Journal of Archaeological Science: Reports 24 (2019) 122–131

Contents lists available at ScienceDirect

Journal of Archaeological Science: Reports

journal homepage: www.elsevier.com/locate/jasrep

"Sod blocks" in kurgan mounds: Historical and soil features of the technique of tumuli erection

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ARTICLE INFO

Keywords:
Tumuli (kurgans) construction
Eurasian steppe
Soil
Sod
Solonetz
Kastanosem

ABSTRACT

Tumuli (Kurgans) over Bronze Age, Early Iron Age, and Middle Age burials are a common attribute of the landscape across the entire steppe zone of Eurasia. For many years, the kurgan embankment was believed to be created from loose soil and underlying sediments. However, in recent years, during the excavation of kurgans, archaeologists began to understand that the mounds contain large blocks of undisturbed soil. These blocks are a type of brick, carved from the upper sodded layer of soil held together in blocks by plant roots.

We suggest the term "sod blocks" for such soil blocks. The earliest kurgan mounds made from sod blocks date to the Early Bronze Age. Sod blocks are found in burials from the Middle Bronze Age, but after that, the tradition of sod brick architecture begins to fade. During the Scythian era, from the 7th to 4th centuries BC, sod blocks are widely used for making huge "King's" kurgans. During the Early Sarmatian culture, in the 3rd to 1st centuries BC, the sod blocks technique disappears, arising again in the Middle Sarmatian of the 1st century AD. We found that sod blocks are well distinguished in tumuli if the kurgan is built from Solonetz, a soil with a light grey upper AE horizon and a reddish-brown underlying Bt horizon. Due to sharp differences between the upper two soil horizons, we can distinguish the sod blocks in kurgan mounds. The growing number of kurgans with traces of sod blocks in the mounds allows one to suppose that this method of kurgan construction was much more widely used than previously thought. Taking into consideration that most of the mounds have not been made from soil-forming rock, but from the upper soil horizons, from which one can easily cut sod blocks, we assume that most of the kurgans were made from sod blocks. The use of sod blocks can significantly expand the range of possible architectural proposals for the creation of the kurgan mound and provide an opportunity for building vertical elements. The purpose of this article is to consider the emergence and development of this kurgan building tradition and to show the most interesting examples of burial mounds built from sod blocks. Another task is to establish, in terms of soil science, why in some burial mounds soil blocks are clearly visible but in other cases are not.

1. Introduction

The tradition of constructing a tumulus above the grave of the deceased arose approximately 6000 years ago among tribes of the Neolithic period and spread rapidly throughout almost all of Eurasia. Most tumuli, however, are concentrated in the steppe and desert-steppe zones, where they are the only archaeological sites from ancient nomadic cultures.

Burial tumuli are an attribute of the steppe landscape of many Eastern European and central Asian countries. Most tumuli are in the countries of the former USSR. For example, in the Volgograd region of the Russian Federation (an area of approximately 114,000 km^2) there are > 100,000 burial tumuli (Galkova et al., 2010). In the Russian archaeological literature, these sites are known as kurgans.

As a rule, the kurgan mound is a spherical hill with a height ranging from several centimetres to 20–30 m. Traditionally, it is believed that the mound was built by adding loose soil over the grave, with the soil taken from a ditch directly adjoining the mound. However, only a few archaeological cultures in the steppe zone used that technique of kurgan construction. Deep ditches of a regular trapezoidal form are often found under excavations of Scythian kurgans (Mozolevskiy and Polin, 2005). In this case, the ditch was a part of the funeral composition, not only providing ground for mound construction but also increasing the kurgan height visually. However, most burial mounds are

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https://doi.org/10.1016/j.jasrep.2019.01.005
Received 31 March 2018; Received in revised form 13 December 2018; Accepted 5 January 2019

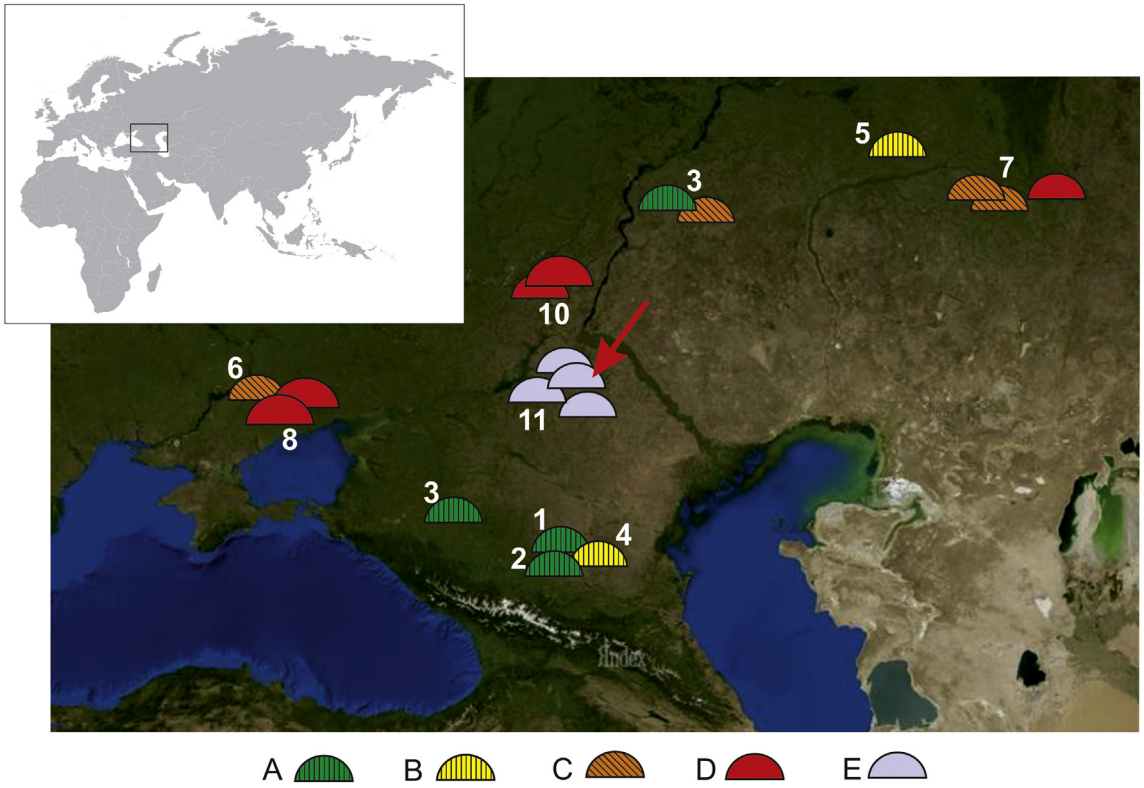

Fig. 1. Kurgans with sod blocks in different epochs in the former Soviet Union: A – Early Bronze Age; B – Middle Bronze Age, C – Late Bronze Age, D – Scythian Time, E – Sarmatian Time; the arrow shows the location of kurgan 3 in the Aksai 3 kurgan cemetery in the Esaulovsky Aksay river basin (1-column fitting image).

without ditches, and only the upper soil horizons were used for mound construction.

It is believed that mounds were created by loosening the soil and filling baskets or sacks with soil that was poured over the burial. As a result, a cone- or spherical-shaped hill was formed. This form is believed to have been the mound at the time of its completion.

It should be noted that the mound of a kurgan has always attracted less attention than the burial beneath the mound, and archaeologists have not given much attention to the study of mound features. The main purpose of excavation in the past was the burial. Only the most pronounced stratigraphic features, such as stone construction, layers of soil-forming rocks, masonry, and layers of wooden decay were recorded. If no clear layers and interlayers were visible in the embankment, but only poorly visible patches of different shades, the mound was depicted in the drawings as a uniform material.

Field archaeologists began to pay attention to the heterogeneity of kurgan mounds quite a long time ago, but not being specialists in soil science, they could not correctly interpret the nature of this heterogeneity, and only identified the presence of a heterogeneous soil in the mound (Mozolevskiy and Polin, 2005). This heterogeneity pointed to different mound construction techniques. If a loose soil was used to create an embankment, it was mixed and homogenized, resulting in a uniform mound. If the kurgan includes large amounts of morphologically different soil pieces, in sizes of 10–20 cm and more, this may indicate another technique of kurgan construction that does not use loose soil.

In recent years, studies of a number of burial mounds have established that ancient people did not always use loose soil to build a mound, but often used soil blocks (Borisov et al., 2007; Krivosheev, 2013; Krivosheev et al., 2014). These blocks were a type of brick carved from the upper sodded layer of the soil, which were held together by plant roots. Since the roots of plants stain these blocks, we will suggest the term “sod blocks” for such soil blocks.

It is possible to distinguish two types of use for turf blocks: in the construction of houses and in the construction of tumuli. The technology of sod blocks was widespread for house construction in Western Ireland into the 19th Century AD (Sod and Turf…, 1969). On Nelson Island in vestern Alaska, some Yup'ik inhabitants built sod houses until the early 1960s (Knudson and Frink, 2010). It was also used by European settlers on the US prairies for house construction during the 19th Century AD (Kampinen, 2008). Walls made of brick earth are described for a first century site in London (Goldberg and Macphail, 2017). Among the indigenous peoples of Siberia, in particular among the Siberian Tatars, the tradition of building houses from sod blocks was widespread in the 16th–17th Centuries AD (Belich and Bogomolov, 1991; Tomilov and Shargorodsky, 1979). In Siberia, turf and sod blocks used for kurgan construction during Sarmatian time (Buldashev et al., 1997) and Sargat culure (Matveev and Matveeva, 1991). The best blocks were obtained from marshy soil that was well fastened by the roots. Before laying, they were dried in the sun. Such houses were built on summer pastures, to which each family travelled, but often they lived in turf houses in winter as well (Seleznev, 1995; Belich, 2007). Hall A. suggests the term “turves” for blocks or sheets of plant material and soil cut from the surface of an area of living vegetation that have been used for a variety of purposes in the past (Hall, 2003).

The sod blocks found in the construction of tumuli were widely used. For example, sod blocks were found in Bronze Age tumuli in Derbyshire, UK (Collis et al., 1996). Many prehistoric monuments, such as Silbury Hill, made of English Chalk, were constructed using sod blocks (Leary and Field, 2010).

It was shown that tumuli were constructed with sod taken from the environment surrounding the construction site (Pickett et al., 2016; Beisenov, 2014; Villagran and Gianotti, 2013; Mimokhod, 2009). Sometimes only a part of the tumulus was composed of soil blocks carved from the upper soil horizons, while other mounds were made of loose material from the kurgan ditch (Belinskij et al., 2000). Most similar to that described below, kurgan mounds from sod blocks were reported in an article by L. Theunissen (Theunissen, 1999. Afb. 3.7 P.

46).

In the Russian archaeological literature, many examples of the use of soil blocks in the construction of tumuli have been described. These examples allow us to trace the chronological and geographical features of this tradition of kurgan construction in the territory of the former Soviet Union.

The earliest kurgan mounds constructed from sod blocks belong to the Early Bronze Age in the northern Caucasus and were observed in the mounds of the Maikop culture (Korenevsky, 2005; Rostunov, 2007) (Fig. 1 (1, 2)) and the Novotitorovskaya culture (Gey, 2000) (Fig. 1 (3)). This construction technique of large Maikop burial mounds made it possible to create complex stepped structures. Unfortunately, there is almost no information on this construction technique in publications devoted to these burial mounds. Only the “zebra-like” colour of the embankments of the largest Maikop kurgans indicates the use of sod blocks (Rostunov, 2007).

In the first quarter of the third millennium BC in the North Caucasus, sod blocks are found in the burials of the Early Catacomb and North Caucasian Catacomb cultures (Andreeva and Novikova, 2001; Korenevsky et al., 2007) (Fig. 1 (4)). In the same period, kurgan architecture based on the use of sod blocks extends from the North Caucasus to the Volga-Ural region. At the beginning of the Middle Bronze Age, sod blocks occur in the mounds of large kurgans of the Utevo-Tamarutkul culture (Mimokhod, 2009) (Fig. 1 (5)).

After the middle of the third millennium BC, the tradition of the use of sod blocks in kurgan mounds stops. During the same period in the Late Catacomb culture, the number of newly created burial mounds decreases, and the proportion of burials embedded into previously created burial kurgans increases (Bratchenko, 1976; Bratchenko and Shaposhnikova, 1985; Pislariy, 1988; Sanzharov, 2001; Kleschenko, 2007).

In post-catacomb times (late third millennium BC), sod blocks were not widely used in kurgan mounds, although at an early stage of the Lolinskaya culture, the number of burial mounds increased (Mimokhod, 2009). Among the burial mounds of the next culture of the Late Bronze Age (Bereznovsko-Mayevskaya culture), sod blocks were also very rare (Samar, 1991) (Fig. 1 (6)), although for this culture a large number of burial mounds were investigated (Otroshchenko, 2003). At that time in the Urals, domes made from sod blocks were constructed above the burials of the Sintashta culture (Gening et al., 1992; Zdanovich, 2002) (Fig. 1 (7)).

After the Middle Bronze Age, the tradition of sod block architecture begins to fade. In the Late Bronze Age, kurgans made from ground blocks are rare, and completely disappear in the finale of the Bronze Age and the pre-Scythian period, when in general there is a decline in kurgan construction in the Eastern European steppe.

During Scythian times (7th to 4th centuries BC), across a vast territory from the Urals to the Black Sea region, huge “King's” kurgans appear, in which sod blocks are widely used (Mozolevskiy and Polin, 2005; Boltryk, 2011; Rolle et al., 1991) (Fig. 1 (8, 9, 10)).

During the Early Sarmatian culture in the 3rd to 1st centuries BC, the tradition of complex structures, including sod blocks, again disappears, perhaps due to the proliferation of kurgan cemeteries, where the same mound was repeatedly used for burials (Mozolevskiy and Polin, 2005; Zdanovich et al., 1984; Bessonova et al., 1984).

The “renaissance” of the use of sod blocks in kurgan mounds in the Volga-Don steppes occurred in the Middle Sarmatian time at the beginning of a new era. It is difficult to say why, but at that time, a wide range of cultural traditions of the Savromatian culture of the Scythian epoch reappeared (Skripkin, 1992: 29–30; Krivosheev, 2013: 212). We do not observe these architectural solutions in the kurgan erection of other Sarmatian cultures and in synchronous monuments of neighbouring regions. In 2006–2015 in the Volgograd region, several kurgans of Sarmatian culture made from sod blocks were studied (Borisov et al., 2007; Balabanova et al., 2014). In the burial cemetery Peregruznoe-I, the three largest burial mounds (kurgan numbers 45, 51, 52) were made from sod blocks and the burials beneath belonged to people of high social status (Krivosheev et al., 2014) (Fig. 1 (11)). Huge tumuli built from sod blocks are known from the Middle Ages (Pickett et al., 2016).

Thus, although sod blocks in kurgans are quite common, their location in the mound has not been studied nor has an attempt to reconstruct possible architectural ideas realized in this construction technology been carried out. This article presents the results of studies of architectural features of kurgan mounds created by using sod blocks.

2. Soils in the studied area

Kurgan No. 3 is located in the Aksai 3 kurgan cemetery in the Esaulovsky Aksay river basin in the southern part of the Volga-Don interfluve (Fig. 1). It was the first well-studied kurgan constructed with sod blocks. Excavations of kurgan 3 were carried out as part of the programme of studying archaeological sites that were on a pipeline route. Dr. Igor Sergatskov from Volgograd State University managed the excavation. More than 20 mounds were excavated and investigated along the pipeline, most of which belonged to the Bronze Age and the Middle Ages.

Before describing the tumulus construction, a brief characterization of the soil cover in the region is as follows. Two main soil types, Solonetzes and Kastanozems, are developed in the region of dry and desert steppes. On the northern border of their distribution, the Kastanozems turn into Chernozems.

Solonetzes (according to the World reference base for soil resources, 2006) are soils with a dense, strongly structured, clayey subsurface horizon with a high proportion of adsorbed Na and/or Mg ions. Common international names are alkali soils and sodic soils. Parent materials are unconsolidated materials, mostly fine-textured sediments. Solonetzes are mostly concentrated on flat or gently sloping grasslands on loesses, loams or clays in semi-arid, temperate, and subtropical regions. Well-developed Solonetzes have a white-coloured albic eluviation AE horizon directly over the dark reddish-brown nitric Bt horizon

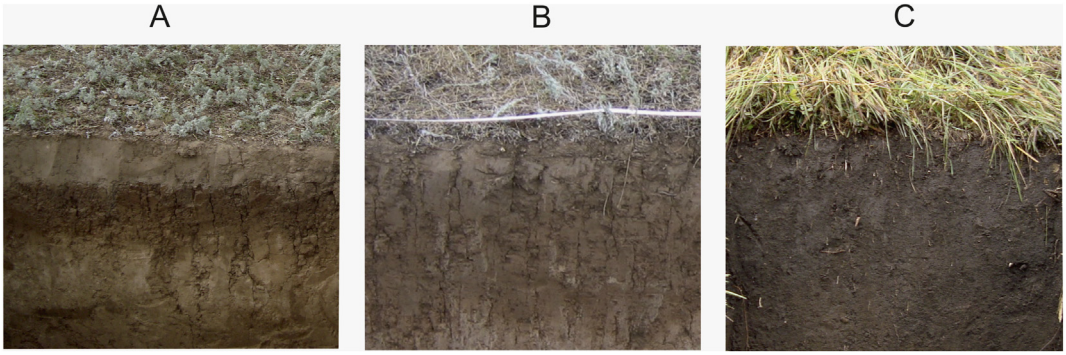

Fig. 2. Soils in the studied are: A – Solonetz, B – Kashtanozem, C – Chernozem (2-column fitting image).

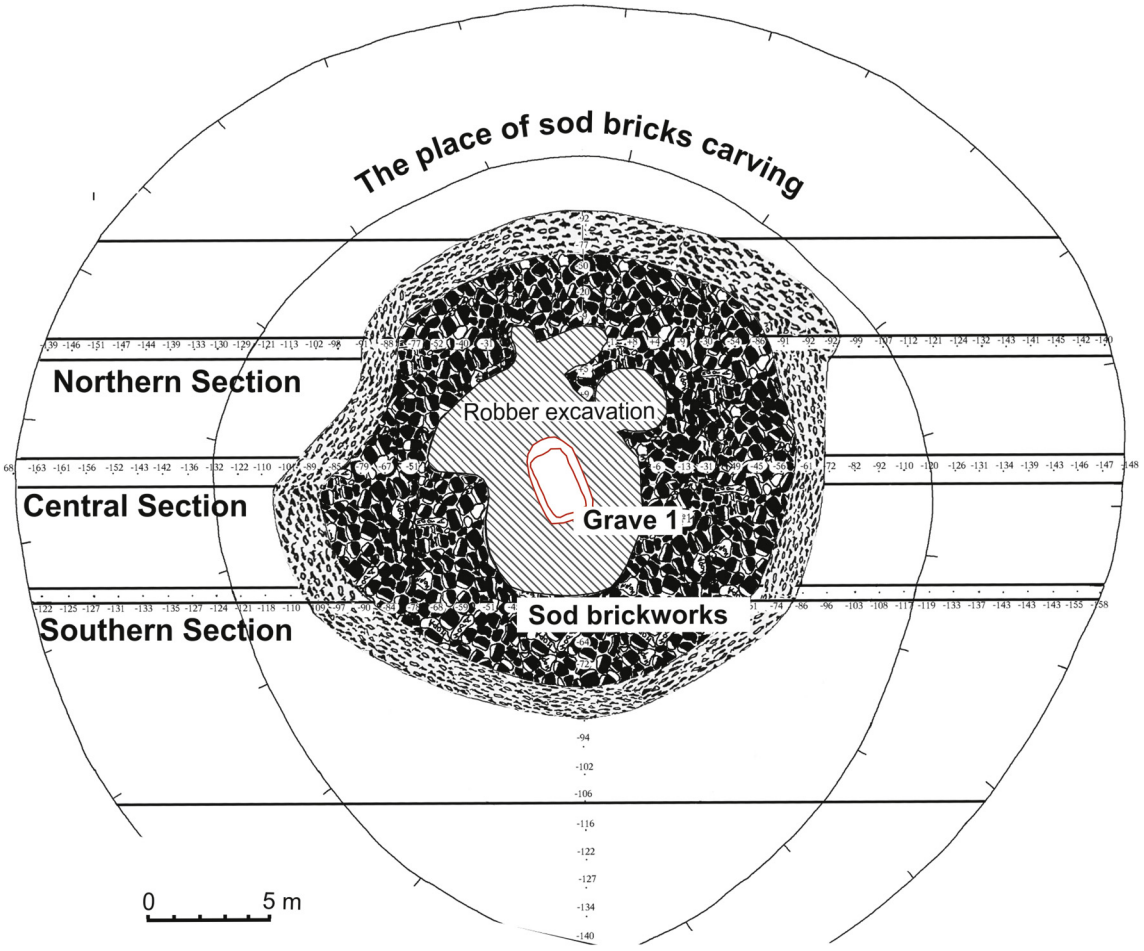

Fig. 3. Plane of Kurgan 3in the Aksai III kurgan cemetery (1.5-column fitting image).

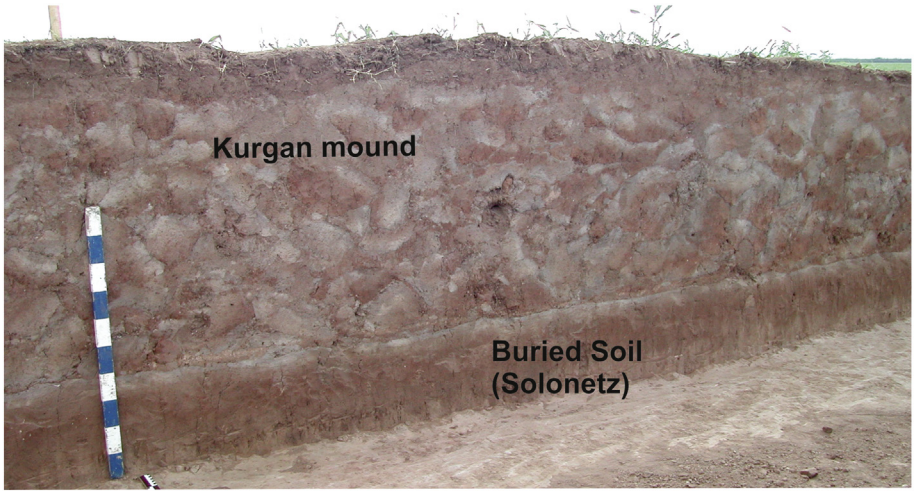

Fig. 4. Sod blocks in kurgan 3 of Aksay-3 kurgan cemetery (2-column fitting image).

(Fig. 2 (A)). A calcic (BCk) or gypsic (Cg) horizon may be located below the natric one. Solonetzes occur predominantly in areas with a steppe climate (dry summers and an annual precipitation of less 400–500 mm), in particular in flat lands with impeded vertical and lateral drainage. Major Solonetz areas are found in the Ukraine, Russian Federation, Kazakhstan, Hungary, Bulgaria, Romania, China, United States of America, Canada, South Africa, Argentina and Australia.

Kastanozems accommodate dry grassland soils, among them zonal soils of a short-grass steppe belt, south of the Eurasian tall-grass steppe belt of Chernozems. Kastanozems have a similar profile to that of Chernozems, but the humus-rich surface horizon is thinner and not as dark as that of the Chernozems and they show a more prominent accumulation of secondary carbonates. The chestnut colour of the surface soil is reflected in the name Kastanozem: *Kastan*, Chestnut (in Russian). The parent material is a wide range of unconsolidated materials; a large part of Kastanozems is developed in loess. The soil is developed in a dry and continental environment with relatively cold winters and hot summers; flat to undulating grasslands dominated by ephemeral short

Table 1
Chemical properties of buried soils and sod blocks in kurgan mound.

Horizon Index	Depth[a] (cm)	pH	Organic carbon	Salinity	$CaSO_4$	$CaCO_3$	Particle size distribution, %	
			%				< 0,001 mm	< 0,01 mm
Buried soil								
AE	0–9	8.0	0.26	0.57	0.25	0.1	8	25
Bt	9–25	8.0	0.35	0.54	0.17	1.6	28	42
Bk	25–46	8.2	0.28	0.63	0.27	9.5	22	38
BCk	46–88	8.5	0.14	0.47	0.29	14.7	22	36
Ck	88–182	8.3	0.12	0.35	0.31	9.0	19	29
Cz	182–200	8.2	0.11	0.99	4.93	9.0	15	31
Sod brick 1								
Upper	layer	8.3	0.29	0.82	0.12	1.2	12	20
Bottom	layer	7.9	0.50	0.63	0.33	2.6	27	37
Sod brick 2								
Upper	layer	8.9	0.36	0,24	0,22	2,5	11	22
Bottom	layer	8.8	0.34	0,58	0,31	2,4	29	39
Sod brick 3								
Upper	layer	8.3	0.36	1,05	0,22	0,5	9	22
Bottom	layer	8.4	0.38	0,58	0,21	2,3	25	35

[a] From the surface of buried soil.

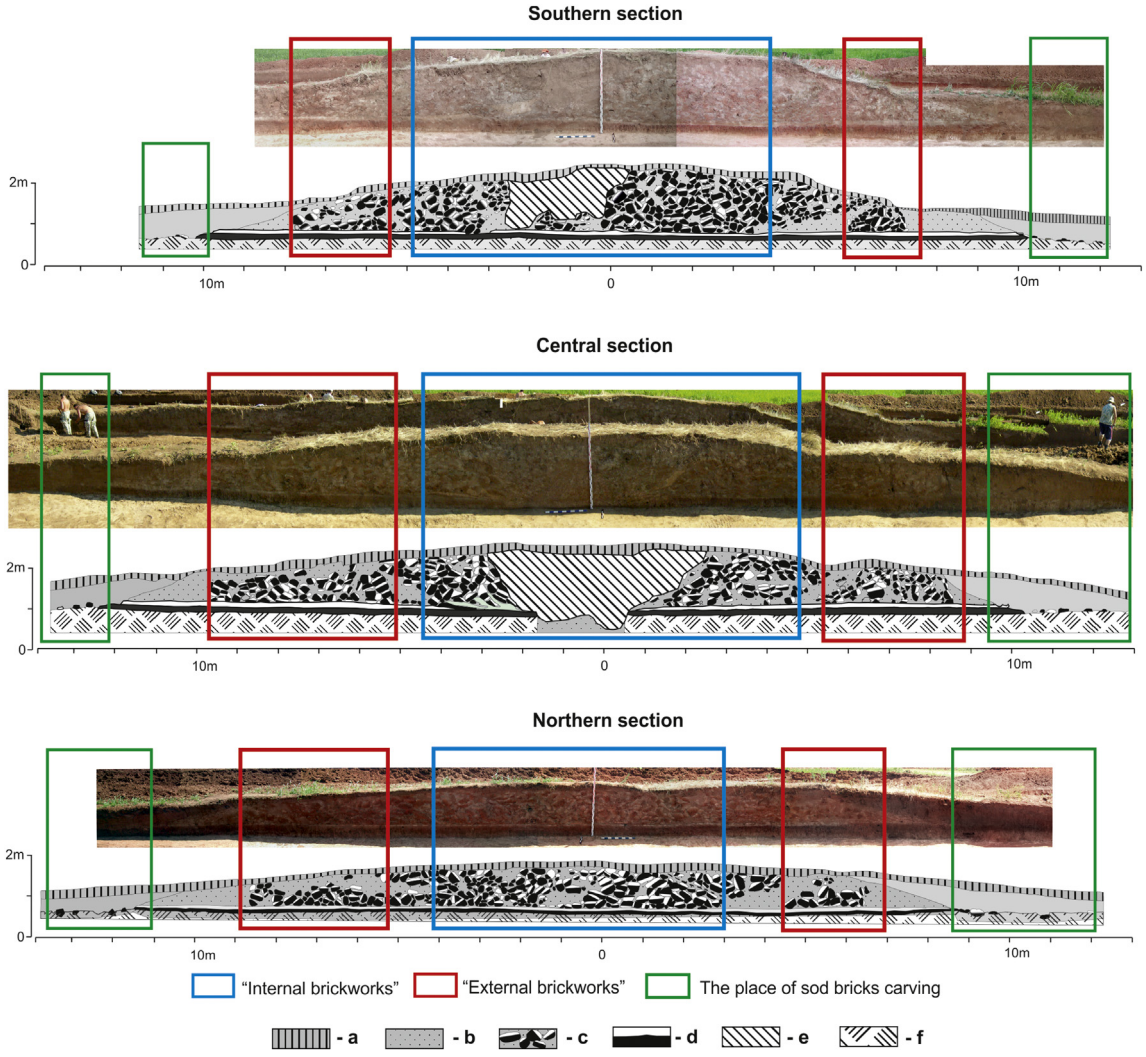

Fig. 5. Structure of mound of kurgan 3. a – surface soil; b – small fragments of destructible blocks; c – sod «brickworks»; d – buried soil (Solonetz); e – robber's excavations; f – soil-forming rock (2-column fitting image).

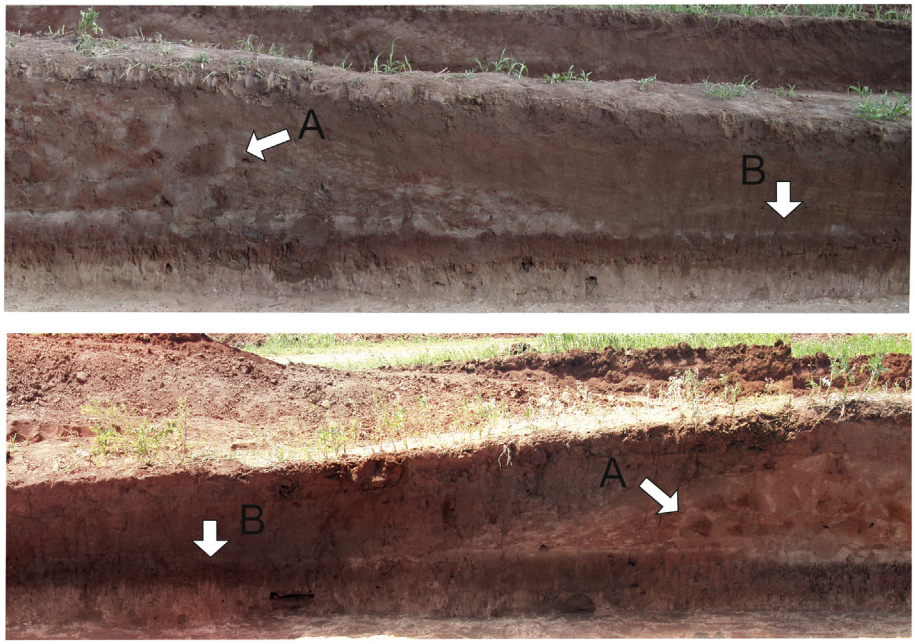

Fig. 6. Vertical walls of the External «brickwork» (A) and the area of sod blocks carving (B) (1.5-column fitting image).

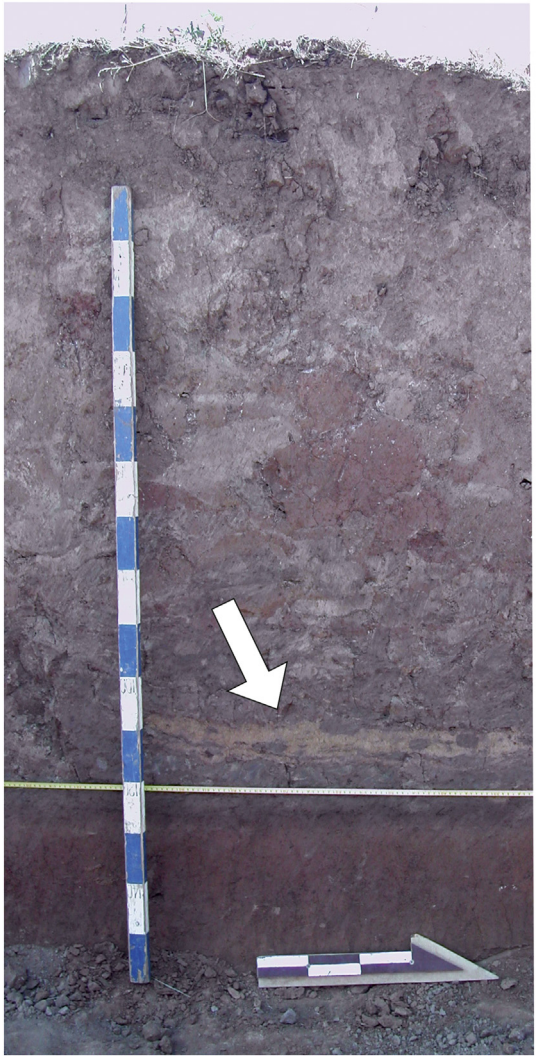

Fig. 7. A passage to the burial with layer of yellow loam

grasses. The profile of Kashtanozems is uniformly coloured, with a poorly visible transition between the two upper horizons. Major areas are in the Eurasian short-grass steppe belt (southern Ukraine, south of the Russian Federation, Kazakhstan, and Mongolia). On the northern border of their distribution, Kashtanozems turn into Chernozems.

Chernozems (from Russian *Chernij*, black) are soils with a thick black surface layer that is rich in organic matter. Chernozems are a typical zonal soil of the tall grass steppes in continental Eurasia. Parent materials are mostly aeolian and rewashed aeolian sediments (loess). Chernozems are common in regions with a continental climate with cold winters and hot summers, which are dry at least in the late summer; in flat to undulating plains with tall-grass vegetation (forest in the northern transitional zone). The profile is dark brown to black with a subsurface horizon with secondary carbonates or a calcic horizon in the subsoil. Chernozems cover an estimated 230 million ha worldwide, mainly in the middle latitude steppes of Eurasia and North America, towards the north of the zone with Kastanozems.

3. Objects and methods

Kurgan No. 3 in the Aksai III kurgan cemetery is 1.4 m high. Considering that the mound was on an arable field that was ploughed for > 50 years, we assume that the initial height of the mound was significantly greater. During the excavation, the mound was dug using a bulldozer. Four trenches were made in the mound, and three walls were left in between (Fig. 3). The trenches were dug to the level of the soil-forming rock. As a result, both the buried soil and the kurgan mound were clearly visible in the section. After all four trenches were dug, three vertical sections were carefully honed to verticality and photographed.

The kurgan was built in the 1st century AD above the grave of a noble soldier of high social rank. The peculiarity of this complex, in addition to the rich burial, was kurgan mounds made from sod blocks approximately 30 × 30 × 30 cm, which had been cut from upper layers of the soil (Fig. 4).

Obviously, during the construction of this kurgan in the 1st century AD, Solonetzes were widely spread out in the soil cover of this area. This is evidenced by the well-preserved buried soil under the kurgan mound. Two sharply outlying upper horizons of Solonetz are well distinguished in sod blocks in the mound: the upper light-grey sandy loam

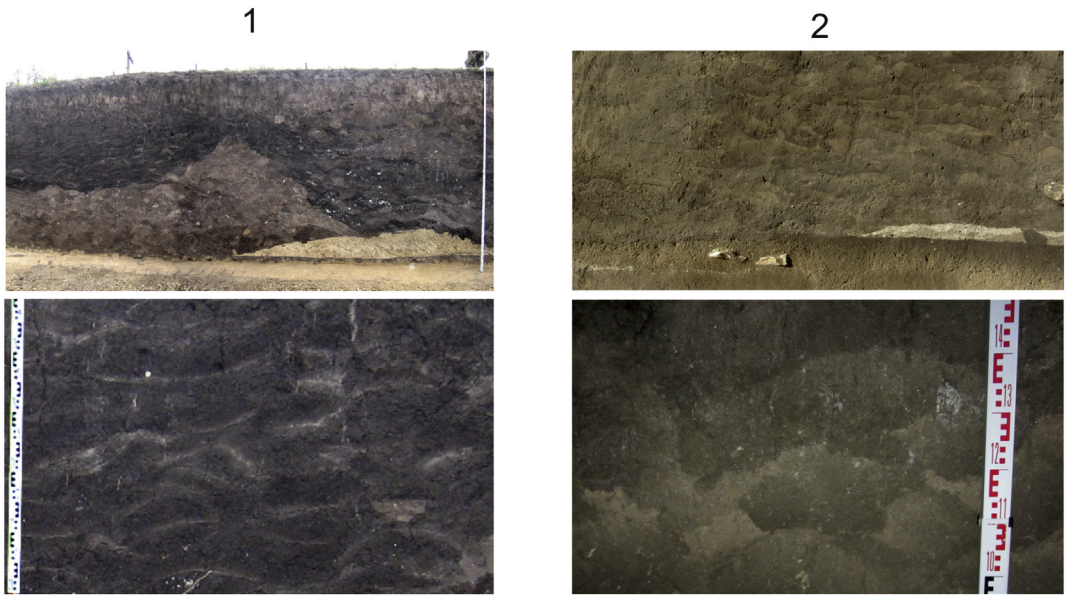

Fig. 8. Sod blocks carved from meadow Chernozem (1) and from thin-layer dark-coloured Calcisols (2-column fitting image).

AE horizon and the underlying red-brown clay Bt horizon. Consequently, we had an opportunity to define the orientation of each visible sod brick in the mound. This has proven very useful in further studies of the mound structure.

We have sampled and described the morphology of the buried soil and the sod blocks in the mound. In the laboratory, we determined the content of organic carbon, the particle size distribution, and the contents of salts, carbonates, and gypsum in the profiles of the buried soil and in the 3 well preserved sod blocks in the mound. Separately, we took the soil from the upper and bottom layers of the blocks, with very similar results with the upper and lower horizons of the buried soils (Table 1).

On the smooth, flat surfaces of the sections, each sod block was clearly visible. However, since the excavations were carried out in July, in the middle of the day, when the sun was very bright, the sod blocks were less visible, so they were painted in the early morning hours. To impart a greater contrast between the upper and lower layers of the sod blocks, the surface of the sections was sprayed with water from a sprayer. After that, each soil block was drawn and its upper part (white-coloured AE horizon) and bottom part (dark coloured Bt horizon) were displayed. Thus, all three walls were drawn from two sides. After all the pictures were analysed, the structure of the mound was clear.

4. Results

4.1. Tumulus structure

The mound had a complicated structure (Fig. 5). In well-preserved sections of the mound, it was possible to establish that the blocks were not stacked chaotically, but rather systematically. The presence of two unconnected structures became obvious and was named External and Internal «brickworks».

The External «brickwork» was a ring of sod blocks approximately 2 m thick arranged in a vertical wall (Fig. 6). The vertical walls were well preserved in the lower part, where they were covered with soil from crumbling blocks.

The internal earthen structure also had vertical walls, and these walls were quite long. This is clearly visible on the central section (Fig. 5). Free space between the inner and outer «brickworks» was filled with small fragments of eroded blocks. After the free space between the masonry was filled with soil, the mound continued to slowly blur and the walls took an inclined position, which is currently fixed.

The internal brickwork was severely damaged by grave robbers, so it was difficult to determine how this part of the monument was organized. Presumably, the inner «brickwork» was a round tower of great height that was built above the grave. The construction of the tower required a large amount of soil; its pressure caused the walls of the inner and outer masonry to slope outward.

An area where blocks had been carved from was behind the mound (Fig. 6 (B)). On this site, the two upper horizons of buried soil were absent and traces of carving sod blocks were visible.

On the northern side, a passage to the grave pit at the centre of the mound led through the external and internal brick layers. A thin layer of yellow loam taken from deep layers of soil-forming rock was poured in; it contrasted very sharply against the brown-grey sod blocks of the walls (Fig. 7). We believe that this kind of decoration of the passage to the centre of the mound was deliberate, since the ground in the passage was taken from very deep layers of soil-forming rock with large gypsum crystals. In buried soil, gypsum crystals are observed only from a depth of 180 cm.

5. Discussion

From the study of a tumulus constructed with sod blocks, we can conclude that, in general, sod blocks are clearly visible only if they are excised from soils with a contrasting profile. In the dry steppe and desert-steppe zones, such a soil is Solonetz, characterized by the presence of two contrasting upper horizons - a light grey sandy loam AE horizon and a red-brown loamy Bt horizon. If the Solonetzes occupy most of the soil cover, they are found everywhere in the kurgan mound and are clearly visible. If, along with Solonetzes, Kastanozem soils with an undifferentiated profile are used, the sod blocks are not sufficiently visible.

The sharp contrast of the two upper soil horizons where the sod blocks were cut from makes it possible to detect blocks in the mound at the present time. However, if the sod blocks were cut from a soil with a less contrasting profile (typical for most of steppe Kastanozems and Chernozems), it is practically impossible to detect blocks in the kurgan mound at the present. Periodic soaking and drying of the upper part of the kurgan mound erodes the boundaries of the sod blocks. As a result, visual differences between soil horizons inside the block and between adjacent blocks are erased and the mound becomes homogeneous. Therefore, at present, sod blocks can be visually distinguished only in kurgans built from Solonetz.

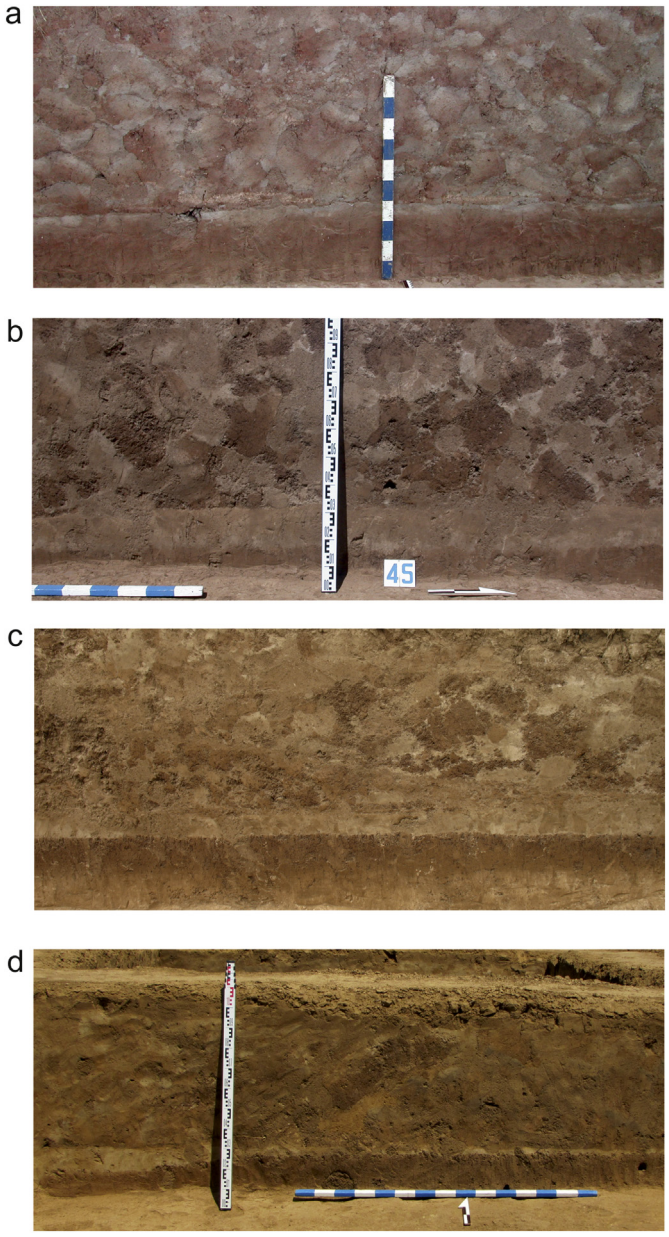

Fig. 9. Well visible sod blocks in the kurgans on Solonetz–kurgan 3 in Aksay-3 cemetery (a) and kurgan 45 in Peregruznoe-1 cemetery (b); poorly visible sod blocks on Kastanosems – kurgan 51 in Peregruznoe-1cemetry (c) and kurgan 52 in Peregruznoe-1 cemetery (d) (single-column fitting image).

However, here one important contradiction arises. It is much more difficult to cut blocks from Solonetz than from Kastanozem or Chernozem. In the Solonetz, the upper horizon is light and free-flowing and the sod is weak. In the summer, the dry Solonetz block bursts and crumbles in ones hands. In contrast, in Kastanozem and Chernozem, the sod is strong and thick, greatly facilitating cutting, transferring, and laying of blocks, even during the dry period of the year.

In the dry steppe and the desert-steppe zones, Kastanozems are usually more widespread than Solonetzes. Therefore, we may assume that the number of kurgans made from sod blocks cut from Kastanozems is also greater. However, because the profiles of Kastanozem are not differentiated and the soil horizons are alike in colour, it is impossible to detect the sod blocks in the kurgan mound.

Therefore, if we find many mounds built of blocks cut from Solonetzes, we are right to assume that even more kurgans were piled from Kastanozem or Chernozem blocks.

In the steppe and forest-steppe zones, the distribution of soil with contrasting colours in the upper horizons is even smaller. The Solonetz process develops only in soils formed at the outcrops of saline clays, and their proportion is only a few per cent of the total area.

In Chernozems, sod is more developed and the thickness of sodded layer can reach 10 cm or more. This allows cutting blocks of up to 20–30 cm in thickness and of any length, but it is even more difficult to detect sod blocks cut from Chernozems because the entire soil profile is monochrome black or dark grey horizons.

The only sign of sod blocks in the kurgan mound in the Chernozem zone is whitish interlayers along the upper edge of the blocks. Such interlayers are usually formed during microbiological decomposition of grass roots in the sod (Fig. 8 (1)). Particularly bright whitish tones appear in sod blocks carved from meadow Chernozem soils that developed under an elevated level of precipitation. Under these conditions, a particularly thick sod is formed, and a decomposed dead plant mass accumulates on the soil surface and in its upper soil horizon. The thicker the sod, the more noticeable the whitish interlayer. Accordingly, in arid periods with less cover, the whitish interlayer in Chernozem sod blocks is much less visible.

Additionally, the sod blocks are quite visible in the mound if the blocks have been carved from thin-layer dark-coloured carbonate Calcisols. In this case, the upper part of the block is black, and the lower part of the block is light grey (Fig. 8 (2)).

It should be noted again that from a technological point of view, the Kastanozems and Chernozems are the most favourable for cutting sod blocks and building kurgan mounds. Long blocks that are permeated with roots of grasses can be cut. They are durable, easily transported, and suitable for the most complex architectural forms, such as vertical walls.

Based on the soil properties, i.e., density, structure, abundance of roots, and clay content, the steppe soils can be arranged in the following descending order for the suitability of cutting sod blocks: Chernozems > Kastanozems > Solonetzes. For the degree of preservation of signs of the presence of sod blocks, the soils are arranged in the reverse order: Solonetzes > Kastanozems > Chernozems. The probability of finding sod blocks in a mound is minimal in the Chernozem zone during arid periods and highest in the desert-steppe zone during humid periods. It should be noted that the extremely strong bioturbation of soil in the Chernozem zone also reduces the safety in the mound outlines of soil blocks.

To date, we have studied several Sarmatian kurgans with sod blocks (Krivosheev et al., 2014). In the kurgan cemetery Peregruznoe-1, located several kilometres from Aksay-3, the three largest kurgans (No. 45, 51, 52) were investigated. The kurgans belonged to people of high social rank (Balabanova et al., 2014; Demkin et al., 2014) and have evidence of sod blocks in the mound. In these burial mounds, the soil blocks were preserved less well than in kurgan 3 in the Aksay-3 kurgan cemetery. The central parts of the mounds were also composed of soil blocks (Fig. 7). However, we did not find those architectural features that were noted in mound kurgan 3. The contrast of the sod blocks in the kurgans of Peregruznoe-1 and Aksay-3 was different. In Aksay-3, soil blocks were clearly visible; in kurgan 45 of Peregruznoe-1, they are less clear, and in mound 51, the soils are even more amorphous. In the kurgan 52, sod blocks are poorly observed, and rarely encountered in profiles.

The reason for different visibility of the sod blocks is the peculiarities of the natric (Bt) horizon in Solonetz. In the soils of the Aksai-3 burial mound, the natric horizon is reddish-brown heavy loam and sharply contrasts with the light-grey sandy loam upper horizon (AE). In the soils of kurgan 45 in burial cemetery Peregruznoe-1, the natric horizon is less perceptible, and in kurgan 52 it only slightly differs from the upper AE horizon (Fig. 9).

At the moment, it is difficult to appreciate the extent of the use of sod blocks in mound construction. One can only confidently isolate those kurgan mounds that were not constructed from sod blocks but

were filled with loose soil. If the kurgan mound consists of a soil-forming rock, then surely a loose soil was used as fill over the burial, because it is impossible to cut out blocks from soil-forming rocks.

Kurgan mounds made from soil-forming rocks are quite rare. In most kurgan mounds, the soil of the upper horizons predominates, and buried soils have no contrast or have uniformly coloured upper horizons. This means that it is impossible to exclude the initial presence of sod blocks in the mound. They probably became blurred and lost their borders.

This makes it possible to raise the issue of a wider dissemination of the tradition of cutting sod blocks for constructing mounds. The currently known cases of mound construction from sod blocks are probably only a small part of the actual scale of this building tradition. In the mound, only blocks cut from Solonetz and meadow Chernozem soils that have limited distribution in the soil cover are visually discernible. In kurgan mounds composed of Kastanozem and Chernozem soil, it is very difficult to find the sod blocks.

It is worth noting that soil blocks are well preserved in kurgans with a height of 1 m or more. At a lesser height, the contours of blocks are invisible as a result of soaking and drying in the mound. Soil blocks are rarely visible in small kurgans.

6. Conclusion

Sod blocks are well distinguished in tumuli only if the kurgan is built in an area of soil with contrasting profiles, such as Solonetz and meadow Chernozem soil. If the kurgan mound is made from sod blocks cut from a soil with a uniformly coloured profile, it is impossible to visually detect sod blocks.

The increasing discovery of sod blocks in kurgan mounds in the steppe zone indicates that this method of mound construction was much more widely used than was previously believed. If material from soil-forming rocks has not been used for kurgan construction, the use of sod blocks may have occurred.

In the steppe area during summer, when the soil is dry, it is much easier to cut blocks out of loose sod than to dig the dense and dry ground of soil-forming rock. Moreover, the use of sod blocks opened wide opportunities for a variety of forms of kurgan mounds and allowed construction of vertical components, such as walls and steps.

Taking into account the above, we believe that it is necessary to take a different look in a broader context at the kurgan mounds of all the kurgans of the Eurasian steppes. There are reasons to believe that originally, a significant proportion of the tumuli were not just piles of soil but were instead complex architectural monuments.

Acknowledgement

This work was supported by Russian Science Foundation. Project 17-18-01406.

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