fully formed (*Bobrinsky 1993*). The unformed state is characterised by the first and second functions of clay; the partly formed state is characterised by the third function of clay and the fully formed state by the fourth function of clay as a raw material. These various states reflect a general chain in the development of pottery production on the one hand, and deep cultural differences between holders of these pottery making traditions on the other.

These general features should be considered in the study of ancient populations. In result all pottery production with unformed ideas about raw material (functions 1 and 2) is called proto-pottery (PP), productions with partly formed ideas (function 3) is called 'archaeo-pottery' (AP), and productions with fully formed notions (function 4) comprise the so-called 'neo-pottery' production (NP). These basic tendencies characterise only an upward evolution, but a downward tendency is also present in pottery traditions in ancient populations. This begins with the fully formed state (function 4) and results in the unformed stage (functions 1 and 2). It is also important to note that certain kinds of raw materials could change in both tendencies, and other types of raw materials can change only downwards. All these main tendencies have been discovered in ancient pottery traditions.

We will now attempt to make some preliminary observations on the evolution of the use of silt as a raw material in ancient pottery productions. Silt deposits (A) obviously define two initial directions in

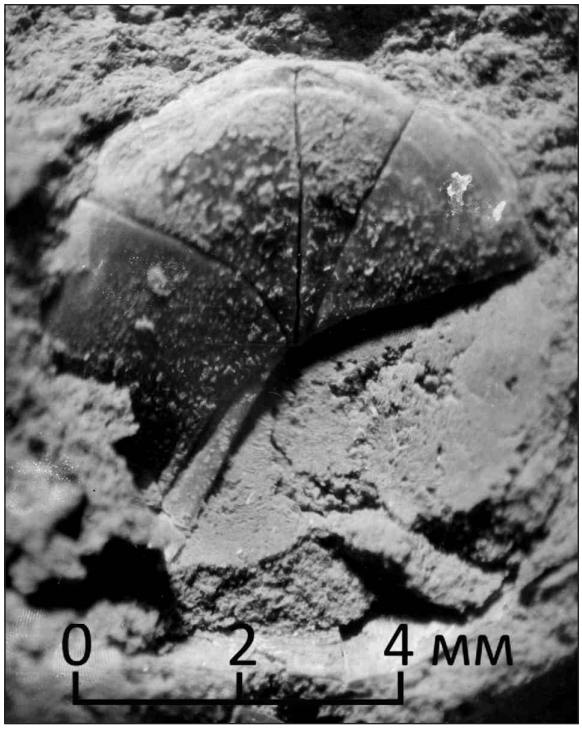

Fig. 6. Fish scale in natural silt.

the selection of raw materials for pottery production. The first direction is connected to the use of silt from shallow waters (rivers, lakes, *etc*.) found on plains, and the second is connected to the use of mountain silts deposited mostly in sub-mountain and mountain rivers. Thus, these directions reflect the environment in which silt could be collected. Plain silts (A1 type) are usually rich in aquatic plants organic remains, round particles of fine clay, pieces and complete shells of small molluscs, sometimes with fish scales and pieces of fish bone, *etc*. A small amount of large and medium-sized sand is usually comprised of rounded mineral grains. Mountain silts (A2 type) include small amounts of organic inclusions (less than 10%), round clay particles, and considerable quantities of rounded sand from soft and hard rocks. Irina Vasilyeva considers these silts to be silty clays.

These attributes of various kinds of silts are not complete. Among plain silts (A1) some may resemble sapropel or clays. Sapropel usually contains a considerable quantity of very fine round sand (<0.5mm) and small amounts of clay particles; the clays include a considerable quantity of clay particles and small amounts of coarse sand. Neither direction has been sufficiently studied; in Russia only two large regions with plain silts (the Volga basin) and mountain silts (the Altai) were used by potters for a long period.

In the history of pottery technology, the tradition of using silts as raw material developed downwards. According to the archaeological data from Eastern Europe, this general tendency developed over three stages: (i) the fully formed stage was especially characteristic of the Neolithic Period and Early Bronze Age; (ii) the partly formed stage is less typical of the Neolithic Period and more typical of the Bronze Age; and (iii) the unformed stage is characteristic of the period from the Bronze to the Early Iron Age. Certain difficulties arise in identifying the use of silts in the partly formed and unformed stages of pottery production (functions 2 and 1). But these stages can be recognised in the use of sand and broken rock temper in pottery pastes. This conclusion is based on a common rule known from ethnography. When potters move to a region where their traditional raw materials are not available, they begin to replicate these materials artificially by adding sand, broken rock, broken shell, or other kinds of temper to the pottery paste.

Conclusions

With all of these data in mind, we can conclude that silts were among the first kinds of raw materials used by ancient potters, and this obviously happened a long time before the creation of pottery technology. We also assume that silts were widely used without special thermal treatment. Bobrinsky (*1999. 84*) labelled such production as pre-pottery production A and divided it further into two stages: pre-pottery production A1, in which plain silts are used, and pre-pottery production A2, in which mountain silts are used.

During the investigation of the earliest ceramic samples from the Northern Caspian region (Kair-Shak III site, 6th millennium BC), it became clear that the pottery paste, aside from plain silt, included some kinds of special organic solutions with various properties. One sample is characterised by a dried glossy (not oily) surface with small black crystals, and another by an oily and fatty surface. There are many such traces in pottery that sometimes included fragments of shells covered by such surfaces. All the vessels had been re-fired and the firing experiments showed that to heat pottery with an oily surface to a red-hot state 5–8 minutes were required, but 96–98 minutes of heating were required for pottery with a dry slim surface. In the second sample, the red-hot colour attained a depth of only 1mm on the outer and 0.4mm on the inner surface. This suggests that vessels with this type of organic solution in the paste were not yet intended for special firing.

It is quite possible that the silt traditions were relics of the pre-pottery production stage. Examples have been discovered in Neolithic pottery in sites from the North Caspian basin, the Volga basin, and some north-western regions of Russia (for example, the Usviytu site in the southern part of Pskov region). While these data are still fragmentary, because the method of red-firing time determination was not known until recently, it is now possible to revaluate the finds from these regions.

Pre-pottery productions can be considered as substrates. They include two types (A1 and A2) on the one hand, and products with function 4, where silt is the only raw material used, and function 3, where silt is the main raw material, on the other. The next step in pottery technology development is connected to proto-pottery production, in which silt was used in the same role, but vessels were already subject to special firing. In the so-called 'archaeo-pottery' and 'neo-pottery' productions, silts were no longer used, since they had been supplanted by organic materials such as temper and clays as the main raw material. Here the downward tendency of silt development was manifested in a gradual decline in its use.

As a result of the study of evolutionary changes in ideas about silts in pre-history and the history of the creation of pottery technology, we can single out two types of pottery production in which silts had different leading functions. The first one is comprised of the so-called pre-pottery ware A1 and A2; the second includes proto-pottery productions A1 and A2, in which silts were the principal raw material or only raw material, as in the pre-pottery production. In conclusion, we regard previous notions regarding raw materials used by ancient potters with some criticism. These data will help to expand our understanding of modern ways to use ancient pottery technology as a source of historical and cultural information.

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