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TRAITS OF THE NEOLITHIC-ENEOLITHIC ARCHAEOLOGICAL LAYERS' FORMATION AT THE SITES OF ALGAY AND OROSHAEMOE IN THE LOW VOLGA BASIN (LOW POVOLJIE)

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Abstract. The Low Volga basin is an important area for the study on the genesis of Neolithic and Eneolithic archaeological cultures in Eastern Europe. Until now well stratified Neolithic-Eneolithic sites had not been found in the Low Volga (Low Povoljie) region. This has been a cause of serious discussion about the periodisation, genesis and interaction between cultural groups during the Late Stone Age in this area. Excavations of new open sites of Algay and Oroshaemoe began in 2014. Both sites are unique for the Low Povoljie. It is important that the archaeological layers are within loess loam and they are interlayered with sterile natural layers. This fact precludes a mixing of artefacts of different ages. Most of the artefacts and ecofacts found in a clear stratigraphic context allow for a presentation of the detailed characteristics of the Orlovskaya Neolithic culture, and the Cis-Caspian and the Khvalynskaya Eneolithic cultures. For the first time, reliable data have been obtained for a periodisation of the Neolithic-Eneolithic of the Low Povoljie. A set of radiocarbon dates for all archaeological layers allows for a determination of the precise chronological frameworks of Neolithic-Eneolithic cultures in this region. The geochemical analysis of archaeological layers and sterile interlayers made possible a reconstruction of climatic characteristics for different periods of the Holocene. The processes of development of archaeological layers in the periods of the Orlovskaya and the Cis--Caspian cultures were considered.

Key words: Low Povoljie, Neolithic-Eneolithic, geochemistry, radiocarbon chronology, Orlovskaya Culture, the Cis-Caspian Culture

Introduction

The Low Povoljie region is the contact zone between southern steppe and forest steppe. It has a key significance in the study of Neolithic-Eneolithic Epochs of the European part of Russia (Fig. 1). Most of the archaeological sites in this territory have mixed archaeological layers with artefacts of different ages. Before new sites were discovered and radiocarbon dates obtained, the discussion was based only on the archaeological typology of artefacts. The excavations of the Algay and Oroshaemoe sites changed the situation substantially. Both sites have a clear stratigraphy. The archaeological layers were developed within loess loams interlayered by sterile layers. Determining the traits of the Neolithic and Eneolithic archaeological layers made it possible to resolve questions regarding the periodisation, chronology, genesis and interaction of archaeological cultures.

Before investigations of the Algay and Oroshaemoe sites, only one location in the Low Povoljie was known to have yielded finds of the Orlovskaya Neolithic culture and the Cis-Caspian culture. It is the Varfolomeevskaya site about 60 km to the west of the Algay site. It has four lithological units: upper, middle (2A and 2B) and bottom. The total thickness of archaeological layers at

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the site is 2.2 m. The conditions of layer sedimentation were reconstructed. The bottom layer of the Varfolomeevskaya site is light yellow loam that resembles the bedding deposits. It does not cover the whole square of the site and it was almost destroyed by the pits of constructions from the middle layer. In the shore zone of the river, in the north-eastern corner of the excavation, this layer has been well preserved and its thickness reaches 0.7 m. The border between the bottom and middle (2B) layers is very clear: the middle layer is darker because of the admixture of humic sediments. According to Yu.A. Lavrushine (see Yudin 1998), there is a chronological hiatus between the bottom and middle layers and there is a buried soil between layers 2A and 2B. Layers 2A and 2B are similarly coloured. These layers have similar archaeological finds. In the north-eastern part of the site, layer 2A is separated from layer 2B by a small interlayer of light loam or interlayers of ochre. The upper layer is thinner and contains fewer artefacts than the bottom layer. It is light yellow and is clearly differentiated from layer 2A. It needs to be noted that this layer contains artefacts of both the Orlovskaya and Cis-Caspian cultures. This fact is evidence that these layers with different cultural complexes were intermixed. No traces of constructions have been found. All these traits of archaeological layers on this site are very interesting. However, it was not clear how they correspond to the stratigraphy at other sites in the region, nor whether they can be associated with any climatic record. Most of the artefacts belong to the Orlovskaya Culture. The abundance of artefacts of the Cis-Caspian Culture is rather low and the context of the archaeological layer is unclear. It is important that in the Cis-Caspian Culture the first marks of animal domestication for this region were recorded (Vybornov *et al.* 2016a). Based on the data from the Varfolomeevskaya site, only the formation of layers of the Orlovskaya Neolithic culture and its periodisation could be presented. The excavations of new archaeological sites of the Neolithic and Eneolithic of the Low Povoljie (Oroshaemoe site and Algay site) provided answers to these questions. This is very important because one of the most ancient ceramic traditions of Eastern Europe was formed from carriers of the Orlovskaya Neolithic culture (Vybornov *et al.* 2018).

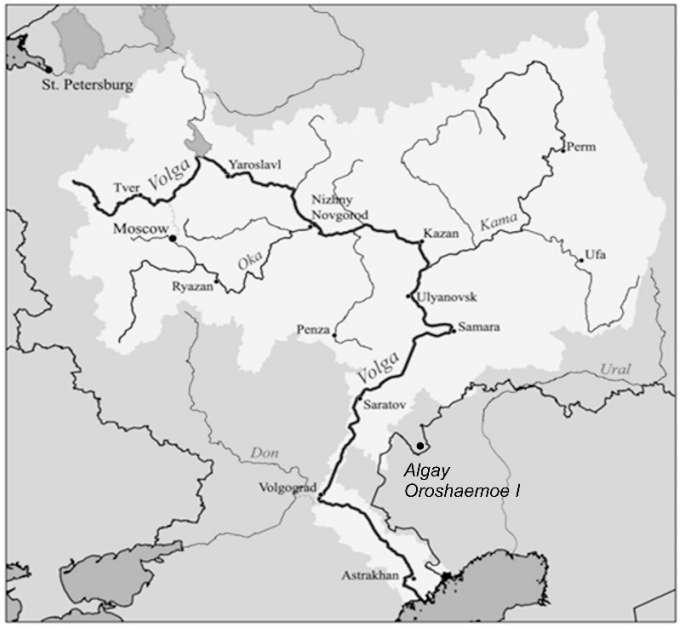

Fig. 1. Map of site locations

Materials and methods

The Oroshaemoe site has been known since its discovery in 1983 by an expedition under the guidance of V.B. Vorobiev. It is located 2 km to the north-west of Alexander Gay district centre in the Saratov oblast on the right shore of the Bolshoy Uzen' River (Yudin 2012) (Figs 2, 3). The investigations on the site were conducted in 2014–19. There were two excavations – Algay and Oroshaemoe – which were located 150 m from each other

(Vybornov *et al*. 2015, 2016b, 2017; Yudin *et al.* 2016, 2017) (Figs 2, 3). The sites are located on a hill of a river terrace. The cultural horizons were excavated in layers of 5 cm each, and the locations of finds were registered using 3D fixation.

The chemical composition of loess loam deposits of the studied outcrop's wall at the Algay and Oroshaemoe sites was determined by XRF-WD (Wavelength dispersive X-Ray Fluorescence) analysis using a SPECTROSCAN MAX apparatus. Fine-grained fractions of <0.25 mm were taken for samples, and ground into powder state in an agate mortar. The tablets for XRF analysis were pressed by means of hydraulic press using boric acid.

The obtained data on the chemical elements' composition were calculated by principle component method (PCA) to determine the landscape-climatic factors that influenced the sedimentation processes. The key concept of factor analysis is that multiple observed variables have similar patterns of responses because they are all associated with a latent variable (Kulkova 2012).

We used the two main factors of the four calculated in order to determine sedimentation characteristics for both sites.

The first principal component (FI) (CaO, Sr/Al_2O_3, SiO_2, MnO, Fe_2O_3) (Figs 3, 4) shows the antagonism between elements of the carbonate group (CaO, Sr) and the group of aluminosilicate minerals (clay minerals, quartz) and iron, manganese oxides (Al_2O_3,SiO_2, MnO, Fe_2O_3). The positive factor loading corresponds to carbonate precipitation having occurred in a period of arid conditions, whereas the clay minerals and iron-manganese oxides with negative loading were formed in humid climatic conditions (Kulkova 2012). The first principal component (F1) characterises the relative change of precipitation. The positive loading of this factor describes the dry climatic conditions, and the negative loading reflects wet conditions. This interpretation is confirmed by other geochemical indicators connected with the relative humidity, such as the Chemical Index Alteration ($CIA=Al_2O_3/(Al_2O_3+CaO+Na_2O+K_2O)$) (Nesbitt, Young 1982) and the CaO/MgO ratio. The index of CIA shows the alteration of aluminosilicate minerals as a result of weathering. The CaO/MgO ratio indicates increasing of CaO *vs* MgO in the carbonate component in the periods of prevailing dry conditions.

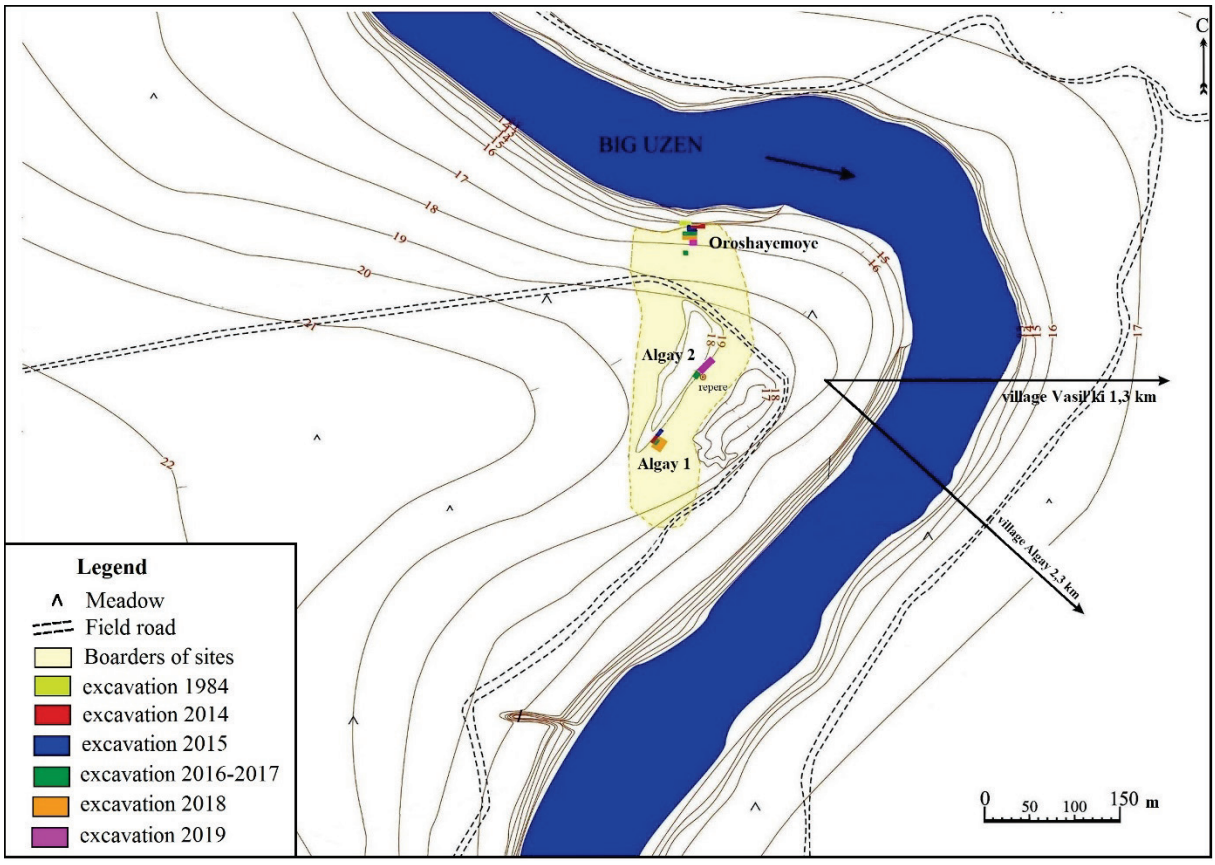

Fig. 2. Topographic schema of Algay and Oroshaemoe 1 sites

Fig. 3. Situation of Algay and Oroshaemoe sites on the river shore

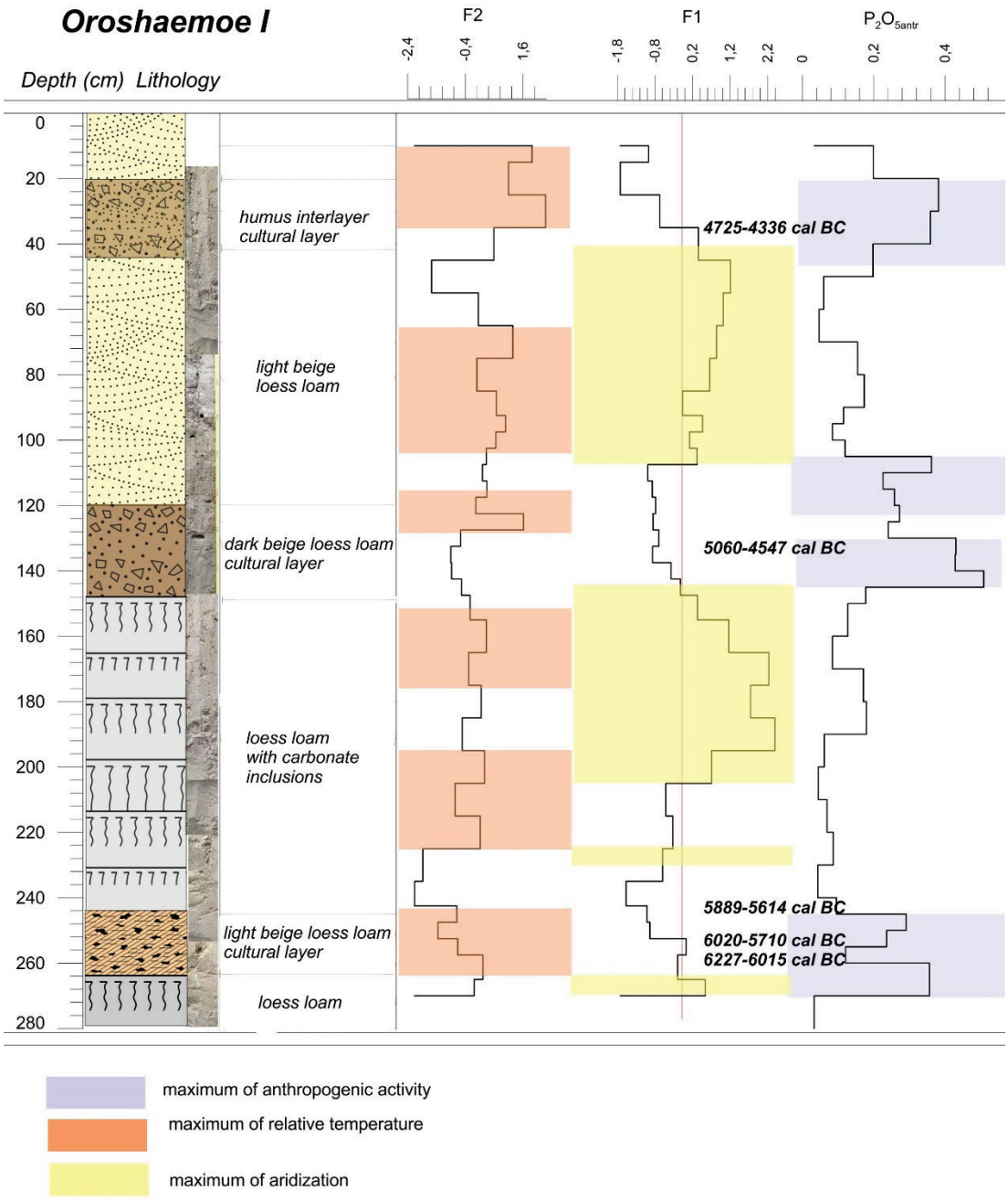

Fig. 4. Lithology and stratigraphy of a cross-section at the Oroshaemoe 1 settlement with geochemical indicators of the palaeoenvironment (according to Kulkova *et al*. 2019)

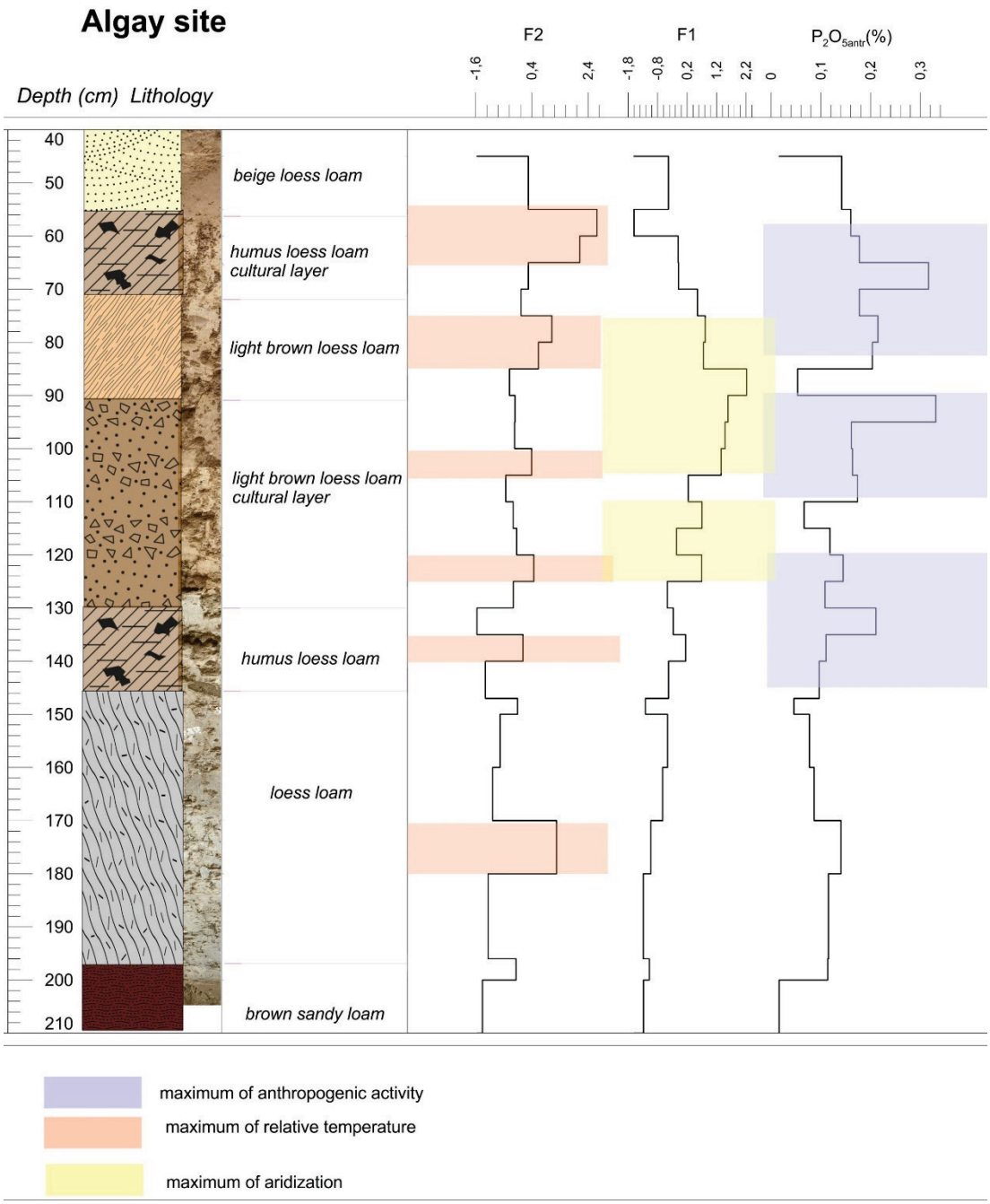

Fig. 5. Lithology and stratigraphy of a cross-section at the Algay site
with geochemical indicators of the palaeoenvironment (according to Kulkova *et al*. 2019)

The second principal component (FII) (P_2O_5 ,Zn,MgO/TiO_2, La, Zr) (Figs 3, 4) displays the antagonism between elements of biogenic processes (P_2O_5, Zn ,MgO) and heavy, accessoric minerals (TiO_2, La, Zr). This factor is connected with the relative temperature changes. Biogenic complexes are formed in loam loess deposits together with organics during warm periods, and the accumulation of heavy minerals connects with a coarse-grain sediment fraction accumulating during cold conditions. So, the positive loading of the second factor indicates warm conditions and the negative loading indicates cold conditions. Aside from this, the relative temperature variations are marked by distribution of zirconium (Zr) in the deposits of cross-sections and the distribution of titanium index (TiO_2/Al_2O_3) (Yudovich, Kertis 2000). The high titanium content in this case in-

dicates the accumulation of heavy titanium minerals in the psammitic fraction, but the increasing of the alumina component is characteristic of the pelitic fraction. The alumina enrichment of the pelitic fraction as a rule is formed in conditions of intense chemical weathering associated with a warm and humid climate (Nesbitt, Young 1982).

Ancient human impact was assessed using the indicator $P_2O_{5anthr}= P_2O_5/(P_2O_5+Na_2O)$ (Kulkova 2012). The values of this indicator increase in the archaeological horizons with remains of the bones and potsherds. It is worth noting that geochemical markers allow climatic episodes to be very precisely correlated with human activity. This is important in the reconstruction of past environments and human migrations. The data for a geochemically based palaeoclimatic reconstruction are presented in Fig. 4 for the Oroshaemoe 1 site and in the Fig. 5 for the Algay site.

Radiocarbon dates were obtained for different organic materials from archaeological layers. Chronological phases for the different cultural traditions on the Algay site were calculated by means of Bayesian statistics using OxCal 4.2 (Bronk Ramsey 2009) (Table 1).

Table 1

Radiocarbon dates on organics from cultural layers of Algay and Oroshaemoe I sites

	Site	^{14}C date (BP)	Lab index	Calendar age 2σ (cal. BC)	Material
1.	Algay	5875±60	SPb_1968	4571–4558	bone animal
2.	Algay	6245±32	AAR 21891	5309–5076	food crusts
3.	Algay	6284±100	SPb-2038	5472–5018	bone animal
4.	Algay	6318±33	AAR–21892	5361–5221	bone animal
5.	Algay	6490±40	Poz-76004	5527–5367	charcoal
6.	Algay	6479±70	SPb_1477	5560–5316	bone animal
7.	Algay	6360±250	SPb_1411	5742–4723	charcoal
8.	Algay	6605±32	AAR-21893	5617–5487	charcoal
9.	Algay	6577±80	SPb_1478	5641–5374	bone animal
10.	Algay	6654±80	SPb_1509	5708–5479	bone animal
11.	Algay	6820±80	SPb_1510	5889–5614	bone animal
12.	Algay	6800 ±40	Poz-65198	5741–5631	food crusts
13.	Algay	7284±80	SPb_2144	6271–6008	humic acids
14.	Oroshaemoe I	5806±26	UGAMS-23059	4724–4557	bone animal
15.	Oroshaemoe I	5934±100	SPb_2091	5060–4547	bone animal
16.	Oroshaemoe I	7010±110	SPb_2143	6072–5674	charcoal
17.	Oroshaemoe I	7245±60	SPb_2141	6227–6015	charcoal

The Oroshaemoe site

At the Oroshaemoe site there are three poorly humified lithological layers with artefacts belonging to different cultural-chronological periods. These layers were formed in light-yellow thick loam of aeolian origin (Figs 6, 7, 8). They are separated by sterile (natural and without artefacts) interlayers of different thicknesses (Fig. 4). The upper archaeological layer of 30 cm thick consists of light-brown loam. Based on archaeological finds, this layer can be related to the Khvalynskaya Eneolithic culture. The middle archaeological layer ranges in thickness from 30 to 60 cm and is homogeneous. This layer contains the artefacts of the Cis-Caspian culture. The bottom archaeological layer that lies on the bedding horizon that is without any finds is presented by lumpy, dark-brown loam enriched by humus. It varies in thickness from 40 to 80 cm. The findings from this layer belong to the Orlovskaya Neolithic culture (Vybornov *et al.* 2017). The thicknesses of both upper layers change throughout the site. The changes in thickness of the cultural horizon can probably be explained by differing intensities of human activity within the settlement area. The distribution of artefacts across the site square confirms this. In some parts of the archaeological layer the pottery finds and stone tools are numerous, but in other parts there are scarce numbers. Animal bones, too, were distributed irregularly. The second Cis-Caspian layer belongs to the soil horizon. It is important that the artefacts were concentrated in the upper part of burial soil. The people of the Cis-Caspian culture occupied this place when the soil had almost been formed.

Fig. 6. Oroshaemoe site. Eastern wall of trench

Fig. 7. Oroshaemoe site. Western wall of trench

Fig. 8. Oroshaemoe site. Southern wall of trench

The bottom horizon of the Orlovskaya Culture differs in thickness in different parts of the site. The side of this layer inclines, according to the ancient shore slope, towards the river. The excavations in 2019 supported previous observations. The maximum thickness of the bottom Orlovskii layer is 120 cm (Fig. 4). In this horizon the sediments are laminated. Some layers of the cultural horizon have remains of fireplaces. This place was probably occupied several times during the Neolithic by people of the Orlovskaya Culture.

So, the lithology of the Oroshaemoe site is unique for the Low Povoljie region. The cultural horizons are divided by thick sterile layers without artefacts. This excludes the existence of mixed archaeological layers. The layer of the Cis-Caspian Eneolithic culture is located below the horizon of the Khvalynskaya culture. This is evidence of the early chronological position of the Cis-Caspian culture and a different time of appearance of carriers of these cultures in this area. The layer of the Orlovskaya Culture does not contain artefacts of the Cis-Caspian culture and they are separated from each other by a sterile layer. This is evidence of these archaeological layers having formed in different periods and under different conditions.

These conclusions were supported by the radiocarbon dates for the selected materials from archaeological layers of different archaeological contexts. On the organics from ceramics of Khvalynskaya type, the date is 5667±100 BP (4725–4336 cal. BC) (SPb-1474). The materials of the Cis-Caspian layer are dated to 5890±120 BP (5056–4462 cal. BC) (SPb-1729) on the organics from ceramics. This date was supported by radiocarbon dates on the bones from this layer: 5806±26 BP (4724–4557 cal. BC) (UGAMS-23059) and collagen from bones: 5934±100 BP (5060–4547 cal. BC) (SPb-2091). Bones of sheep found in the Cis-Caspian archaeological layer were determined and dated by radiocarbon analysis. This led us to conclude that domestication had appeared in households of the Eneolithic people in the Low Povoljie region. The beginning of this process occurred in this territory in the first quarter of the 5th millennium BC (Vybornov *et al*. 2016a).

The formation of the bottom Orlovskaya Culture horizon can be interpreted as follows. First, in this place the archaeological layer of the early phase of the Orlovskaya Culture was deposited. This is supported by both archaeological materials and radiocarbon dates. The radiocarbon dates for charcoal from a bottom part of horizon are 7245±60 BP (6227–6015 cal. BC) and 7010±110 BP (6072–5674 cal. BC) (SPb-2143), and for a bone from the middle part is 6889±100 BP (5933–5631 cal. BC) (SPb-2090). For the upper part of the layer, the radiocarbon dates for charcoal are 6620±100 BP (5720–5377 cal. BC) (SPb-2854), 6580±100 BP (5674–5338 cal. BC) (SPb-2853) and 6551±40 BP (5617–5469 cal. BC) (Hela-4005). It is also possible that this interlayer was formed as a result of further cultural development but, on the other hand, these particles of charcoal may have occurred as a result of Aeolian processes having transported the material from higher areas neighbouring the Algay site (Fig. 3) (Vybornov *et al.* 2019).

The Algay site

The stratigraphy of the Algay site is more complex. The archaeological layers are up to 2.4 m thick and they are unhomogenised within the entire site (Fig. 9). There are lithological horizons including two Eneolithic and two Neolithic archaeological layers. The Eneolithic finds are similar to the Oroshaemoe site and belong to the Khvalynskaya (layer 1) and Cis-Caspian (layer 2) cultures. Neolithic materials belong to the Orlovskaya Culture. The Neolithic layer is divided into two clear horizons on the basis of stratigraphic traits: the upper (layer 3) and bottom (layer 4). According to Yudin (2004) a typological comparison of these materials and the artefacts from layers 2A and 2B of the Varfolomeevskaya site shows their similarity.

The stratigraphy of this part of the excavation shows the following (Fig. 5):

Layer 1 (the Khvalynskaya Culture) is represented by a crumbly dark humic horizon. Artefacts are scarce. The bottom boundary is ragged because of ice-wedge structures within basement loams. Layer 1 is poorly expressed and is traced only in excavation 2, which is located between excavation 1 of Algay and the Oroshaemoe site (Vybornov *et al*. 2019). In the north-eastern part of the main excavation, this layer had been preserved and is about 0.3 m thick. In the south-western part of the excavation, the layer becomes thin and wedges out. The border between the Khvanskaya and Cis-Caspian layers is clear. A sterile horizon of about 30 cm thick separates these layers.

Layer 2 (the Cis-Caspian Culture) has a brownish colour. This layer, in contradiction to layer 1 of the Khvalinskaya Culture, is traced across the whole the area. There is a scarce occurrence of artefacts. The maximum thickness of *ca* 35 cm was denoted in the north-eastern part of the excavation. Towards the south-west the layer becomes thinner. This is

Fig. 9. Algay site. Southern and eastern walls of trench

probably one of the reasons why this layer with artefacts of the Orlovskaya Culture was not found in the excavation in 2016. Therefore, the formation and distribution of the Cis-Caspian archaeological layer at the Algay site is impossible after further excavations.

The Orlovskaya Culture horizon can be separated into two sub-horizons. It was supported by the analysis of numerous artefacts. The complexes of finds differed between the upper and bottom parts of horizon. Layer 3 was found to extend across the whole area of excavation. In the north-eastern area of the excavation it is located right on the bedding horizon. The layer was mixed and grey in colour. In some areas this layer is very similar to the bedding horizon. Remains of ash and small particles of charcoal were found in the layer, as well as finds of animal bones, potsherds and stone tools. This allows the archaeological layer to be distinguished from the bedding. The border between the third and second layers is clean. Layer 3 is darker in colour because of its high humus content. A sterile horizon of about 20–30 cm separates these layers.

In the excavation of 2016 part of housing structures with entrances were found. The Neolithic dwelling is presented by a semi dugout that, after being abandoned, was filled with animal bones (Yudin *et al.* 2016). Layer 4 has the highest thickness. In some parts it has a thickness of about 1 m, with numerous finds. In the north-eastern part of the excavation the fourth layer is absent. The fourth layer can be divided into two interlayers: dark grey loam and light grey loam. But typologically the archaeological material does not differ between the two layers. In the south-western area of excavation these interlayers were separated by a thin light layer or a layer rich in animal bones. The finds from the bottom layer are probably older, within the frameworks of the Neolithic, but for proof of this suggestion more data should be obtained. The clear layering of the Orlovskaya Culture horizon in the north-eastern part of the excavation could not be explained by weathering or erosion. It is possible that at first the Orlovskaya Culture communities occupied the south-western part of the settlement. This is evidenced by the layer being thicker in this part, by the presence here of segments with "geluanian" (bilateral) retouching of stone tools in the bottom layers, and by the occurrence of more archaic types of ceramics analogous with pottery from layers 3 and 2B of the Varfolomeevskaya site (Yudin *et al.* 2017). This layer was also dated to 7284±80 BP (6358–6008 cal. BC) (SPb-2144) (humine). On the Algay site these horizons decrease sharply in a north-westwards direction, to the river bank that characterises the ancient surface in the Neolithic.

Results

The geochemical indications (Kulkova *et al.* 2019) (Figs 4, 5) showed that the interbedding of cultural and sterile layer deposition depends on the climatic variations within the study area. On the Oroshaemoe site, the deposition of the bottom layer took place during the end of a cold and dry event, and the transition to the moderately humid and warm conditions occurred around 6200–6000 cal. BC. The first evidence of the Orlovskaya Culture communities relates to this period. The radiocarbon age of the horizon at the depth of 240–260 cm is *ca* 5900–5600 cal. BC. Intense human activity data was registered in this layer, based on geochemical data. The occupation by people of the Orlovskaya Culture traditions began exactly in this period. At that time, the conditions became warm and humid. Beige, loess loam with carbonate inclusions is deposited at depths of 243–150 cm. Based on geochemical indicators, in this horizon low human impact was registered. The maximum aridisation and warm climatic conditions is marked for these deposits (Fig. 4). Especially strong arid conditions with carbonate formation are registered at a depth of 180–150 cm. This episode is dated to *ca* 5050 cal. BC. The layer of the Cis-Caspian Culture coincides with the Holocene climatic optimum. The artefacts of the Cis-Caspian Culture are dated to *ca* 5000–4700 cal BC. The climatic conditions in the beginning of the deposition of this archaeological layer were cold and humid. At the end of this period, there is registered the transition to more humid and warm conditions. The next event of maximum aridisation and high temperatures was recorded in the deposits of light-beige loess loam at a depth of 100–70 cm. It was a short episode characterised by a quick rate of sedimentation. The human activity was low. The upper layer (45–20 cm), formed by the humic horizon interlayered with loess loam, was deposited during warm and humid conditions. The human activity grows again. The radiocarbon age of organic ecofacts from this layer is 4700–4336 cal. BC. This is the period of the Khvalynskaya Eneolithic culture development.

Similar reconstructions had been provided for the Algay site (Fig. 5). At the depth of 147–130 cm, the humified loess loam with artefacts of the Orlovskaya Culture were deposited. The climatic conditions are recorded as humid and warm. The radiocarbon dates for this layer are at an interval of 5800–5650 cal. BC.

At the depth of 130–90 cm, light brown loess loam was deposited. Climatic conditions in this period were warm with a trend towards aridisation. The more intense human activity is revealed at a depth of 130–120 cm. The radiocarbon date set for this layer is from 5600 to 5470 cal. BC. Decreasing human activity was registered at a depth of 120–113 cm. This period corresponds with cooling and dry climatic conditions. The next peak in human activity is recorded at a depth of 110–90 cm. That coincides with the archaeological layer dated to 5350–5120 cal. BC. This time was probably the most favourable period for human existence in this settlement. Similar situation was registered at the Varfolomeevskaya site. The increase in temperature and humidity occurred while the deposits at depths of 100–105 cm were sedimenting. They were formed in moderately cold conditions with increasing aridity during 5120–5050 cal. BC. The maximum of aridisation and high temperatures occurred according to geochemical data in the period of light beige loam formation at a depth of 85–75 cm. Low human activity was revealed in this layer. This episode can be dated to around 5050–4900 cal. BC. The next period of high human activity concerns the period of 4900–4366 cal. BC, and is recorded in the deposits at a depth of 80–55 cm. This stage is characterised by a cold, humid climate but in the ending is marked by a transition to warm, humid conditions.

Conclusion

Multidisciplinary investigations of the well stratified Algay and Oroshaemoe sites in the Low Volga basin provided new data about the development of the Neolithic and Eneolithic occupations of the region. The similar archaeological layers on the Algay and the Oroshaemoe sites have some differences of distribution. The beginning of human occupation during the formation of the bottom layer at the Oroshaemoe site. Later, people moved to the Algay site area. At this site, the development of the Orlovskaya Culture continued. Furthermore, according to the changes in archaeological layer thickness we can suggest the different intensities of occupation of the two sites.

The most well developed archaeological layer of the Cis-Caspian Culture is presented on the Oroshaemoe site. The archaeological layers of the Khvalynskaya Culture at both the Algay and Oroshaemoe sites are less clear than those of the

Orlovskaya and Cis-Caspian cultures. All archaeological layers had been formed during the Atlantic period, though under unstable climatic conditions with changes from cold and arid to more warm and humid, and *vice versa*. Our data showed that the periods of archaeological layer formation are characterised by favourable climatic conditions in this territory.

Acknowledgments

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References

Bronk Ramsey C. 2009. Bayesian analysis of radiocarbon dates. *Radiocarbon* 51(1): 337-360. http://dx.doi.org/10.1017/S0033822200033865

Kulkova M.A. 2012. Metodi prikladnih paleolandshaftnih geohimicheskih issledovanii [Methods of applied paleolandscape geochemical research]. Saint-Petersburg, Herzen University Press.

Kulkova M.A., Vybornov A.A., Yudin A., Doga N., Popov A. 2019. New interdisciplinary research on Neolithic-Eneolithic sites in the Low Volga River region. *Documenta Praehistorica* 46: 376-387.

Nesbitt H.W., Young G.M. 1982. Early Proterozoic climates and plate motions inferred from major chemistry of lutites. *Nature* 299: 715-717.

Vybornov A.A., Yudin A.I., Vasil'eva I.N., Kosintsev P.A., Kul'kova M.A., Goslar T., Doga N.S. 2015. Novye materialy neolita Nizhnego Povolzh'ya. *Izvestiya Samarskogo nauchnogo centra RAS* 17(3): 46-49.

Vybornov A.A., Oinonen M., Doga N.S., Kulkova M.A., Popov A.S. 2016a. O khronologicheskom aspekte proishozhdeniya proizvodyashego hoziaystva v Nizhnem Povolzhie. *Vestnik Volgogradskogo Universiteta. Seriya 4. Istoriya. Regionovedenie. Mezhdunarodnie otnosheniya* 21(3): 6-13.

Vybornov A.A., Yudin A.I., Vasilieva I.N., Kosintsev P.A., Kulkova M.A., Doga N.S., Popov A.S. 2016b. Issledovaniya poseleniya Oroshaemoe v Nizhnem Povolzhie. *Izvestiya Samarskogo nauchnogo zentra RAS* 1 (3): 140-145.

Vybornov A.A., Yudin A.I., Vasilieva I.N., Kosintsev P.A., Kulkova M.A., Doga N.S., Popov A.S. 2017. Novie materiali issledovanii na poselenii Oroshaemoe v Nizhnem Povolzhie. *Izvestiya Samarskogo nauchnogo zentra RAS* 19(3): 185-190.

Vybornov A.A., Vasilieva I.N., Kulkova M.A., Philippsen B. 2018. O vremeni poyavleniya i dinamike rasprostraneniya drevneyshih keramicheskih tradiciy v stepnom Nizhnem Povolzhie. *Vestnik Volgogradskogo Universiteta. Seriya 4. Istoriya. Regionovedenie. Mezhdunarodnie otnosheniya.*

Vestnik Volgogradskogo Universiteta. Seriya 4. Istoriya. Regionovedenie. Mezhdunarodnie otnosheniya 23(2): 6-16.

Vybornov A.A., Vasilieva I.N., Doga N.S., Roslyakova N.B., Kosintsev P.A., Kulkova M.A., Popov A.S., Yudin A.I., Oinonen M., Possnert G., Streltsov M. 2019. Itogi issledovanija poselenija Oroshaemoe v 2018 godu. *Samarsky nauchnii vestnik* 7 (4): 211-219.

Yudin A.I. 1998. Orlovskaya kultura and istoki formirovaniya stepnogo eneolita Zavolzhya. The problems of ancient history of the Northern Caspian Sea region. Materials of scientific articles. Samara Pedagogical University Publishing House: 83-105.

Yudin A.I. 2004. Varfolomeevskaya stoyanka i neolit stepnogo Povolzya. Saratov, State University Press.

Yudin A.I. 2012. Stoyanka Kumiska i eneolit stepnogo Povolzya. Saratov, State University Press.

Yudin A.I., Vybornov A.A., Vasilieva I.N., Kosintsev P.A., Kulkova M.A., Goslar T., Philippsen B., Baratskov A.V. 2016. Neoliticheskaya stoyanka Algay v Nizhnem Povolzhie. *Samarsky nauchnii vestnik* 3(16): 61-68.

Yudin A.I., Vybornov A.A., Baratskov A.B. 2017. Neoliticheskaya stoyanka Algay v stepnom Volgo-Ural'skom mezhdurechie. V (XXI) Russian archaeological congress. Materials of conference. Barnaul: 1199-1200.

Yudovich Ya.E., Kertis M.P. 2000. Osnovi litogeohimii. Nauka Press, Moscow.