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# A.P. Derevianko's Multivolume *Three Global Human Migrations in Eurasia* and Its Place in Paleolithic Studies

*Academician A.P. Derevianko's longterm studies are summarized in the first four volumes of his monograph on three global human migrations in Eurasia. The routes whereby early humans dispersed from Africa and eventually spread over nearly entire Eurasia are reconstructed, and numerous empirical and theoretical problems stemming from these reconstructions are convincingly resolved. Derevianko headed the excavations of Paleolithic sites scattered across vast territories of Asia. Especially important are the discoveries in the Altai. This work has raised a number of questions of key importance, for which no universally accepted answers have been given so far. Based on the hominin fossil record and having critically examined the principal hypotheses and proposals concerning both biological and cultural aspects of human evolution, A.P. Derevianko has come up with his own theory of the origin of the genus Homo, originating from Australopithecines. Some groups of the latter are believed to have been mentally predisposed for developing cumulative knowledge relating to lithic technologies and other aspects of culture. One of these aspects is the behavior relating to the interment of the dead—the first specifically human cultural trait, documented since the final Acheulean. Human migrations involve a plexus of issues: properties of the raw material affecting lithic industries, and the extreme environmental variability peculiar to the largest continent. Despite the exponential growth of publications addressing human evolution, Derevianko's conclusions, both empirical and theoretical, outlined in the first volumes of his summarizing work, retain a key importance.*

Keywords: *Paleolithic, hominins, genus Homo, Australopithecines, lithic industries, migrations.*

The progress in the scientific developments apparently raises a considerable number of new questions. Science is a continuous search for answers to questions. Some questions have not been answered for centuries, but the river of knowledge, in this case, the Paleolithic issues, is constantly replenished by new answers and questions thanks to collective efforts of scientists. Occasionally, this river receives such powerful flows of answers that can change the direction of its course. The series by A.P. Derevianko *Three Global Human Migrations in Eurasia* is exactly such an inflow (2015, 2017–2020, 2022).

This study is unique in terms of the scale and depth of the analysis of the process that had evolved over more than 2 million years. The works by H. Obermaier *Prehistoric Man* (1913) and H. Osborn *Men of the Old Stone Age* (1924), published a century ago, as well as the monograph *Primitive Society* by the Soviet archaeologist P.P. Efimenko (1953), can be regarded as minor parallels. In terms of significance, as compared to the Derevianko's multi-volume series, these editions look like manuals on the history of the Stone Age. As a researcher, I am following with great interest this long-term process of creating of a grandiose and coherent picture of the ancient history of early humans on the basis of findings on each identified trace of *Homo sapiens* in Eurasia, the largest continent of the earth. This is a bold challenge to the aphorism "one cannot embrace the unembraceable".

I will focus on the first four volumes of the A.P. Derevianko's series, which describe the first two waves of global human migration from Africa to Eurasia. The question immediately arises: were these two waves separated in time or were they a continuous stream of bearers of the pebble-flake industry followed by those with the Acheulean tradition? This is a methodological question. Most likely, these waves followed one another without interruption.

Anatoly Derevianko worked together with A.P. Okladnikov from his young age and became a worthy student of his mentor: under Derevianko's leadership, the Institute of Archaeology and Ethnography SB RAS in Novosibirsk became one of the world-known centers of prehistoric archaeology. Novosibirsk archaeologists carry out their studies all over Asia, from the Middle East to the Far East and from the Arctic to India. Over the years of experience in field research and laboratory studies, Anatoly Derevianko has come up with the idea of creating a general picture of the initial dispersal and settlement of Eurasia by hominins throughout the Stone Age, which makes up 99 % of the history of mankind on the Earth.

A.P. Derevianko spent most of his life in field studies all over Eurasia, and saw firsthand the lithic collections of various cultural traditions in Siberia, Central Asia, the Far East, Southeast Asia, India, the Middle East, and Europe. He has understood the necessity of a global systematization of the whole Paleolithic evidence from Eurasia, which would have been impossible without referring to the Paleolithic of Africa, the ancestral home of mankind. Derevianko realized the importance of resolving the long overdue problem of general systematization of the Paleolithic data from Eurasia, primarily Asia, Asian western periphery, and Europe. Starting with research on the origins of the classic Oldowan and small-tool lithic industries, the scholar proceeded with a global consideration of this phenomenon. And in my view, he made the correct conclusion that the features of certain Lower Paleolithic industries had been determined by the raw materials used. Of course, the creators of these small items simply did not have large pieces of stone. The second problem associated with the origins of the Paleolithic culture throughout Eurasia was the so-called Movius line.

Anyway, systematization of the Eurasian Paleolithic in space and time is an issue of great importance. I suppose that Anatoly Derevianko began to develop this idea in the 2000s. It turned out that the assumption of H. Movius about the fundamental differences between the Paleolithic traditions of the industries of Western and Eastern Eurasia is not entirely true: he proposed the boundary dividing the traditions, but it appeared to be the boundary on which the Acheulean migration from Africa "faded away". Derevianko found out that the second wave of migrants from Africa did not reach the extreme northern, eastern, and southeastern outskirts of Eurasia. Migrants from Africa assimilated into *Homo erectus* of the first migration wave, practicing the Olduvai or Clactonian lithic traditions. The bearers of this older technical tradition continued their successful evolution in the northern and eastern peripheral regions of Eurasia, which differed in their environmental and climatic conditions. Derevianko argued that *H. heidelbergensis*, representatives of the Acheulean culture, could have penetrated the northern and eastern outskirts of Eurasia; hence, they could also have borrowed the techniques of lithic industries from the former inhabitants of these areas, whose economy was adapted to the local resources.

The value of the *Three Global Human Migrations in Eurasia* lies in the fact that it provides important information on most "blank spots" in the Paleolithic of Africa and Asia, thanks to the discoveries made by many scholars, including A.P. Okladnikov and A.P. Derevianko. The series presents a profound picture of the Eurasian Paleolithic. Outlining a general scheme of human evolution on the planet during more than 2 million years, the author had to consider hundreds of various issues. However, the essence of the dialectic of a scientific research is precisely that while searching for answers to specific questions, new question arise that have yet to be answered.

A.P. Derevianko's work summarizes the 200-year long history of the study of the ancient past of mankind. The study provides information concerning the origin of man in Africa and human dispersal throughout Eurasia. It was Eurasia and Northeast Africa (owing to the diversity their geo-bio-chemical factors, which led to the formation of various ecological provinces) that proved to be the cradle of humankind.

Anatoly Derevianko has identified the main processes of peopling of the world. In his work, he considers three stages of human settlement, corresponding to three waves of migration of hominins from Africa—*H. erectus*, *H. heidelbergensis*, Denisovans, and *H. sapiens*. Volumes I and II present the analysis of migration routes of the first wave; volumes III and IV, those of the second wave—hominins with the Acheulean industry. These streams moved from west to east through vast regions, with various environmental and climatic conditions. The process of adaptation of *H. erectus* to new environments was long and complicated. It took hundreds of thousands of years. Describing the main stage of the Paleolithic historical drama, the author identifies several large geographical provinces: the Levant, the Middle East, Asia Minor with Iran and Afghanistan, the Caucasus, India, Kazakhstan, Central Asia, Altai, Mongolia, Siberia, the Far East, and Southeast Asia. These lands differ in relief, climate, as well as water and food resources. The author indicates hundreds of Early Paleolithic sites and localities, and provides relevant geological and biological characteristics. Distinctive features of rather rare anthropological materials are also discussed. Apparently, the environments of particular physical-geographical provinces, available raw materials, and typical flora and fauna of the latitudinal zones of Eurasia affected the development of lithic industries and hunting/gathering practices of the migrants.

A detailed analysis of the movement of the first wave of *Homo* across Eurasia showed that there were two main migration routes from west to east. One of the roots ran through the Middle East, passed along the coast of the Indian Ocean, and reached the Far East. The climatic and environmental conditions of the regions along which this route ran were about the same as in Africa and did not require long-term adaptation. At that time, the south of Eurasia, similarly to Africa, was inhabited by giraffe, elephant, hippopotamus, ostrich, and other animals. Humans having reached the south of Eurasia with their African fauna might not have realized they entered another continent.

The early hominin migration along the second continental route—through the middle latitudes—was slower; they moved through the Middle East to the Caucasus. At the Caspian Sea, the path forked. The Southern Caspian route ran through the wooded uplands of Elbrus, the Kopet Dag, the slopes of the Hindu Kush, and led to India. The Northern Caspian route led from the Caucasus to the steppe zone of the middle latitudes, from where hominins could move both to Eastern Europe and through Central Asia to the Far East.

The early hominins, who had already mastered the tropics and subtropics of Eurasia, reached the northern regions of Eurasia most likely during the warm interglacial periods; therefore, the dates of the oldest Paleolithic sites in the middle latitudes are 800–700 ka BP.

Volumes III and IV describe the cultures of the second wave migrants practicing the Acheulean industry. Anatoly Derevianko distinguishes between the sites with the classic Acheulean culture (characteristic tools—handaxes, cleavers, pick-like tools, and Kombewa flakes) and other older and younger sites where, in particular, handaxes were found. It is noted that the materials of the latter sites, including the oldest Acheulean site in the Levant (1.4 mln years old), might have been of local origin.

Notably, the Acheulean site in the Levant, Gesher Benot Ya'aqov, located, like Ubeidiya, at the exit from Africa, is almost twice as young as the latter, 800–600 ka BP. The Gesher Benot Ya'aqov's lithic industry reveals the entire set of the above-mentioned artifacts of the classic Acheulean. Derevianko points out that its representative was *H. heidelbergensis*. Based on available evidence, the author traces the advance of the Acheulean to the Middle East, the Caucasus, and the territory of India, where cleavers and pick-like tools are occasionally found along with handaxes; and in Central India, Kombewa flakes have also been reported. Considering the issues of the Acheulean in Europe, Derevianko notes that the bearers of this culture could have gotten to Europe not only through the Bosphorus and the Dardanelles, but also through Gibraltar, and during a sharp drop in the level of the Mediterranean Sea, from Tunisia to the Apennine Peninsula. The Acheulean culture in Southern Europe is represented by cleaver-like tools and sometimes Kombewa flakes. However, in Northern Eurasia, only handaxes are found. This culture raises many questions; in particular, some handaxes from V.P. Lyubin's and H.A. Amirkhanov's collections, judging by the available images, can hardly be attributed to it.

From the Caucasus, the handaxe culture spreads to the north, to the Southern Urals; many sites with handaxes were found in the upper reaches of the Or, Ilek, Irgiz, and Emba rivers in the Mugodzhary Mountains. Further to the east, in Central Kazakhstan, sites with rare handaxes, and sometimes with single cleavers, form a scarce chain, stretching east to Mongolia.

The pattern of the Acheulean distribution in Central Asia is noteworthy. In the west, handaxes were spread over the Aral-Caspian region and the Caucasus; handaxes have been found not only in the Caucasus, but also in the southwest of Turkmenistan, on the Ustyurt Plateau and the Mangyshlak Peninsula, and in the Mugodzhary Mountains, to the north of the Aral-Caspian region. At the lower Syr Darya River, sites with handaxes are rare (Mamirov, 2010: 13–17).

In the foothills and middle mountains of the Pamir-Alay and the Tien Shan, no Lower Paleolithic sites with Acheulean-like industries have been identified. The buried soils in loess sections, studied by V.A. Ranov, yielded only pebble-flake industries from 900–800 to 600–500 thousand years old. Similar artifacts were reported from the foothills and middle mountains of Southern Kazakhstan. It is possible that the regions of the upper reaches of the Amu Darya and Syr Darya rivers were rather densely populated by representatives of the first migration wave from Africa by the time when humans with the Acheulean culture reached this area. Therefore, the *H. heidelbergerensis* tribes passed over these territories. Anatoly Derevianko assumes that in the Middle Acheulean period, a branch of the *Homo altaiensis* diverged from the *H. heidelbergensis* genetic pool; *Homo altaiensis* tribes moved eastwards through Central Asia and reached the Altai.

Kuldara, the oldest Paleolithic site in the south of Central Asia, is located not very far from the most ancient sites in the Soan River basin, aged 1 mln years or more, although A.P. Derevianko considers these dates to be overestimated. Anyway, during the warm Günz-Mindel Interglacial, the oldest *H. erectus* tribes from South Asia could have reached the north of Central Asia and arrived to Karama in the Altai 800–700 ka BP. No Acheulean sites proper have been recorded in the Altai to the north of Torgalyk, studied by S.N. Astakhov. In terms of morphology and typology, the Torgalyk artifacts are very close to the finds from contemporaneous localities in the Mugodzhary Mountains.

By the beginning of the Middle Paleolithic, all areas inhabitable for early hominins were occupied. Then, a fundamentally new stage in the evolution of humans and their culture began. Selected pebbles were used for grinding, softening and crushing the products of gathering—grains, seeds, rhizomes, and stems of plants. V.P. Lyubin, in his publication on the Mousterian culture of the Caucasus, reported the occurrence of fish bones in the cultural layers of some caves. Recently, the information about numerous fish bones found in almost all cultural layers at Gesher Benot Ya'aqov Cave, in the Jordan valley, dating back to 800–600 ka BP, appeared. The analysis of the remains of fish heads showed that inhabitants of the cave were engaged in regular fishing; they baked fish on coals in the way that fishermen cook it today (Zohar et al., 2022). Such obvious traces of fishing in Central Asia during the Paleolithic have not yet been found.

During the Middle Paleolithic, or in the Mousterian, the territory of Eurasia (up to the Altai and the Tien-Shan) was settled by the Neanderthals, and there appeared specialized stone tools: burins for processing solid organic materials, knives for cutting meat, and bone burnishers for dressing skins.

In the foothills of the Levant, as I believe, the local type of Neanderthal man, with the genome showing traces of gene flow from early *Homo sapiens* from Africa, has apparently been formed rather early. In the Middle East, these evolutionary processes possibly began earlier than in other parts of Eurasia.

I consider it premature to discuss the results on the Middle Paleolithic developments proposed by Anatoly Derevianko, although in the fall of 2022 I have already received from him volume V, full of new observations and ideas. As far as I know, volume VI is being prepared for publication.

The style of the author of the multi-volume series under discussion is characterized by returning to the topics previously stated by him; he continues to develop these topics on the basis of discoveries of recent years, complementing and correcting his earlier conclusions. Not every researcher follows such an approach.

Noteworthy are some issues that arise in reading the first four volumes of the Derevianko's extensive study. One of them concerns Australopithecus. According to a well-known hypothesis, life in the savanna was full of dangers, which awaited upright walking primates. They were able to survive solely owing to socialization patterns that originated in some primate populations. For example, a male, having become a father, began to take care of the offspring, protect and feed them and their mother. Only such couples left heirs. If we assume that the first humans differed from apes in their ability to make stone tools, then we can suggest that humanism-based family life was formed long before the invention of wooden and lithic tools. Thanks to the family, humans began to produce first tools, which required the elaboration of methods and means of storing and transmitting information. This is where technology training began. The first tool was a stick that could be processed only by a stone. That is, Australopithecus can be called proto-human. These assumptions are supported by the famous traces of a mother and child preserved on the surface of petrified volcanic ash in Africa. Australopithecines invented more than just the human family. They settled all Africa and, judging by the recently discovered Austrolopithecus bones in China, also the southern part of Asia. Notably, stone tools of Dmanisi humans do not show signs of retouch, while those of *Homo habilis* were processed by primitive retouch.

Populations of some Australopithecus species apparently consisted of already socialized individuals, which differed from animals in having a developed signaling system. This system made the community a complex social organism, without which the invention and development of tool-making technology would have been impossible; human culture was developed on the basis of a complex of skills and knowledge transmitting methods.

Human relationships took a long time to develop in Australopithecine communities: from *Australopithecus* *garhi* to the first *Homo*. Recently, at the Nyayanga site in Southwestern Kenya, in the earliest layer aged 3.032–2.581 Ma BP, a culture-bearing horizon was identified. Along with numerous fragments of mammal bones, this horizon revealed 330 coarse stone items made of rhyolite and quartzite, as well as two teeth of Paranthropus. Thus, the early lithic industries of Africa were practiced not only by *Homo erectus* and *Homo habilis*, but also by more primitive Paranthropus (Plummer et al., 2023).

Communities of early hominins were apparently formed not only through ancestral ties, but also on the basis of information about typical situations that required appropriate solutions. They might have also produced wood, bone, leather and stone goods, of which only stone products survived until nowadays.

The question of the effect of raw materials on the technology and typology of stone tool production has long been discussed. I see the answer to that question in the expansion of experimental studies with the rocks that were available to ancient humans inhabiting a specific site within the area of their subsistence cycle.

The above issue is related to migrations and relationships between small tribal communities of ancient hominins. As was previously assumed, they had all forms of friendship and enmity recorded in history and ethnology. In recent years, thanks to the methodology developed by S. Pääbo, it was found out from the Altai materials that ancient people actively maintained marital ties with neighboring communities. According to ethnographic observations, girls of all nations choose a stranger as a marriage partner when there are several candidates. It is not reasonable to consider the relationships between various groups of ancient hominins through similarities and differences in the typology of cores, flakes, and tools. Despite the great abundance of available isotropic stone rocks that were used for the production of several known forms of cores and no more than two dozen types of tools, researchers often draw conclusions about the kinship of lithic industries that are very distant from each other. This gives rise to ideas about cultural migrations over thousands of kilometers. Apparently, there is no reason to completely deny such migrations. In ancient times, migrations took place on the Eurasian continent from west to east. In the west, especially in the Mediterranean regions, population density was always higher than in the northeast.

Another debatable topic is connected with the known burials of ancient hominins. The earliest mass burials of bones of the deceased are known in Sima de los Huesos Cave in Spain, dating back to ca 500 ka BP, and in Zhoukoudian Cave (burials of skulls) ca 300 ka BP. In the Rising Star cave system in Africa, specially made burials of *Homo naledi* were discovered, dating back to 236–335 ka BP (https://naked-science.ru/article/anthropology/homo-naledi-mogli-polzovatsya-ognem). Funerary rite of Neanderthals emerged in the Middle Paleolithic. The burials of early *Homo sapiens* in the caves of the Klasies River valley in southern Africa also pertain to this period. Many researchers argue that religious ideas based on ordinary human feelings emerged in the Paleolithic. Religious doctrines were developed considerably later. Burial of a deceased loved member of a family was a reaction to a disaster. For each of us, the death of a loved one is the greatest loss. This irreparable loss causes a desire to preserve the remains of the deceased, and the memory of this person gives rise to the illusion that he has gone to another world (because he appears in our dreams). This is how the idea of the otherworld was formed. The hope for an afterlife, which is well known from the mythology of all ancient peoples, helps to get over the grief of loss.

In conclusion, we would like to note the great success of Anatoly Derevianko in establishing a friendly team of talented youth and ensuring the archaeological studies at the highest methodological level. Thanks to the work of his students in the late 20th to early 21st centuries, important discoveries were made in the Altai. Stunning findings about the family relationships of Neanderthals in the Chagyrskaya and Denisova Caves have been made under the leadership of A.P. Derevianko.

The discussed multi-volume generalization, providing a wealth of details, raises completely new and often unexpected questions that change the scholar's line of thought. Apparently, not all readers of the Derevianko's series *Three Global Human Migrations in Eurasia* will agree with his conclusions. These books address fundamental issues of the origin of the genus Homo, dispersal of humans over the continent, their material and spiritual culture in the Pleistocene, and evolution of anatomically modern humans, and are based on the findings of the most recent archaeological, anthropological, genetic and other scientific studies. This series is the first generalization of this kind in the world literature, which is made not by a large group of authors, but by a single researcher, and it undoubtedly makes an important contribution to the study of ancient human history.

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# Core-Shaped Tools from the Early Pleistocene Deposits at Bairaki, Moldova

*This article deals with a series of core-shaped tools from Early Pleistocene deposits (layers 5 and 6) of the stratified site of Bairaki, located on high above-floodplain terrace VII of the Dniester, in the outskirts of Dubăsari, Moldova. The site was discovered in 2010 by the joint Russian-Moldovan archaeological expedition and excavated in 2011–2014. The interdisciplinary studies revealed six layers with Early Paleolithic artifacts. Two lowest layers (5 and 6) are associated with the channel alluvium of terrace VII. The paleomagnetic studies have shown that these deposits correspond to the Jaramillo episode of the Matuyama epoch. The lithic industry of layers 5 and 6 are comparable to the Late Oldowan. Most artifacts are made of poor quality flint; there are also pebble tools made of non-silicic rocks. Most lithics are small. A distinct series of core-shaped end-scrapers and side-scrapers made on residual cores (9 spec.), fragments (1 spec.), and flakes (5 spec.) is identified. All these tools are robust and had been processed in a similar way. They are made of pebbles no larger than 6 cm. The steep working edges of all implements in this series are heavily retouched. Similar items have been recorded from the Early Paleolithic materials of the region. Such tools were widespread in the Early Paleolithic of Africa and Eurasia. The earliest pieces were found in the Bed I assemblage of the Olduvai Gorge.*

Keywords: *Southwestern part of Eastern Europe, Moldova, Transnistria, Bairaki site, Early Paleolithic, core-shaped tools.*

## Introduction

The archaeological complexes of the earliest Paleolithic, including the Oldowan, along with the usual pebble items and flake artifacts, contain cores and core-shaped tools. The core-shaped tools are robust, and many of them resemble end-scrapers. Side-scraper varieties are less common. Residual cores were commonly used as blanks. Series of such tools are usually reported from the Early Paleolithic industries of the pebble-flake and Acheulean traditions. The oldest assemblage of them was found in Bed I of the Olduvai Gorge (Barsky et al., 2018). In the Middle Paleolithic, such tools have been recorded only in the Tayacian assemblages, where they were usually fashioned on robust Clactonian flakes (Anisyutkin, 2016). The morphology of core-shaped end-scrapers has been thoroughly analyzed elsewhere (Lyubin, Belyaeva, 2004a; Barsky et al., 2018).

This article considers core-shaped tools an important component of the Early Paleolithic pebble-flake complex. Particular attention is paid to the features of accommodation. The discussion is based on the lithic industry of the most ancient Early Paleolithic site in the Russian Plain (about 1 million years old), which originated from lowermost layers 5 and 6 of the site of Bairaki on the outskirts of the city of Dubăsari, in Lower Transnistria.

## General description of the site and materials

The Bairaki site was discovered in 2010 by the joint Russian-Moldovan archaeological expedition; excavations and multidisciplinary research were carried out in 2011–2014 (Anisyutkin, Chepalyga, Covalenko, 2015). The site is located on the left side of the Bairaki gully near the city of Dubăsari, Pridnestrovian Moldavian Republic (Fig. 1). The Bairaki gully is relatively short, its upper part is a gentle hollow partially filled with Holocene humic talus. The gully's slopes show different geological structures: the right side is composed of Middle-Upper Pleistocene diluvium; the left side, of the older Early Pleistocene deposits. The excavation unearthed ca 26 $m^2$. The total thickness of the deposits exceeds 8 m. The following stratigraphic sequence has been recorded within the excavation.

*Layer 1* (0–0.7 m). Modern black soil (chernozem), with rodent burrows.

*Layer 2* (0.7–1.25 m). Brown to reddish-brown loam, with a minor admixture of humus—a carbonaceous horizon of modern soil.

*Layer 3* (1.25–1.60 m). Yellowish-brown to pale yellow loam; diluvial, carbonaceous, loess-like.

*Layer 4* (1.6–2.2 m). Brown paleosol sediment; clayey, cloddy, Middle Pleistocene in age.

*Layer 5* (2.2–2.8 m). Reddish-brown paleosol; double layered, with distinct fissures, which are filled with homogenous reddish-brown sediment. These fissures penetrate into the underlying gley soil. This layer revealed solitary well-preserved flint pieces corresponding to cultural layer 2, as well as patinated items from destroyed archaeological layer 1.

*Layer 6* (2.8–3.4 m). Brownish-greenish hydromorphic soil of the gleyzem type, covering the floodplain deposits. It is cut with through cracks from layer 5. The soil contains archaeological layer 3 with solitary weakly rounded flint artifacts and fragments of fossil animal bones.

*Layer 7* (3.4–5.1 m). Floodplain alluvium facies: greenish-gray and light brown sandy-argillaceous carbonaceous silt. The lower part of these deposits yielded archaeological layer 4, containing an alignment of limestone slabs and four artifacts of flint and chert.

*Layer 8* (5.1–5.8 m). Deposits of oxbow alluvium facies, with alternating thin beds of gray siltstone and orange-brown gley sublayers.

*Layer 9* (5.8–6.5 m). The cover of the channel alluvium. Light brown deposits, consisting of coarse-grained sand with thin lenses of fine gravel. Its lower part is dark, owing to manganese inclusions in the brown pebbly substrate. The base is a sublayer of light gray sand with small pebbles, representing the beach facies deposits. Numerous lithic artifacts from archaeological layer 5 were found here, including large pebble pieces and small flint tools, rolled to varying degrees. There are a lot of flint chips, which are usually not preserved in deposits of this type. Among several small fragments of unidentifiable bones, a fragment of the calcaneus of a small Cervidae animal was discovered.

*Layer 10* (6.5–7.9 m). Several horizons of gravel-sand deposits. Here, the number of gravel-pebble inclusions, forming lenses in coarse-grained yellowish-gray sand, noticeably increases. The lower horizon is oversaturated with pebbles, but no large or medium pebbles were recorded. Artifacts from this layer were attributed to archaeological layer 5. There are few artifacts, rolled to varying degrees. Tiny flakes and chips are also rather rare. Solitary unidentifiable bone fragments were found.

*Layer 11* (7.9–8.2 m). Small-sized gravel, cemented in some areas, often forming

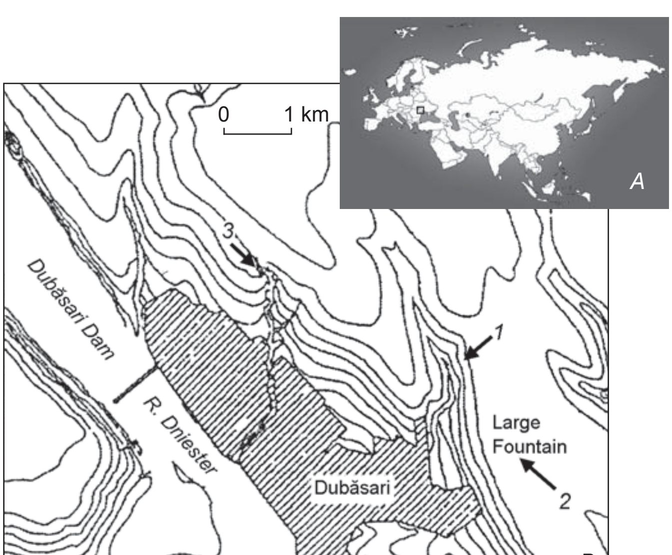


*Fig. 1.* Map showing location of the Bairaki site in the south of the East European Plain (*A*) and the Early Paleolithic sites within the city of Dubăsari (*B*).
*1* – Bairaki; *2* – Bolshoi Fontan; *3* – Creţeşti.

a conglomerate. Pebbles of medium size (5–7 cm) were recorded. The layer was studied on a small area and wasn't excavated completely. It reveals solitary heavily rounded flint artifacts. This is clearly the redeposited and destroyed cultural layer 6.

The main profile of the site shows a complex structure of the lower alluvial part of the ancient terrace, while the upper loess-soil layer is thin. There is no clear division into paleosol and loess levels in this structure. Paleosols lie one over another, and facies are in the form of pedosediments. Taking into account these findings, we made additional profiles in the fills of paleo-incisions of various ages, located down the slope, where the thickness of the deposits noticeably increases. In such geomorphological situations, soils are better preserved and consist of several horizons, separated by diluvial or loess layers. In order to clarify the Bairaki stratigraphy, in the uppermost part of the left side of the gully, a section was made at the northeastern wall of the excavation over a length of more than 70 m. The sections were arranged downwards along the gully's slope (Sychova, Anisyutkin, Khokhlova, 2022). As a result, layers of diluvial loams were identified between the three paleosols, which were better preserved in this part of the gully.

The lower paleosol, containing archaeological layer 3, is overlain by stratified brown loam, in which a side-scraper on a thick flint flake was found. Paleomagnetic analysis of a sample of this loam showed reverse polarity, indicating the end of the Matuyama epoch. The underlying hydromorphic paleosol corresponds to one of the latest episodes of this epoch. Samples from archaeological layers 5 and 6 belong to the Jaramillo episode (Chepalyga et al., 2013; Anisyutkin, Chepalyga, Covalenko, 2015). This dating corresponds to the absolute TL-dates of 940 ± 200 and 1100 ± 250 ka BP previously derived for the alluvium from the same terrace, near the village of Kitskany, in the vicinity of Tiraspol (Antropogen…, 1986: 56).

The upper and middle (red-colored) paleosols were separated by a brown loam horizon with solitary flint artifacts from archaeological layer 1. In 2010, a part of this horizon with artifacts bearing white patina was identified in this excavation. Some of these artifacts were found redeposited in the middle (red-colored) soil layer. In total, 15 patinated flint items were found in layer 1, including two cores, four Early Paleolithic tools, and flakes.

Archaeological layer 2 yielded a small collection of flint artifacts (20 spec.) originating from the middle layer of paleosol. The collection includes a chopper, a core-shaped end-scraper, four side-scrapers, two cores, and a pebble stone with traces of working, as well as flakes and solitary chips. All the items bear no patina and show a good state of preservation of surfaces. Several small fragments of unidentifiable bones were found. It is possible that these are the remains or the outskirts of the preserved culture-bearing layer.

Archaeological layer 3 yielded 15 lithic artifacts, including a pick, two choppers, two cores, a side-scraper on flake, three pebbles with flaking scars, and flakes. The tools are slightly rounded and bear a blueish-white patina. Several fragments of unidentifiable bones and a fragment of a mandible with teeth from the Süssenborn horse (*Equus (Allohippus) sussenbornensis*) typical of the second half of the Early and the initial Middle Pleistocene were found in the layer (Stratigrafiya…, 1982: 272).

Archaeological layer 4, associated with floodplain alluvium deposits, yielded four lithic artifacts, three sandstone pebbles, and a fragment of an unidentifiable tubular bone of an ungulate. It also revealed an alignment of limestone slabs approx. 1.5 $m^2$ in size, which has not been studied yet. The alignment was laid up and covered with deposits.

Cultural layer 5 contained the largest number of lithic artifacts. It was associated with deposits of the beach facies of channel alluvium of the 7th (Kitskany)* above-floodplain terrace of the Dniester; the previous and recent paleomagnetic datings suggest the Matuyama age for these deposits.

The lithic industry from lower layers 5 and 6 belongs (sensu lato) to a pebble-flake complex comparable with the developed Oldowan C (Schick, Toth, 2009). The assemblage from layer 5 contains more than 880 artifacts, including a few pebble and core-shaped items, cores, flakes, and flake tools. Small pieces made from gray and black flint predominate, which is largely explained not only by the simplicity of the technology used, but also by the specifics of the raw materials available. As a rule, small flint nodules rarely exceeding 5 cm were used. All relatively large tools are pieces of pebble often made from non-silicic rocks. These are choppers and picks made from both flint and larger pebbles of Cosăuti and Devonian sandstone. This was a low quality flint with fissures and caverns. The average size of flint flakes and the relevant tools is slightly more than 3.2 cm (Anisyutkin, 2020).

*In some geological publications, the Kitskany terrace is defined as the 8th terrace (Antropogen…, 1986: 18).

## Description of the core-shaped stone tools

The set of core-shaped tools under discussion consists of 15 flint items. Some of them are fashioned on residual cores; others are prepared on natural fragments and flakes. These products demonstrate a combination of two common features: robust blanks, and steep working edges of end- and side-scraper-like tools processed with heavy vertical retouch. The majority of these tools were found in layer 5. Residual cores (9 spec.) and flakes (3 spec.) were used as blanks for the manufacture. One end-scraper, recovered directly from a small-pebble conglomerate, was made from a small rounded fragment of gray flint. Two artifacts were identified as side-scrapers on robust flakes. Judging by the totality of their characteristics (the use of rare robust flakes as blanks, distinctive secondary processing of working edges), the tools may well be included in the same group with end-scraper-like tools. The collection also contains several similar, but less expressive, products. These are often combination tools.

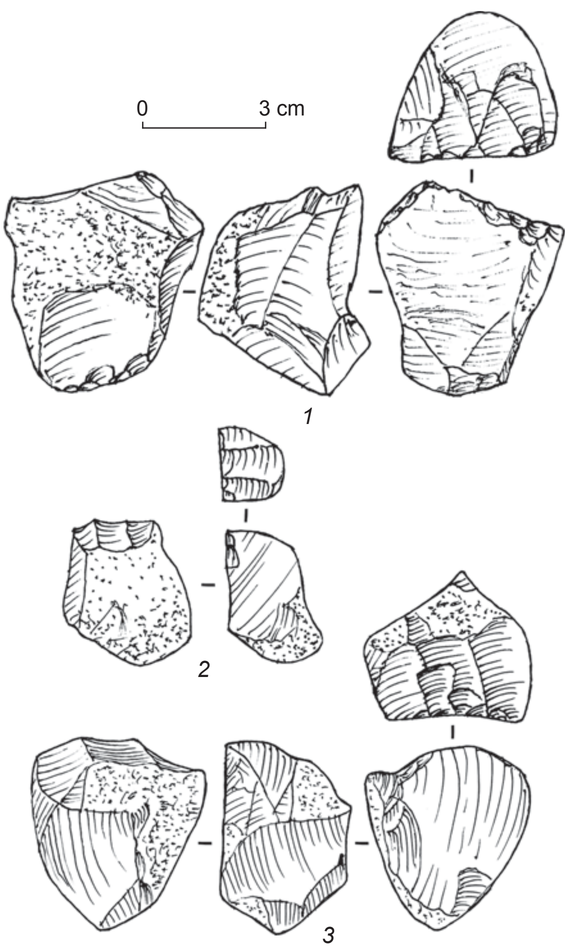

*Fig. 2.* End-scraper-like tools on residual cores from layer 5 (*1*, *3*) and on a flint fragment from layer 6 (*2*).

The largest tool in the collection was fashioned on a multiplatform core of gray flint, the maximum length of which barely exceeded 5 cm (52 × 48 × 45 mm). This item is partially rounded and is of a light brown color, which is typical of most gray flint artifacts found in layer 5. The exceptions are the steep working edge of the end-scraper-like tool, formed through a series of facets of flattening retouch, and its ventral surface, formed by natural knapping, which are almost not rounded and retain a gray color. This is the case of the secondary use of the item. This pear-shaped tool shows localized traces of wear on the narrowed end, suggesting the use of the artifact as a hammerstone. Upon another percussion, the impact went along a natural crack and formed the necessary element for making an end-scraper-like working edge. It can be assumed that this rounded core was picked up by hominins from alluvium and used as an ordinary hammerstone. Later, it was modified into a massive end-scraper-like tool (Fig. 2, *1*). The necessary raw materials were most likely selected from alluvial deposits.

The second similar item from layer 5 was made of dark gray flint. It is weakly rounded and not colored (Fig. 2, *3*). The blank was a residual core of small size (42 × 40 × 34 mm), retaining natural cortex over almost half of the surface. Negative scars of previous removals are clearly visible. The ventral surface was formed by a single removal. Marginal facets of flattening retouch can be traced on the surface of the clearly visible negative scar of the detached flake. The convex and steep working edge was prepared by elongated facets of "end-scraper" retouch.

A small end-scraper on a natural fragment of gray flint (35 × 30 × 22 mm) is rather expressive. Small facets of utilization can be traced along the working edge prepared by three distinct parallel removals. The fragment is rounded, its surfaces show a light brown color, while the negative scars of the working edge preparation retain the natural color of gray flint. This tool was recovered in 2010 from a block of small-pebble conglomerate lying on the surface of the quarry, overlain by deposits of layer 5 within the excavation area, which allows us to attribute this artifact to layer 6 (Fig. 2, *2*).

The maximum dimensions of the rest of the artifacts barely exceed 3 cm. The steep working edges of these tools were prepared through parallel micro-blade removals. The items are reminiscent of small end-scrapers of the Upper Paleolithic type. One of these tools (27 × 23 × 18 mm), with the working edge formed by distinct parallel micro-blade removals, shows two well-expressed notches at the sides, which allowed it to be held firmly in the hand (Fig. 3, *1*). A similar end-scraper (28 × 27 × 20 mm), with the narrowed working edge formed by parallel microblade facets, was made on a piece of gray flint (Fig. 3, *2*). A small end-scraper with two opposing working edges (23 × 22 × 17 mm) was formed on a residual round core (Fig. 3, *3*). Noteworthy is a small product made of black flint, reminiscent of a single-platform core with negative parallel scars on one surface and with a striking platform formed by a single removal (30 × 26 × 24 mm). The back side of the "nucleus" retains natural crust. Formerly, this product was identified as a core (Anisyutkin, 2020: 23). However, the analysis of the flaking surface has shown that the detached laminar flakes were very thin and could not have served as blanks. After detachment, they broke up into several pieces. This conclusion has been confirmed experimentally. Therefore, this artifact can also be attributed to end-scraper-like forms (Fig. 3, *4*).

Three tools were made from flakes. All of them are small and thick. One of these tools from black flint was found on the surface of the quarry, in the remains of pebble conglomerate, which suggests its attribution to layer 6. The scraper's working edge was prepared by vertical retouch (Fig. 3, *5*). The opposing robust tip was fashioned through discontinuous bifacial processing (43 × 41 × 23 mm). This item has been classified as a combination tool. Its ventral surface is the inverse face of the flake, which may be of natural origin, judging by the indistinctness of the curvature. The second tool was made from a black flint flake (40 × 33 × 24 mm). The end-scraper-like working edge was formed on the place of the striking platform, which was removed by secondary working (Fig. 4, *1*). Its ventral surface, retaining the elements of the flake inverse face, shows clear series of flattening faceting scars on the lower edge of the end-scraper; this faceting was used for the edge sharpening. Signs of accommodation can be observed here. The third tool was made from a shortened primary flake of dark gray flint (24 × 29 × × 20 mm). Its surface has a slight yellowish-gray color. An extremely steep end-scraper-like working edge was fashioned on the place of the removed striking platform, and processed with abrupt and vertical retouch (Fig. 4, *2*). The main features distinguishing these tools from conventional end-scrapers on small flakes, with their working edges prepared on distal ends (Fig. 4, *3–5*), are their greater robustness and location of the working edge on the place of the removed striking platform of the original flake.

Noteworthy are two side-scrapers from layer 5. One of these is fashioned on a black flint flake (46 × 32 × × 27 mm). An insignificant area of the residual striking platform bears natural cortex (Fig. 4, *6*). The notched working edge of the tool was formed by large removals in combination with fine marginal retouch. The notch is well prepared. The implement can be classified as either a notched tool or a side-scraper. The presence of widespread retouch suggests its identification as a side-scraper with a concave working edge. It can be assumed that the notch was formed as a result of the intense use of the tool. This is confirmed by the clearly visible use-wear signs on the opposite edge. The second side-scraper shows a steep and convex working edge and a poorly distinguished tip. A thick flake of black flint (31 × 29 × 26 mm) was used as a blank. The plain and very wide striking platform with negative

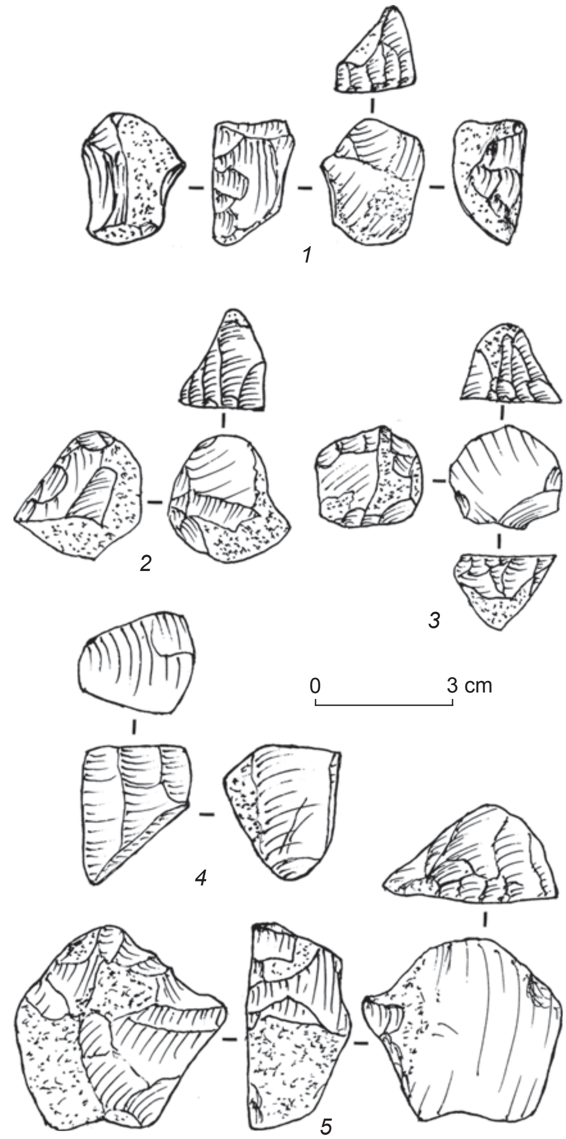

*Fig. 3.* End-scraper-like tools on cores and core-shaped fragments from layer 5 (*1–4*) and a scraper-point on a flake from layer 6 (*5*).

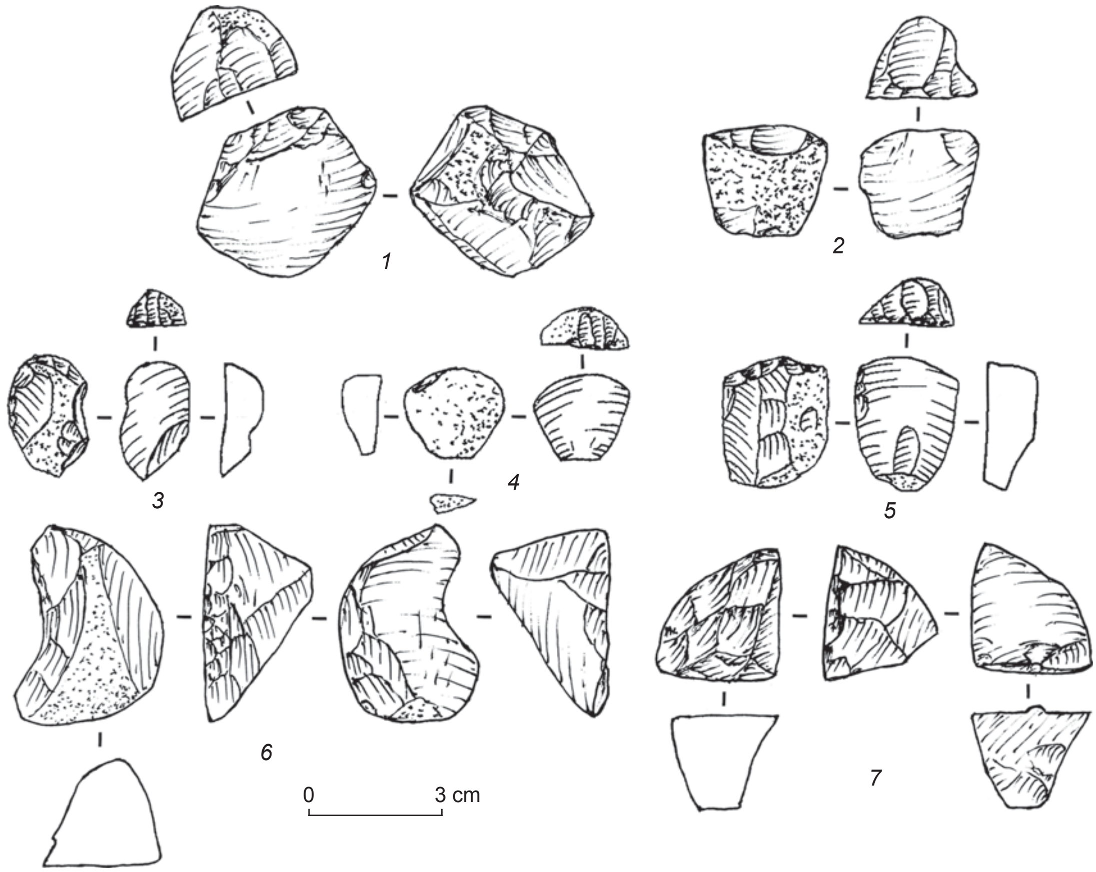


*Fig. 4.* Core-shaped end-scrapers (*1*, *2*), common end-scrapers on flakes (*3–5*), side-scrapers (*6*, *7*) from layer 5.

scars of removals forms a right angle with the ventral surface, which obviously indicates the orthogonal flaking technique. A cone and a convex percussion bulb are clearly visible. The steep working edge of the side-scraper is formed by the large negative scars of direct percussion with retouch facets along the edge (Fig. 4, *7*). The tool is noticeably rolled, but has no traces of collisions. The absence of such traces on almost all the artifacts described above suggests that this roundness is the result of wave abrasion. The abandoned sites were recurrently flooded, and the items deposited at a shallow depth were shifted within the deposition horizons by strong wind and rough water. Small particles of sand and silt, suspended by waves from the bottom, polished the artifacts' surfaces. The large and medium-sized pebbles were absent in layer 5, the number of small pebbles was small; this prevented obvious damage to the surface of lithic products. Moreover, the abundance of tiny flakes and chips in this layer indicates indirectly that there was no noticeable current.

## Correlations

In the Bairaki Early Pleistocene collection, the category of core-shaped tools, including atypical forms, presents a distinct series. In the oldest regional Paleolithic, the parallels to the Bairaki artifacts were observed in the materials from the contemporaneous site of Cretesti (Anisyutkin, Stepanchuk, Chepalyga, 2013; Anisyutkin et al., 2021). Similar tools were found in Cretesti upper layer 2 and at the site of Bolshoi Fontan. Both these assemblages are dated to the Mindelian or Cromerian stages, within the range of 700–450 ka BP (Chetvertichnaya paleografiya…, 1996: 145; Sycheva, Anisyutkin, Khokhlova, 2022: 12). The latest lithic industries containing such tools date back to the early Middle Paleolithic. These are the Tayacian assemblages, where similar end-scrapers are common. The collection from layers 4 and 5 of Duruitoarea Veche Cave in Moldova can be considered an example (Anisyutkin, Ketraru, Covalenko, 2017: 76, 93).

Similar tools were recorded in the materials of the ancient sites of Taman and Dagestan (Shchelinsky, 2014: 141). However, these collections do not include small end-scrapers with micro-blade flaking of the working edges, which is probably explainable by the specifics of the raw materials. The ancient Paleolithic of Armenia also lacks the expressive varieties of such tools. This is likewise due to the characteristics of raw materials (Belyaeva, 2022: 36–39). Pebble end-scraper-like tools have been reported from the Oldowan industry of Dmanisi in Georgia (Lyubin, Belyaeva, 2004a: Fig. 3, 4; Barsky et al., 2018: Fig. 4). In the younger Early Paleolithic assemblages of the Caucasus, such tools were recorded in the Acheulean materials from Kudaro I, Yashtukh, Darvagchay-1, and other sites (Lyubin, Belyaeva, 2004b: 148; Derevianko, 2015: 182, 184). Very interesting parallels were reported from the ancient Paleolithic of Africa, where these tools are defined as rabot (Piperno, Bulgarelli, Galotti, 2004: 563). They are larger than the core-shaped tools from Bairaki. In other features, the differences, including the blank's robustness and the shape of the steep working edge prepared by subparallel and even parallel flaking, are not significant.

## Conclusions

The core-shaped tools were prepared on very robust blanks, including residual cores, natural flint fragments, and flakes. The pieces on flakes are distinguished by the location of their working edge on the place of the striking platform. Scraper edges were prepared through the abrupt retouch; small pieces often bear parallel facets of micro-blade retouch. The degree of exhaustion of the angle of the working edge depends entirely on the intensity of the tool's use. The small size of the pieces from Bairaki layers 5 and 6 can be explained by the features of the raw material. Clear traces of accommodation are noticeable.

Core-shaped tools were typical implements in the earliest Paleolithic, including the Oldowan. These tools, along with choppers and other pebble and core-shaped varieties, as well as tools on flakes, are characteristic of the pebble-flake complex of Africa and Eurasia, spanning a wide range of regions and periods. These tools are also typical of the Acheulean, and disappear at its terminal stages. In Africa and neighboring regions of Western Asia, these tools survived till the end of the Acheulean (Lyubin, Belyaeva, 2004a: 164).

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# Early-Middle Acheulean Occupation of the Northern Transcaucasian Highland

*In the northern part of the Transcaucasian Highland (Lori Depression, Armenia), three stratified sites dating to the Early-Middle Acheulean—Karakhach, Kurtan I, and Muradovo—have long been subject to archaeological studies. On the basis of absolute dates and paleomagnetic records relating to the first two sites, their age falls in the interval between the mid-Early and initial Middle Pleistocene. All three sites yielded a uniform industry with a peculiar toolset (various choppers, picks including chisel-ended ones, handaxes, large scrapers, macro-chisels, and macro-knives), manufactured mostly on natural tabular fragments of local volcanic rocks. Certain indicators of this industry, such as subrectangular and fan-shaped choppers, slab-like chisels, etc., are described. Information on 28 other localities with Acheulean artifacts, including 11 stratified ones, recently discovered in various parts of the Lori Depression and in adjacent areas of the Shirak Depression and the Debed River valley, is provided. It is demonstrated that the lithics from all these sites belong to the Karakhach tradition. Data are cited suggesting that three sites (Yagdan, Agvi-canyon, and Agvorik) are over 2 mln years old, and two more (Kurtan II and Dzhradzor) are at least 1.5 mln years old. It is concluded that people associated with the Karakhach Acheulean tradition had appeared in the northern Transcaucasian Highland ~2.0 Ma BP, then settled widely in this area, and remained there for several hundred thousand years. In my view, this may be explained by the very favorable environmental conditions of the region during the Early Pleistocene, and by the abundance of large rock fragments suitable for tool manufacture.*

Keywords: *Transcaucasian Highland, Early and Middle Acheulean, geochronology, paleoenvironmental data, occupation range, industrial tradition.*

## Introduction

The issues of the origins and dispersal of the carriers of the most ancient Acheulean traditions in various regions of the Old World have constantly been in the focus of attention for modern researchers of the Early Paleolithic. In the discussion of this topic, the author relies on the currently widespread understanding of the Acheulean, which is briefly set out in the following definition: "…Acheulean represents a more complex industry than the previous (and pene-contemporary) Oldowan industry (which consists mostly of small flakes, flaked cobbles and percussive tools) based on the technological ability to produce large flake blanks and to recurrently shape large cutting tools (LCTs)" (Diez-Martin et al., 2015). In this definition, it would be more correct, however, to use the concept of "technocomplex" introduced by J.D. Clark (1970: 78), since this concerns not two separate industries, but two types of industries distinguished by the listed features. The main categories of large tools marking the emergence of the Acheulean technocomplex are considered to be handaxes, picks, and cleavers. Such tools were prepared on specially selected rocks of appropriate dimensions (pebbles, nodules or tabular fragments), as well as large flakes produced through special techniques (Semaw, Rogers, Stout, 2009; Beyene et al., 2013; Diez-Martin et al., 2015; Galotti, Mussi, 2018). Generally, the Acheulean is not regarded as a single cultural tradition. Acheulean-type industries can be related, but they can also emerge independently from one another, as a result of convergent technological development based on different types of large-sized raw material. This concept also implies spatial and chronological variability within the Acheulean technocomplex (Belyaeva, 2022: 16–17). It is this approach that makes it possible to attribute to the Acheulean a group of sites discovered in the latest two decades in the northern part of the Transcaucasian Highland (Armenia). These sites yielded sets of various artifacts, including handaxes, picks, and large flake-blanks. As is justified below, their chronological range covers the second half of the Early through early Middle Pleistocene (Belyaeva, Lyubin, 2014; Belyaeva, 2020). According to the currently most accepted ideas about Acheulean periodization (Clark, Schick, 2000), this range corresponds to the Early Acheulean and the initial Middle Acheulean.

### Reference sites and their geochronological and paleoecological context

The sites under consideration are located in the north of Armenia, in the Lori Depression and the adjacent areas of the upper Debed River valley and the Shirak Depression (Fig. 1). In 2005–2015, three sites were excavated in the Lori Depression—Karakhach and Muradovo at the southeastern foothills of the volcanic Javakheti Range, and Kurtan I on the slope of the Bazum Range.

The deposits studied in the Karakhach quarry (Fig. 1) turned out to be the most informative and rich in lithics. Two deposit units have been identified in the walls of the quarry. The upper one (unit I, up to 9 m), consisting of non-layered sandy loams with poorly rounded boulder-pebble debris, was formed by slope processes, including mudflows. The unit tops show reversed polarity (Matuyama epoch), the bottoms normal polarity (Jaramillo episode?). Unit II consists of compressed volcanic ash with pyroclasts, or tuff (~5 m) with reversed polarity. Using zircons extracted from the ashes, U-Pb dates were generated for it: 1.944 ± 0.046 Ma BP for the bottom of the northwestern wall, and 1.826 ± 0.02 Ma BP for the upper part; 1.750 ± 0.02 and 1.804 ± 0.03 Ma BP for the bottom of the southeastern wall, and 1.799 ± ± 0.044 Ma BP for the lower part (Presnyakov et al., 2012; Trifonov et al., 2016). Three test pits uncovered the bottoms of unit II and revealed Acheulean artifacts made of andesite-dacite. Most of them were found in pit 3 (616 spec.).

The older unit III was exposed at five localities. The deepest profile (~8 m) was established in excavation 2, where 14 layers were identified. Layers 1, 2, and 11 are redeposited paleosols (Khokhlova et al., 2018), while layers 3–6, 8, 10, and 12–14 are sandy loams with variously-sized rounded detritus, the color of which varies from yellowish to dark gray, depending on saturation with volcanic ash. Layers 7 and 9 are large ash lenses (Trifonov et al., 2016). For layer 7, the U-Pb date of 1.947 ±

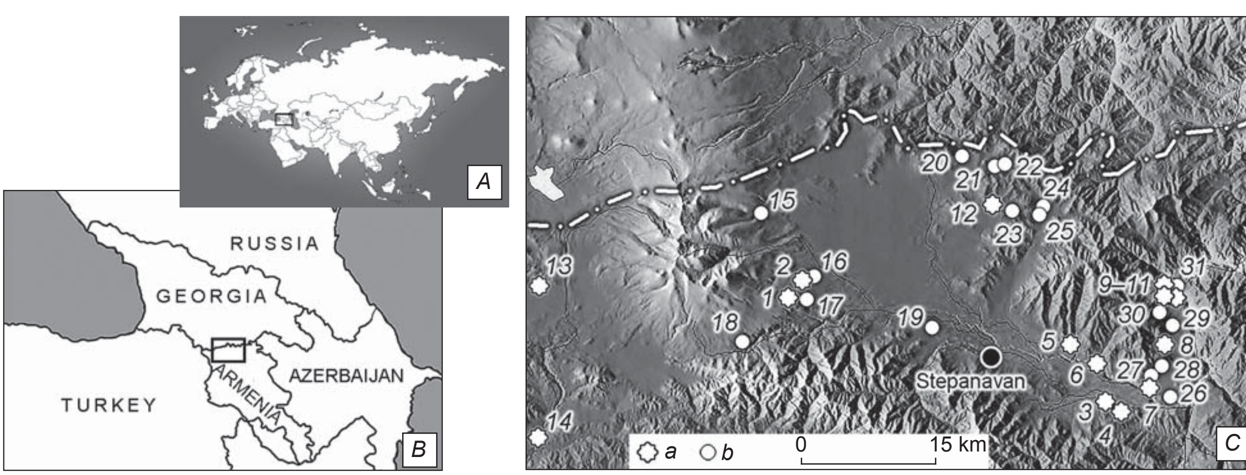


*Fig. 1.* Location of the area under study on the maps of Eurasia (*A*) and the Caucasus Territory (*B*), and location of sites with Early and Middle Acheulean artifacts of the Karakhach tradition (*C*).
*1* – Muradovo; *2* – Karakhach; *3* – Kurtan I; *4* – Kurtan II; *5* – Agorak; *6* – Yagdan; *7* – Karmir-Akhek; *8* – Ardvi; *9–11* – Agvi-1–3 (Agvi-terrace, Agvi-quarry, and Agvi-canyon); *12* – Lernahovit-quarry; *13* – Agvorik; *14* –Dzhradzor; *15* – Dashtadem-1; *16* – Blagodarnoye; *17* – Karakhach-bridge; *18* – Karakhach-pass; *19* – Katnakhpyur; *20* – Dzoramut; *21*– Norashen; *22* – Sarchepet; *23* – Lernahovit; *24*, *25* – Privolnoye-1, -2; *26* – Arevatsag; *27* – Kokhes; *28* – Mgart; *29* – Odzun; *30* – Amozh; *31* – Agvi-4.
*a* – stratified sites; *b* – non-stratified sites.

± 0.045 Ma BP was derived (Presnyakov et al., 2012). Layers 2–10 show a normal polarity; taking into account the date, this suggests that unit III was accumulated during the Olduvai paleomagnetic episode (1.95–1.77 Ma BP). Since the underlying lavas produced the K-Ar date of 1.87 ± 0.10 Ma BP, the age of this unit is estimated in the range of 1.77–1.85 Ma years. The poor sorting and varying degrees of roundness of the detritus, as well as the presence of lenses, indicate the proluvial origin of the sediments (small temporary streams, slope microflows) (Trifonov et al., 2016; Belyaeva, 2022: 79).

In excavation 2, all layers of unit III, except for the first layer, yielded the total of 2968 Early Acheulean artifacts made of rhyolite and rhyodacite. A significant number of such artifacts (131 spec.) were found in a small trench 1, where layers 1–7 were exposed. In pits 5, 6, and 8, where only layers 1–3 were exposed, the finds were rare. The proluvial origin of the deposits, as well as the moderate or weak degree of roundness of most items, suggest that the artifacts are unlikely to have been deposited *in situ*. However, in the Karakhach profiles, there are no signs of heavy watercourses that could have transported lithics from afar, i.e. these were rolled in small streams, without significant transportation. The accumulation of finds in excavations 1 and 2 can only be explained by human activities. The site is classified as a habitat, i.e. a piece of terrain occupied by a certain population (Reimers, 1988: 166), where separate zones of human activities can be identified (Belyaeva, Lyubin, Trifonov, 2019; Belyaeva, Shchelinsky, 2022). Analysis of paleosols and phytoliths found therein suggests a subtropical climate and a savanna-like landscapes (Lyubin et al., 2015; Khokhlova et al., 2018).

The site of Muradovo was found 3.5 km eastwards of Karakhach (Fig. 1), on the terrace of a stream flowing from the Javakheti Range. The excavations exposed deposits with a total thickness of ~7 m, subdivided into nine stratigraphic layers. Layers 1 and 2, representing horizons of the Holocene soil, contained redeposited Late Acheulean artifacts of hyalodacite (flattened handaxes, Levallois flakes). Layer 3 is a buried Pleistocene soil, containing ca 100 more archaic and weathered hyalodacite artifacts, including choppers and picks. Layers 4, 5, and 7–9 are alluvial-proluvial sandy loam deposits with pebbles, gravel, and individual boulders; and layer 6 is volcanic ash with weakly rounded detritus (Belyaeva, Lyubin, 2013, 2014, 2019). In terms of their lithological features and shapes of artifacts, layers 4–9 are similar to unit III of Karakhach, and are apparently of a similar age (Trifonov et al., 2016). Items from these layers (more than 900 spec.) are moderately or weakly water-rolled, but are not severely damaged. These obviously did not occur *in situ*, nor were they transported from afar by strong streams. The site of Muradovo, like localities 1 and 2 at Karakhach, is described as a habitation site. Taking into account that the stream valley near the site is widened and forms a basin, and that there are traces of a small channel in the lower part of the profile, during the accumulation of layers 4–9 humans probably lived on the shores of the paleolake and the inflowing streams (Belyaeva, Lyubin, Trifonov, 2019; Belyaeva, 2020).

The site of Kurtan I is located in the southeastern end of the Lori Depression (Fig. 1), at the foot of the Surb-Sarkis Mountain (Bazum Range). The quarry was laid on the banks of the Gerger River, which flows into the Dzoraget River. In the quarry sides, loose deposits (5–20 m) are exposed, underlain by basalts of the Javakheti Range (K-Ar-date 2.08 ± 0.10 Ma BP), which flows spread along the Dzoraget valley and its tributaries. The noted sagging layers indicate that the quarry uncovered a buried gorge of a paleostream (Belyaeva, Lyubin, 2013). The deposits were studied by small excavations in three sections of the quarry walls where the number and thickness of the identified layers vary. The correlation of the stratigraphic profiles made it possible to compile a summary column consisting of seven main layers (Trifonov et al., 2016). Under modern soil, there are three loamy/sandy loamy paleosols with carbonate nodules (layers 1–3, up to 7 m), which are similar to Muradovo layer 3 (Khokhlova et al., 2018; Trifonov et al., 2016). Layers 1 and 2 show normal polarity; the bottom of layer 2 shows the change to reverse polarity, i.e., Brunhes-Matuyama transition (0.77 Ma BP). This means that the three upper paleosols at Kurtan I, as well as Muradovo layer 3, were deposited in the terminal Early to initial Middle Pleistocene. This age is supported by the teeth of rhinoceros (*Stephanorhinus hundsheimensis*) recovered therein, and a shoulder blade of southern elephant (*Archidiskodon* ex gr. *meridionalis Nesti*) found in similar layers in the nearby quarry of Kurtan II (Trifonov et al., 2016). At Kurtan I localities 1 and 3, these paleosols are underlain by volcanic ash (layer 4) with U-Pb date of 1.432 ± 0.028 Ma BP. Below lies a sequence of tuffaceous and pumice sands (layers 5 and 6, up to 8 m). The upper part of this sequence yielded U-Pb dates of 1.495 ± 0.026 and 1.496 ± 0.021 Ma BP and $^{39}Ar$-$^{40}Ar$ dates of 1.49 ± 0.01 Ma BP (Presnyakov et al., 2012; Trifonov et al., 2016). At locality 3, below layer 6, another paleosol layer was recorded (layer 7, up to 25 cm), overlying basalts (Khokhlova et al., 2018).

Layers 1–3, excavated by step-trenches at localities 1 and 2 at the sides of the Kurtan I quarry, yielded more than 240 Acheulean artifacts made from local raw materials (rhyolite, basalt, and volcanic pebbles). In layer 5, locality 3, quite few artifacts have been found so far (flakes, a pick-shaped tool, and a side-scraper), which have been attributed to the Early Acheulean on the basis of the absolute dates of ~1.5 Ma BP. An even older layer 7 was recorded in a small area at locality 3;

only two dozen small pebble artifacts were found here, reminiscent of the Oldowan industry from Dmanisi (Georgia), located 30 km northwards. Features of the lower paleosol at Kurtan I (layer 7) are similar to those of the contemporaneous Early Pleistocene paleosols of unit III at Karakhach, indicating a subtropical climate and savanna-like landscapes (Khokhlova et al., 2018). Detailed analysis of pedisediments and phytoliths from layers 1–3 at Kurtan I showed that in the terminal Early to initial Middle Pleistocene, the climate became more temperate (Lyubin et al., 2015; Khokhlova et al., 2018). The local inhabitants probably settled on the shore of a small lake that emerged ca 2 million years ago owing to the damming of the paleostream by basalt flows (Belyaeva, 2020).

## The Karakhach Early Acheulean Industry: features and development

The comparative analysis of the collections of artifacts originating from various layers of Early Pleistocene unit III of Karakhach showed that this is a single Early Acheulean industry based on local stone raw materials (rhyolite and rhyodacite), with a rich set of large tools (choppers, picks, handaxes, macro-scrapers, macro-chisels, and macro-points) and a variety of small implements (side-scrapers, small handaxes, end-scrapers, points, chisels, push-planes, notched-denticulate, and combination tools). In the artifact collection of this unit (over 3000 spec.), debitage products account for no more than 3 %, but they include several large flakes, which are considered one of the main indicators of the Acheulean. Such flakes were used as blanks for the manufacture of certain large tools (macro-scrapers, two cleavers, and three handaxes). Cores (20 spec.) demonstrate simple single-platform reduction. Most of the large and small tools were made on natural blanks in the form of flattened tabular fragments of various shapes and sizes. These blanks were formed as a result of cracking of rhyolitic and rhyodacitic raw materials with a fluidal or layered structure. The rather regular shape of many such blanks ensured the geometrized outlines of a large proportion of the Karakhach tools (choppers, macro-chisels, partly picks and macro-scrapers, simple side- and end-scrapers).

Owing to the presence of very large tablets among the macro-tools (15–30 % of all the tools), there are many specimens longer than 15 cm, and some even exceed 20 cm. The shapes of the handaxes (about 60 spec.) are very diverse, but almost all of these tools show partial bifacial processing; these usually have a butt, and often a back. Choppers, macro-scrapers, and picks dominate and mainly show a flat-convex section; their outlines vary from subtriangular to lanceolate and pear-shaped. Noteworthy is the significant proportion of picks with chisel-like edges, and other chisel-like tools. Fan-shaped and subrectangular choppers, handaxes in the form of a "gable roof house", slab-like chisels and push-planes (Fig. 2, *1*, *7–9*, *14*), as well as knife-hatchets, are the specific types, and can be regarded as indicators of the Karakhach industry (Belyaeva, 2022: 106–107; Belyaeva, Shchelinsky, 2022).

Muradovo layers 4–9 yielded a lithic industry that was similar in terms of toolkit and types of blanks (926 spec.) (Fig. 2, *2*, *10*, *15*). The lithological-stratigraphic comparisons have shown that these layers correspond to the Early Acheulean layers at Karakhach, and should presumably be attributed to the close Early Pleistocene time (Trifonov et al., 2016). The younger Acheulean assemblages from Karakhach unit II, Muradovo layer 3, and three upper paleosols at Kurtan I quarry (Figs. 2, *3*, *5*, *11*) belong to the same industrial tradition, despite the different varieties of volcanic raw materials used, the greater number of flake blanks, and the absence of certain types of tools ("gable roof house"-shaped handaxes, knife-hatchets). At the top layers of the Kurtan I quarry paleosols, the Matuyama-Brunhes paleomagnetic reversal (0.77 Ma BP) was revealed, which indicates the transition to the Middle Pleistocene. Consequently, the Karakhach tradition (Fig. 2) continued to develop in the Lori Depression until the initial Middle Acheulean (Belyaeva, 2022: 127).

## Dispersal of people associated with the Karakhach Early Acheulean tradition in the Lori Depression and adjacent regions of the Transcaucasian Highland

The sites of Karakhach and Muradovo are located in the southwestern part of the Lori Depression, and Kurtan I in its southeastern end; the distance between the sites exceeds 30 km. In recent years, during the intense survey in various parts of this region and the adjacent areas, another 28 sites have been discovered (see Fig. 1), containing artifacts similar to those of the Karakhach Early Acheulean industry. Most of them are localities with surface occurrence of artifacts. Many of these sites provided quite few finds; but at Arevatsag, Privolnoye-1, -2, and Lernahovit, from 15 to 20 artifacts were collected from each. At Arevatsag, the finds were scattered over the side of the hanging valley of the paleostream that was previously a tributary of the Dzoraget River. The assemblage includes picks, handaxes, and choppers typical of the Karakhach Early Acheulean, including one fan-shaped (see Fig. 2, *13*) and three subrectangular choppers, as well as large flakes. One of these flakes was fashioned as a cleaver. On the slopes of the terrace near the village of Privolnoye, chisel-ended picks,

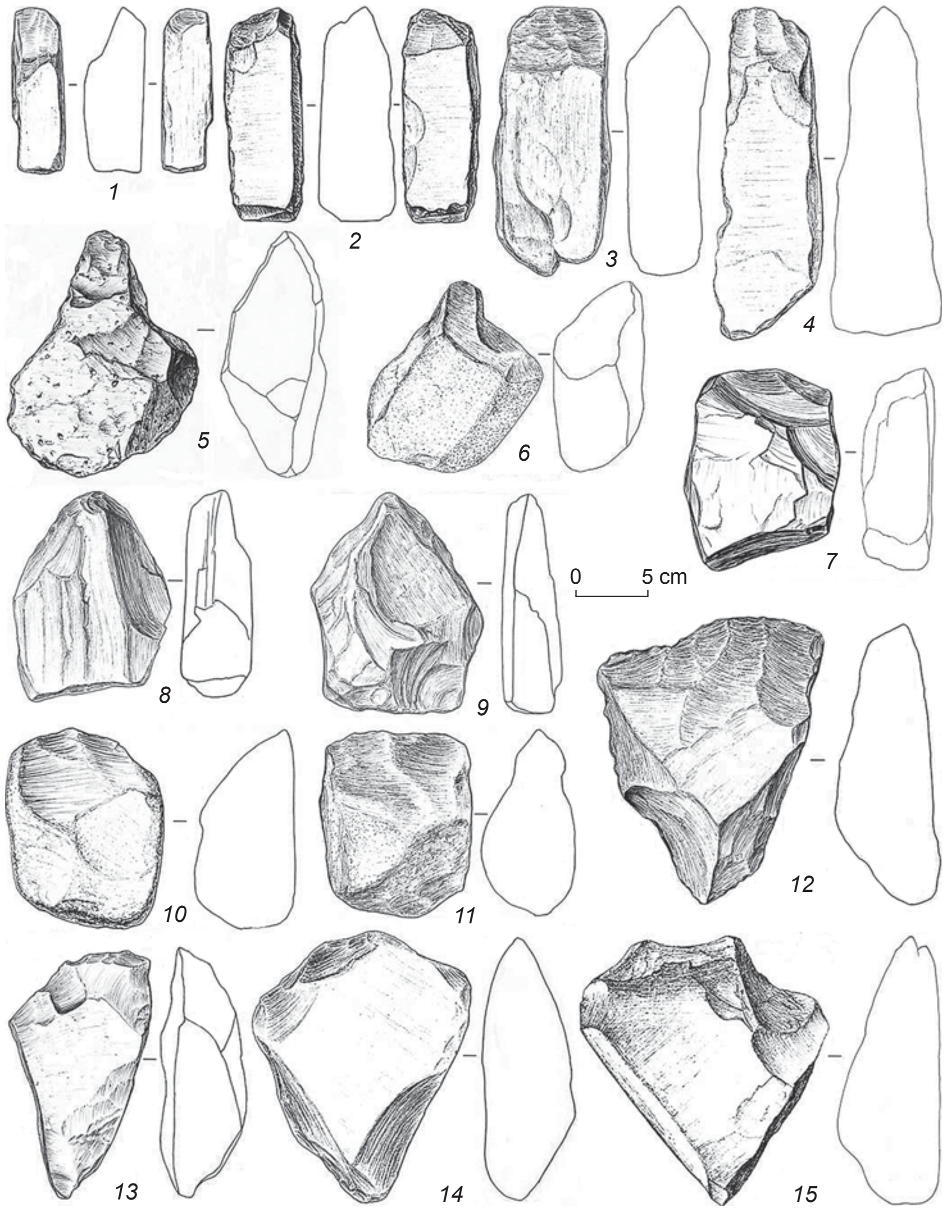


*Fig. 2.* Examples of Acheulean tools typical of the Karakhach tradition.
*1–4* – slab-like macro-chisels; *5*, *6* – pear-shaped picks with chisel-like edges; *7*, *10*, *11* – subrectangular choppers; *8*, *9* – "gable roof house"-shaped handaxes; *12–15* – fan-shaped choppers. *1*, *7–9*, *14* – Karakhach; *2*, *10*, *15* – Muradovo; *3*, *5*, *11* – Kurtan I; *4*, *6* – Agorak; *12* – Karmir-Akhek; *13* – Arevatsag.

subrectangular choppers, and slab-like chisels were found. At Lernahovit, artifacts were also collected at the paleostream terrace, and included macro-tools similar to the above.

The most interesting are nine new stratified sites (see Fig. 1). These were identified both in the Lori Depression and in the area of the left bank of the Debed River valley adjoining Lori from the east. The Lernahovit Quarry is located near the locality of Lernahovit. Excavations at the quarry exposed deposits similar to the Kurtan paleosols, which dated the site to the interval between the second half of the Early and the initial Middle Pleistocene. At present, quite few artifacts have been found; however, the assemblage includes a pear-shaped chisel-ended pick, which has parallels in the collections of Karakhach, Kurtan I, and Agorak (see Fig. 2, *5*, *6*). The site of Yagdan in the gorge of one of the left-side tributaries of the Dzoraget is especially noteworthy. Several artifacts found (a single-platform core, flakes, a handaxe with traces of bifacial working, a subrectangular chopper, a macro-scraper, and picks), in terms of their appearance, should be attributed to the Karakhach tradition; these artifacts were recovered from paleosols overlain by a basalt flow and later exposed in the eroded walls of the stream. The age of the stream can be ca 2 mln years, since this is the age estimation of the cover basalts in the Kurtan I quarry 5 km south of Yagdan. Although this age still needs to be confirmed by direct dating of the Yagdan basalts, the site suggests that the Karakhach Early Acheulean industry could have appeared in the north of the Transcaucasian Highland not 1.85 Ma BP, as follows from the established age range of Karakhach, but somewhat earlier (Belyaeva, 2022: 128). The site of Agorak (see Fig. 1) is located near Yagdan, in the valley of a neighboring stream that cut through the proluvial sediments. The finds (16 spec.) include picks characteristic of the Karakhach Early Acheulean, including chisel-like tools (see Fig. 2, *6*), slab-like chisels (see Fig. 2, *4*), push-planes, and subrectangular choppers. The site of Karmir-Akhek (see Fig. 1) is located in the southeastern end of the Lori Depression, not far from the Dzoraget canyon's edge. The deposits underlain by basalts are gravelly sandy loams with cementation horizons and interlayers of pedosediment type. A total of seven tools was found, including the varieties of picks and choppers typical of the Karakhach industry (see Fig. 2, *12*).

A promising site was found in 2022 near Kurtan II quarry, on the right bank of the Dzoraget River; it was located about 2 km eastwards of Kurtan I quarry described above (see Fig. 1). At Kurtan I, the paleosols with the Acheulean industry at the late stage of the Karakhach tradition are underlain by pumice sand (ca 1.5 million years old), and still below, there is a basalt flow (ca 2 million years old) (Ibid.: 86). In addition, at one of the excavation areas in this quarry, under pumice sand, a thin but well-developed paleosol was recorded, directly overlaying the basalt (Khokhlova et al., 2018). A similar stratigraphy was identified in Kurtan II quarry. Next to this quarry, in the side wall of the road excavation, the same pumice sand, with two underlying layers of paleosol, was cleaned; the thickness of the lower paleosol layer and the underlying deposits have not yet been established. In the lower visible layer of paleosol, five Acheulean items were found, whose age should be older than 1.5 Ma BP, taking into account the age of the sand. The items include a very large pick and two subrectangular choppers, suggesting the Karakhach tradition.

Beyond the eastern border of the Lori Depression, four more stratified sites with Acheulean artifacts were found on the left bank of the valley of the Debed River, framed by the slopes of the Somkhet Range (see Fig. 1). At Ardvi, a quarry uncovered a 5–6 meter thick stratum of rubble deposits with interlayers of ash and paleosol. Among a dozen lightly-rounded finds, two slab-like push-planes typical of the Karakhach industry were found. Three more localities are situated near the village of Agvi. The first one is an exposure of a terrace of a small stream flowing into the Debed. The deposits here are similar to those uncovered at Agorak. So far, only two slightly-rounded tools have been found at this locality (Agvi-terrace): a macro-push-plane and a macro-chisel, clearly pointing to the Karakhach tradition. At the next locality (Agvi-quarry), a road excavation cut in the lower part of the slope of the Somkhet Range, exposing rubble sandy loams with interlayers of paleosol. These yielded a dozen items, including the characteristic Karakhach forms (chisel-ended picks, subrectangular choppers, macro-push-planes). Northwards of Agvi-quarry, in the side-slope of a stream flowing into the Debed, an outcrop of pebble-gravel deposits underlying the basalts was recorded (Agvi-canyon). These deposits contained several lightly-rounded items of Early Acheulean appearance, including a large macro-chisel, which is similar to those found at the sites of the Karakhach tradition. Like Kurtan I and Yagdan, these blanket basalts should be ca 2 million years old, which supports the hypothesis of such an early arrival of the Early Acheulean people to the north of the Transcaucasian Highland.

Noteworthy are two more localities with similar finds. They were discovered in the Shirak Depression, adjacent to the Lori Depression from the west (see Fig. 1). At the locality of Dzhradzor, the finds were recovered from the deposits close in age to unit III at Karakhach (Olduvai episode (Shalaeva et al., 2019; Belyaeva, 2022: 128)); and at Agvorik, artifacts were found in the earlier layers, which were formed before the Olduvai episode, judging by the available paleomagnetic data (Ozhereliev et al., 2020). These localities are 70–80 km in a straight line from the easternmost sites of the Karakhach Early Acheulean tradition.

## Conclusions

It has been established that artifacts typical of the Karakhach Early Acheulean industry occur at a large number of sites in various areas of the Lori Depression and in the neighboring regions of the Transcaucasian Highland. The discoveries of the mentioned sites provide the grounds for establishing the age range of the Karakhach industry (mid-Early to initial Middle Pleistocene) and for recording a fairly broad distribution of the carriers of this Acheulean tradition over the northern part of the Transcaucasian Highland. The latter seems to be explained by the very favorable environmental conditions of the region in the Early Pleistocene (low relief, subtropical climate, and predominance of savannah landscapes), and abundant sources of volcanic rocks, ensuring the development of Acheulean technologies and mass production of macro-tools (Lyubin et al., 2015; Trifonov et al., 2016; Belyaeva, 2020).

The noted features of the Karakhach Acheulean tradition are largely determined by the local raw materials. However, some tools resembling the Early Acheulean Karakhach ones (chisel-ended picks, slab-like chisels, and others) were found in deposits of a similar or even earlier age in the Armenian Highland regions adjacent to the Transcaucasian Highland (Ozhereliev et al., 2020). It can be assumed that the Acheulean tradition under consideration originated from these mountainous regions, where no later than in the middle of the Early Pleistocene the humans producing some more archaic Oldowan-type industries started to use large-sized volcanic raw materials, which contributed to the transition to the Acheulean. The next stage of occupation of the Transcaucasian Highland by the carriers of the Acheulean traditions corresponds to the second half of the Middle Pleistocene, i.e. after a long chronological gap. At that time, in the area under study, Late Acheulean industries existed, with developed Levallois technologies and the predominant fashioning of handaxes on large flake-blanks. The features of these industries do not suggest their direct connection with the Karakhach tradition (Belyaeva, 2022: 138).

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# Nikolaevo-Otradnoye II— A New Early and Middle Paleolithic Site in the Northeastern Azov Region

*We describe materials from a new Paleolithic site, discovered in 2020 on the right bank of Mius estuary, near its confluence with the Taganrog Bay of the Sea of Azov, in the southern outskirts of the village of Nikolaevo-Otradnoye, which is in the Neklinovksky District of the Rostov Region. The clearing of a 10-meter-high river-bluff revealed a complex stratigraphy of subaqueous and subaerial Late and Middle Pleistocene rocks. Horizons with lithics and faunal remains were identified. Cultural remains found in the coastal exposure and in the stratigraphic section belong to the Early and Middle Paleolithic. The early stage in the peopling of the Northeastern Azov and the Lower Don regions is documented by Early Paleolithic artifacts found in the subaqueous deposits of layers 5 and 6 (MIS 9–11, ~420–270 ka BP). Heavily waterworn patinated lithics include a core-shaped artifact, various types of side-scrapers, a scaled piece, flakes, and chips. This complex is an informative addition to known complexes from the region, including contemporaneous ones. The most interesting is the Middle Paleolithic industry of layer 4 under the Kamenka (?) soil—layer 3, MIS 7. The toolkit consists of a diagonal side-scraper and a chip found in the section, as well as radial and Levallois cores, various side-scrapers, a partly bifacial tool, spalls, and chips found in the denudation. Technological and typological criteria (primarily the Levallois technology) and the tentative date of non-waterworn patinated lithics*

Archaeology, Ethnology & Anthropology of Eurasia 51/3 (2023) 25–31 E-mail: Eurasia@archaeology.nsc.ru

*make it possible to attribute them to the Early Middle Paleolithic of the southern Russian Plain. It is concluded that cultural remains of the Early Middle Paleolithic, dating to ~243–191 ka BP, have been found in the region for the first time, filling the gap in the local Early Middle Paleolithic sequence. In adjacent regions, similar industries have been known since the late 1900s.*

Keywords: *Northeastern Azov region, Early and Middle Paleolithic, Mius estuary, early peopling of Eastern Europe, Middle Paleolithic humans, stone tools.*

## Introduction

In the Middle and Late Pleistocene, climate and environmental settings in the Northeastern Azov region provided favorable conditions for the accumulation of sedimentary loess-soil deposits, which contain numerous paleontological and archaeological items. The loess-soil series of the Northeastern Azov region occurs on lagoon deposits of various ages, constituting a complex of terraces (Lebedeva, 1972; Konstantinov et al., 2018) up to 30 m thick, with six well-distinguished buried pedocomplexes (Velichko et al., 2012). Paleolithic sites in the region have provoked the longstanding interest of specialists (Danilchenko, 2022); their systematic research began in the late 1920s. An important stage in studying the "Mousterian and pre-Mousterian" sites on the coast of the Taganrog Bay was the research carried out by N.D. Praslov in the first half of the 1960s (1968). Since 2016, the Azov Expedition from the Institute for the History of Material Culture of the Russian Academy of Sciences has been working in the Northeastern Azov region (Otcherednoy et al., 2018). During the survey of archaeological heritage sites in 2020, Y.N. Zorov discovered two new sites with cultural remains of various periods, from the Paleolithic to the Middle Ages, on the southern outskirts of the village of Nikolaevo-Otradnoye in the Neklinovsky District of the Rostov Region, on the right bank of the Mius estuary (Fig. 1). This article presents the evidence of the Early and Middle Paleolithic materials discovered at the site of Nikolaevo-Otradnoye II.

## Materials

The coastal cliff was unearthed in the area where it had the most complete profile of subaqueous deposits underlying loess-soil series (Fig. 2). The works revealed the presence of the following lithological and stratigraphic units at the Nikolaevo-Otradnoye II site (as documented by the 2021 section).

*Layer 1* (0.0–0.8 m). Modern chernozem-like soil of a dark gray color and granular-lumpy texture, partially washed away by surface erosion. The mechanical composition is light loam.

*Layer 2* (0.8–2.6 m). Light, pulverous brown-straw-colored loess-like loam, with scattered loose pulverous carbonates.

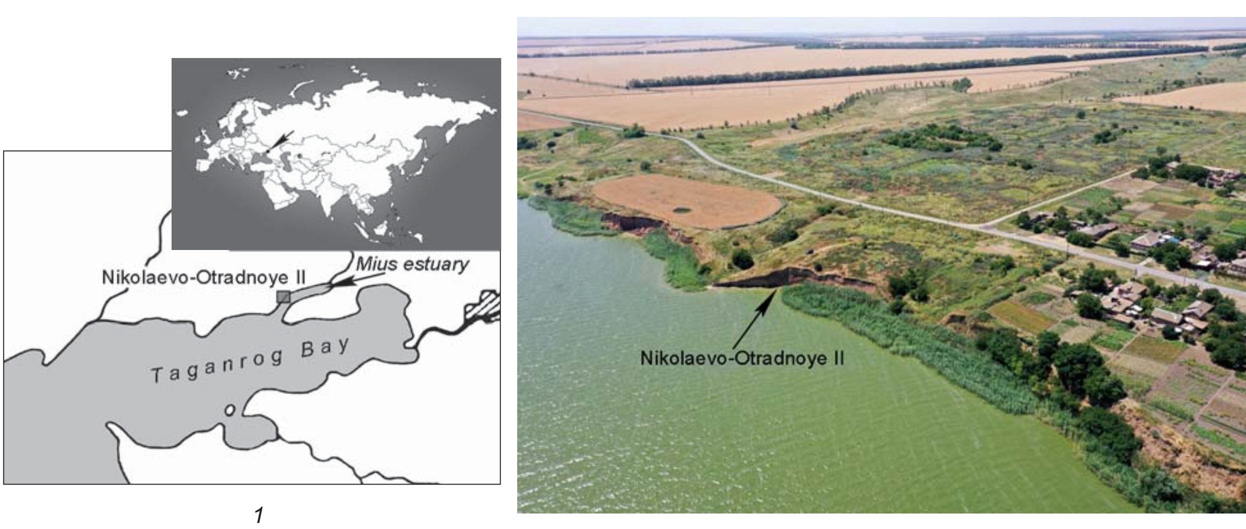


*Fig. 1*. Location of the Nikolaevo-Otradnoye II site (*1*), general view of coastal section of the Mius estuary (*2*).

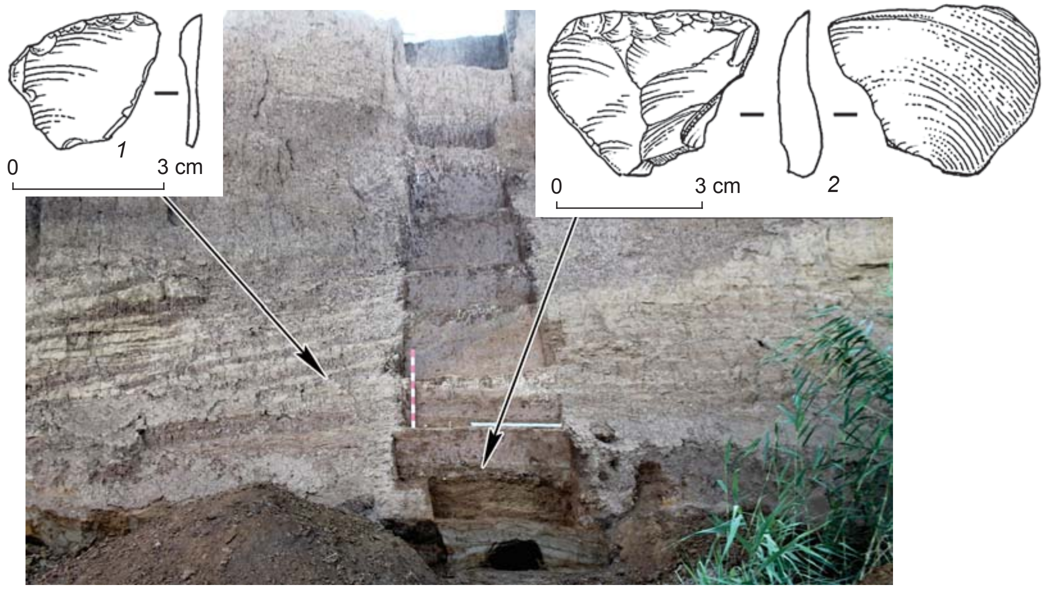


*Fig. 2*. Clearing of the outcrop of the coast.
*1* – scraper-like item *in situ* from layer 4; *2* – scraper-like like *in situ* from layer 5 at Nikolaevo-Otradnoye II.

*Layer 3* (2.6–4.4 m). Distinctive pedocomplex (Kamenka?). Loam ranging from gray-brown (in the upper part) to dark brown (in the bottom part), with humic spots and streaks, inclusions of loose carbonate nodules and small gypsum crystals. The buried soil increases in thickness as it extends towards the north-northeast, displaying a richer, saturated dark brown coloration, and cracks filled with soil from the layer above. Along the strike to the south-southwest (in the direction of the ravine), buried soil is facially replaced by dark gray-brown pedosediment, filling an erosional hollow.

*Layer 4* (4.4–6.0 (6.5) m). Oblique interlayering of yellow-gray light loam and medium brown humic loam. The slope of the layers is directed towards the ravine to the south-southwest, with an angle of gradient reaching 15–20°. The filling material consists of products of deluvial-slope demolition of ancient dark brown buried soil. Interlayers are discontinuous, with many small lenses. Individual flints with white patina were found in the lower part of the paleoincision in the unearthed area.

*Layer 5* (6.0 (6.5)–8.1 m). Subhorizontal wavy interlayering of yellow-brown unevenly grained gravelly sand, with medium light brown loam and straw-colored sandy loam. The thickness of interlayers ranges from 1 to 10 cm. The interlayers are not clearly distinct along the strike; they frequently intersect and contain numerous lenses. In the upper part of the layer (0.5 m), there are noticeable inclusions of different shell debris, with individual intact shells measuring around 5–7 mm. Towards the base of the layer, where rounded objects resembling Early Paleolithic artifacts can be found, there is a 10 cm interlayer rich in crushed flint fragments and grus.

*Layer 6* (8.1–8.5 (8.6) m). Unevenly grained sand with gravel and pebbles, grus, and rubble (up to 30 %). Clasts are predominantly of flint. The layer contains sandy lenses with thin oblique bedding. In some places, the pattern of the interlayers is cross-bedded. The lower contact zone is abrupt and wavy.

*Layer 7* (8.5 (8.6)–9.1 m). Layered light gray loam with red interlayers. The interlayers are uneven, with upward bends and folds. Mushroom-shaped deformations, which are probably collapsed structures, are observed 5 m southwest of the main stratigraphic section.

*Layer 8* (9.1–9.9 m). Gray-yellow layered unevenly grained sand with gravel (up to 5 %).

The structure and composition of the deposits allow for a preliminary genetic and stratigraphic interpretation to be made. According to its lithological features and stratigraphic position, the light loess-like loam (layer 2), underlying the modern soil, can be correlated with late Valdai loess (MIS 2). It was weakly subjected to pedogenesis, and overlays layer 3 with erosion. The color and textural features of the pedocomplex from layer 3 unambiguously indicate the pre-Mikulin (Middle Pleistocene) age (Velichko et al., 2012; Panin et al., 2018). The Kamenka pedocomplex (MIS 7) has a very similar morphological appearance; it has a gray-brown color. Cracks filled with light loess have been observed in some stratigraphic sections (Chumbur-Kosa, Vorontsovka). The underlying obliquely layered deposits of layer 4 are a filling of a paleoincision—a small ravine or hollow. The filling material partly constitutes erosion products of dark brown buried soil. The sand and gravel band at the base of the section (layers 5–8) consist of interlayered ravine alluvium and lagoon deposits. Such a complex of sediments could have resulted from sea ingression, which spread up a ravine or small valley.

The average content of sand is 4.2 % in the upper part of the loess-soil series (layers 1 and 2), and 2.2 % in layer 3. A sharp change in the distribution of particle sizes indicates a probable break in sedimentation and disruption of regular loess-soil structure. Layer 3 in the section of Nikolaevo-Otradnoye II consists of very thick buried soil with high values of magnetic susceptibility, loose carbonate concretions, gypsum crystals, and deep vertical cracks. In terms of particle-size distribution, this layer almost does not differ from layer 4. Taking into consideration the textural characteristics, layer 4 can be classified as pedosediment, which is a result of erosion and redeposition of more ancient soil on slopes. The observed interlayering, particle-size distribution, and the presence of aquatic fauna suggest that layers 5–8 can be confidently identified as a sedimentary unit originating from the coastal zone of a shallow bay or lagoon.

Faunal remains have been found both on the beach directly under the outcrop and in the layer (small fragments of tubular bones, fragment of a mammoth's enamel plate). Small bone fragments from ungulates and plates of elephant teeth, as well as hardly identifiable remains of rodents and freshwater fish, were found in layer 5 during surface examination and washing of the soil. The enamel thickness of three different fragments of elephant enamel plates ranges from 1.75 to 2.44 mm, with an average thickness of 2.1 mm, and corresponds to the boundaries of enamel variability in *Mammuthus trogontherii* (Pohlig, 1885), typical of the first half of the Middle Pleistocene, and *M. intermedius* (Jourdan, 1861). Individual waterworn and highly fragmented mammoth remains from *Mammuthus trogontherii* aut *intermedius*, deer Cervidae gen., and other large ungulates were found in alluvial layers. Lithological layer 5 contains numerous shells of fossil mollusks at a depth of 6.0 (6.5)–8.1 m:

| Genus, species | Number, spec. |
|---|---|
| *Viviparus* sp. | 4 |
| *Microcolpia daudebartii acicularis* (Férussac, 1823) | 20 |
| Hydrobiidae gen. | 2 |
| *Lithoglyphus pyramidatus* (Möllendorf, 1873) | 16 |
| *Borysthenia intermedia* (Kondrashov, 2007) | 5 |
| *Valvata* (*Cincinna*) *piscinalis* (Müller, 1774) | 1 |
| *Unio* ex gr. *tumidus* (Philipsson, 1788) | 3 |
| *Unio* sp. | 1 |
| *Sphaerium* (*Rivicoliana*) *rivicola* (Leach in Lamarck, 1818) | 7 |
| *Pisidium amnicum* (Müller, 1774) | 1 |
| *Pisidium clessini* (Neumayr, 1875) | 2 |
| *Pisidium* sp. | 1 |
| *Dreissena polymorpha* (Pallas, 1771) | 4 |
| *Didacna* cf. *baericrassa* (Pavlov, 1925) | 1 |
| Cardiidae gen. | 1 |
| *In total* | 69 |

The malacofauna mainly included freshwater river varieties and one brackish-water species of *Didacna* cf. *baericrassa*, indicating the proximity of the sea. It was common among the Early-Middle Pleistocene Chaudian fauna, but was also quite numerous among the Late-Middle Pleistocene Euxino-Uzunlarian fauna (MIS 9–11). Similar association of mollusks occurred in this region in the Lower-Middle Pleistocene (with remains of the Tiraspol faunal complex) deposits (Platovo, Semibalki-2, etc.) (Frolov, Kurshakov, 2015).

Paleolithic artifacts were discovered in both a coastal outcrop and in the area of the beach near the estuary, directly beneath the outcrop. These artifacts were categorized into two conventional complexes: Early Paleolithic and Middle Paleolithic. The so-called boulder flints of alluvial origin had been used as raw material. The flints derived from Upper Cretaceous sources appear as clasts with smooth, rounded dark gray crusts. These flints were likely transported by the paleo-Mius water flows from the southern spurs of the Donets Ridge, composed of Cretaceous rock formations.

The Early Paleolithic assemblage includes 31 flint items. The flints of this complex were waterworn and covered with reddish-brown and spotted yellow-brown patina. Some of the tools were made on natural fragments with traces of honeycomb weathering, or on flakes from cores. Directly in layer 5, the following tools were found: a small transverse side-scraper on a flake (Fig. 2, *2*), a chisel-like tool (Fig. 3, *1*), two flint chips, and six small spalls. Surface finds on the beach included 3 chips, 15 flakes of various sizes (Fig. 3, *4*), a longitudinal convex side-scraper on spall with surviving chalk crust (Fig. 3, *5*), a longitudinal convex side-scraper with notched edge on natural fragment of pebble flint (Fig. 3, 2), and a robust core-shaped item with a distinct spike-like area on the retouched edge (Fig. 3, *3*).

The Middle Paleolithic assemblage comprises slightly rounded flint artifacts with well-preserved edges, most often covered with a milky white or porcelain-like patina. There are 35 such items in the collection. Artifacts of that kind were found in the coastal outcrop layer and on the beach. A chip and a diagonal side-scraper on a small thin flake (see Fig. 2, *1*), discovered in the lower part of layer 4, are considered a stratigraphic marker. The assemblage of finds collected on the beach includes 1 chip, 21 flakes of various sizes (Fig. 4, *4*), 1 laminar spall (Fig. 4, *1*), 6 cores with semi-volumetric and slightly convex working surfaces, and tools with traces of secondary processing. The cores with slightly convex working surfaces include some specimens with signs of radial reduction (Fig. 4, *2*), as well as a Levallois core (Fig. 4, *3*). Tools include

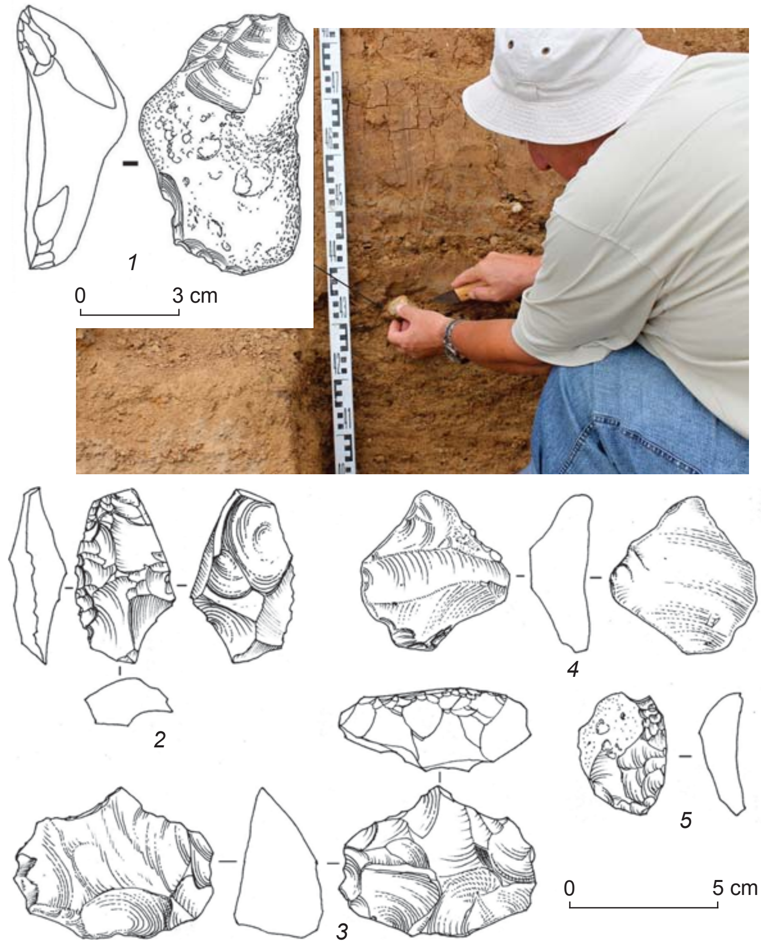


*Fig. 3*. Chisel-like tool *in situ* from layer 5 (*1*), Early Paleolithic flint artifacts collected on the beach (*2–5*), Nikolaevo-Otradnoye II.

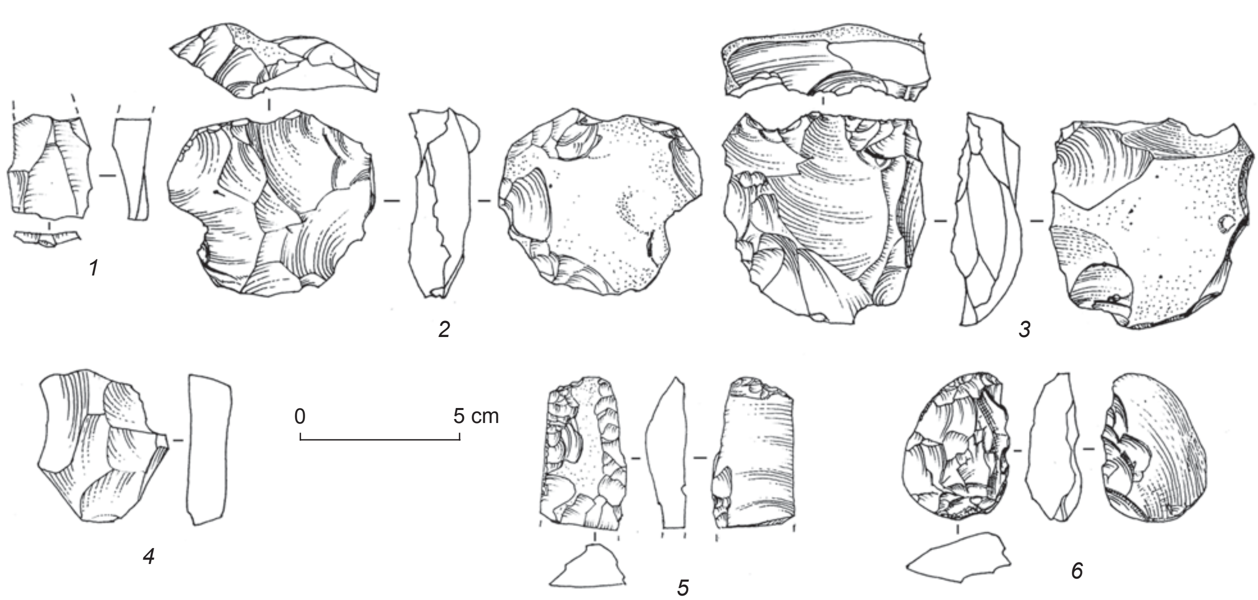


*Fig. 4*. Flint artifacts of Middle Paleolithic appearance collected on the beach, Nikolaevo-Otradnoye II.

a double (Fig. 4, *5*) and a single longitudinal side-scraper with signs of core thinning, longitudinal convex side-scrapers on primary and backed flakes, and a partially bifacial asymmetric tool (Fig. 4, *6*).

## Discussion

The subaqueous deposits of the Nikolaevo-Otradnoye II site (MIS 9–11, ca 420–270 ka BP) manifest the features typical of the initial stage of the peopling of the Northeastern Azov and Lower Don regions. This long phase of the early history of the region is documented by the Early Paleolithic (pre-Mousterian) sites of Gerasimovka on the banks of the Mius estuary, as well as Khryashchi and Mikhailovskoye in the lower reaches of the Seversky Donets (Praslov, 1968). The Gerasimovka site on the left bank of the estuary, with the fauna of the Tiraspol complex (ca 800–400 ka BP), is considered to be the earliest (Praslov, 1995). G. Bosinski linked the Gerasimovka complex with the period of settlement in Eurasia ca 780–500 ka BP (1996). According to the latest data, the Acheulean (according to V.E. Shchelinsky) Khryashchi site in the lower reaches of the Seversky Donets belongs to the Likhvin climatic rhythm (MIS 9–11) (Shchelinsky et al., 2020: 66), that is, is contemporaneous with the site under discussion.

The Nikolaevo-Otradnoye II site is important because its evidence, with traces of the Early (by regional standards) Middle Paleolithic, originates from the deposits of earlier than 243–191 ka BP (MIS 7). In the 1980s, there were many discussions on the criteria for attributing the Middle Paleolithic from the traces of the Levallois technique of primary reduction (Bosinski, 1982), the appearance of tools made of flakes (Tuffreau, 1982), and the disappearance of large chopping tools. While the definition of the "Middle Paleolithic" is conventional, these criteria have proven to be effective in identifying and characterizing different regional models of Paleolithic development. All regional reports on the Middle Paleolithic of the Russian Plain and Crimea (Sitnik, 2000; Kolesnik, 2003; Chabai, 2004) mentioned the occurrence of industries with Levallois features in lithological-stratigraphic deposits of no earlier than 123–109 ka BP (MIS 5e). In Western Europe, the Early Middle Paleolithic sites were dated within MIS 7 and 8 (Kozłowski, 2016: Fig. 1). Well-dated Middle Paleolithic complexes from the lower layers (15, 14) of Denisova Cave in the Southern Altai (Derevianko, Shunkov, Kozlikin, 2020) belong to MIS 7.

## Conclusions

Generally, the assumption on the origin of the Middle Paleolithic complex of Nikolaevo-Otradnoye II from the deposits below buried soil that dates to 243–191 ka BP (MIS 7) does not contradict the dates of the Early Middle Paleolithic complexes from the western part of Eurasia within MIS 6–8. It should be admitted that peopling of the Northeastern Azov region in the Early Middle Paleolithic occurred in the general context of multi-vector settlement across Eurasia. The hominin species from the early stage of the regional Middle Paleolithic in the southern region of the Russian Plain remains unidentified to this day. The late stage of the regional Middle Paleolithic (MIS 5, 4) is represented by a single paleoanthropological find—a tooth of *Homo neanderthalensis* from layer 4 of the Rozhok I site at the mouth of the Mius estuary (Zubova et al., 2022a: 142; Zubova et al., 2022b).

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# On the Attribution of Lithic Industry from the Early Paleolithic Site of Bogatyri/Sinyaya Balka, the Taman Peninsula

*The study describes and compares lithic artifacts from the Early Paleolithic site of Bogatyri/Sinyaya Balka, as well as those collected in coastal screes and on the nearby beach. Interdisciplinary studies, which have been ongoing at the site for more than 20 years, have made it possible to conclude that the age of the site exceeds 1 mln years, and that it was a butchering place. In the Early Pleistocene, a lacustral crater of a mud volcano was situated nearby. This mud marsh was a place where many large mammals such as Taman elephants and Caucasian elasmotheres bathed and perished. Humans procured them before they had drowned, and butchered them, as evidenced by the specific toolkit. The industry of the site is attributed to the Taman variety of the Oldowan stage of the Early Paleolithic. As the comparative analysis indicates, lithics from the screes and from the beach near the site are morphologically different from those at the site. The rocks of which they are made are of a higher quality, and the types are more expressive, which especially concerns cores and spalls. This industry should be attributed to the Taman variety of the Acheulean stage of the Early Paleolithic.*

Keywords: *Early Paleolithic, Northern Eurasia, Oldowan and Acheulean technological stages, Taman Peninsula, Bogatyri/Sinyaya Balka, lithic industry.*

## Introduction

In 2022, 20 years had passed since the discovery of an archaeological site at the stratotype paleontological site of Sinyaya Balka, on the Taman Peninsula: lithic artifacts were found in association with animal bones in the course of a sightseeing tour to an outcrop (Bosinski et al., 2003). The very first cleanings and excavations of the site showed that stone tools and bones of large animals had been deposited together. Thus, a unique Early Paleolithic archaeological site was discovered; it was given the double name Bogatyri/Sinyaya Balka, because the local name of this place is “Cape Bogatyr”. The co-occurrence of artifacts and bones of large animals makes it possible to correlate reliably the traces of ancient human activities to the time of existence of the Taman faunal complex of Eastern Europe, i.e., to the range of 1.4–0.7 Ma BP. Since 2005, Bogatyri/Sinyaya Balka has been studied by the Azov Multidisciplinary Expedition of the Institute for the History of Material Culture RAS, with the participation of paleontologists and geologists from various academic institutions and museums of Russia. During the excavations of the site, the Taman coastal cliffs were constantly surveyed; as a result of these survey trips, four more habitation sites and a number of Stone Age localities were discovered in the immediate vicinity of the main site, over a distance of 1 km along the coast. On the basis of these finds, the Taman Paleolithic archaeological complex was compiled by 2011 (Fig. 1). The history and results of this study have been described in numerous publications (Kulakov, 2018b, 2019a; Ranniy i sredniy paleolit…, 2022: 45–52; Shchelinsky, 2021; Shchelinsky, Kulakov, 2009; Kulakov, 2019b; Shchelinsky et al., 2010b).

### General information on the site

On the basis of the findings of many years of interdisciplinary studies at Bogatyri/Sinyaya Balka, this site was interpreted as a unique place of meat procurement by ancient *Homo* groups. According to modern reconstructions, in the Early Pleistocene, there was a lacustrine depression in the crater of a mud volcano filled with fresh water, with swampy shores formed by hilly breccia, on the coast of the brackish-water basin. This lake attracted large animals (Taman elephants and Caucasian elasmotheres), coming to water and take "mud baths". Most likely, people tracked when one of the animals got stuck in the mud and could not get out on its own, finished off the animal, and tried to butcher the carcass as quickly as possible until it finally drowned in the mud (Kulakov, 2018c, 2020). A whole set of various butchering stone tools was used to this end. The butchering of carcasses of large animals is vividly evidenced by very large and robust choppers and coarse chopping tools found *in situ* in unredeposited layers; these tools were designed to cut through thick skins and to separate large parts of carcasses (Kulakov, 2018a). The people involved in the procurement of meat supposedly did not stay long at the site (only for the time required for the work), but lived in more secluded places nearby. Some culture-bearing lenses around the site are probably the remains of such short-term habitation sites (Fig. 1) (Kulakov, 2018c). When the site was abandoned and no longer used as a butchering-place, catastrophic post-deposition changes began. A huge fragment of the ancient coast, including the remains of the Bogatyri/Sinyaya Balka site, was separated from the main land, overturned on its side, and covered with volcanic mud

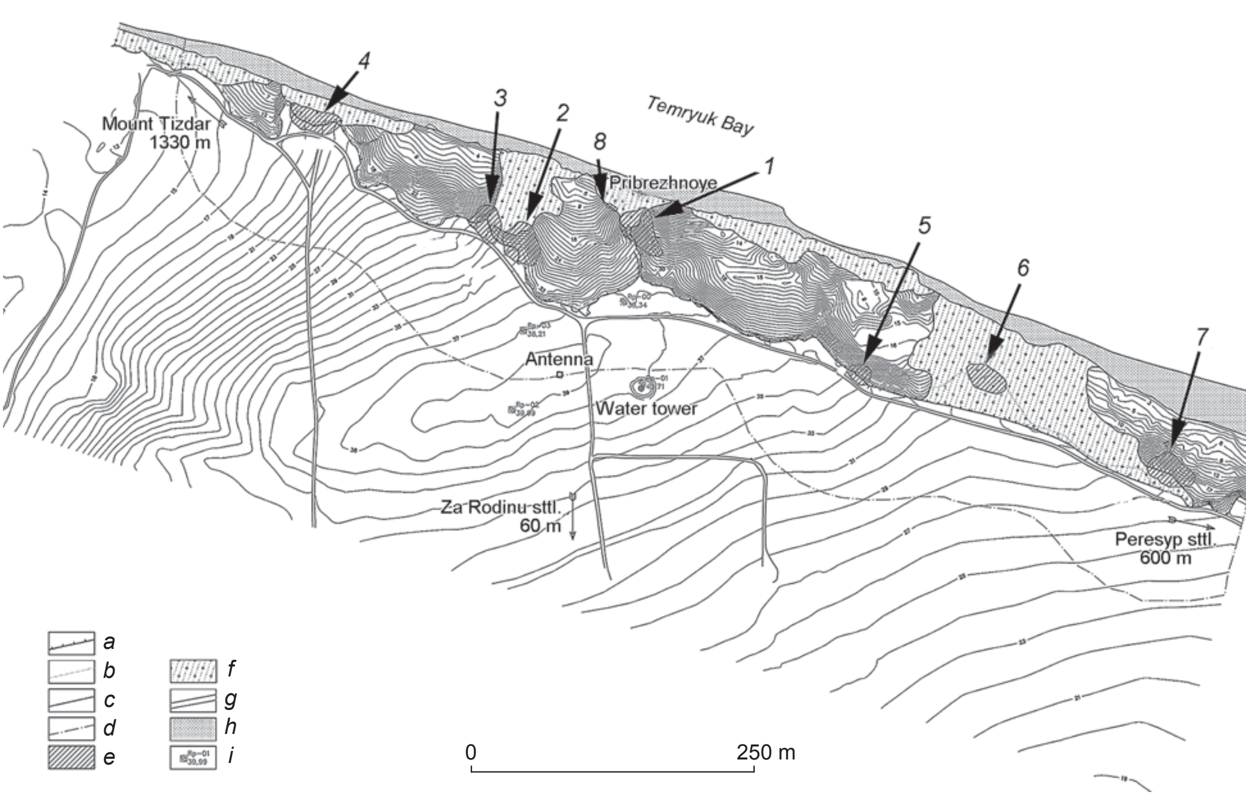


*Fig. 1.* Topographic plan of the Taman Paleolithic complex. 2011. *Performed by M.A. Galkin*.
*1* – the site of Boratyri/Sinyaya Balka; *2* – the site of Rodniki-1; *3* – the site of Rodniki-2; *4* – the site of Kermek; *5* – the locality of Lisy; *6* – the locality of Peresyp-1; *7* – the locality of Peresyp-2; *8* – the locality of Beregovoye (Rodniki-4).
*a* – coastline in 2011; *b* – the same in 2006; *c* – boundary of the archaeological site; *d* – boundary of the protective zone of the archaeological site; *e* – territory of the site; *f* – collapse zone of the edges of the coast and construction fillings; *g* – earth road; *h* – beach area; *i* – benchmark.

deposits. Because of this, the cultural layers survived till nowadays (Kulakov, 2020).

Recently, the sites of the Taman Paleolithic complex have been subjected to the ever-accelerating destruction of the Sea of Azov's coast. The Taman coast in the area from the village of Peresyp in the east to the village of Primorsky in the west is being constantly destroyed at various rates depending on the state of wetting of the "mainland" clay of the ancient Kuyalnik basin; the sediments overlying the clay's sliding surfaces creep into the sea. In 2006, in the area of the Taman Paleolithic complex, the process of the sliding of an extensive fragment of the bank, along an extended fissure, began. As a result, in 2010–2011, the northwestern end of Cape Bogatyr, including the northern part of the excavation, started to erode; the lower excavations of 2005 and 2008 at Rodniki-1 were also destroyed. The process of destruction was further exacerbated after 2010, owing to intense development of barren land between the settlements of Peresyp and Za Rodinu for private housing (Fig. 1). In 2013–2014, there was a heavy caving of the bank to the west of Cape Bogatyr. The result was the collapse of the site of Rodniki-1, which turned into a huge scree slowly creeping into the sea (Fig. 2). The last straw in the rapid destruction of the bank was the construction in 2021 of a road to the sea in a landslide cirque between Bogatyri/Sinyaya Balka and Rodniki-2 (Fig. 2). The cracks formed and enlarged as a result of this impact will lead to the collapse of a huge fragment of the bank including Cape Bogatyr with the archaeological site (Fig. 2). We can hardly predict when this collapse will happen, but most likely in the near future.

On the other hand, the destruction of the coast in the area of the Bogatyri/Sinyaya Balka and Rodniki-1 sites created an exceptional situation. When the screes reach the sea, they are washed off by the water and many stones remain on the beach. Among these stones, a representative collection of artifacts was assembled, which were different from the lithics yielded from the excavation.

## Lithic industry

The lithic artifacts from all the sites of the Taman complex were made from local rocks—heavily silicified dolomite, according to the identification made by petrographer I.V. Tibilov (St. Petersburg State University) in 2006 based on the samples from the excavation at Bogatyri/Sinyaya Balka. Dolomites in the form of flattened blocks, flat slabs, and tablets of various sizes occur in clays, sands, and hilly breccias, and are easily accessible in coastal outcrops, screes, and on the beach. Raw nodules differ not only in size, but also in color, fracturing, crust thickness, and most importantly, in grain structure and porosity (Shchelinsky, Kulakov, 2009). Experiments by V.E. Shchelinsky and E.Y. Girya have shown that these rocks, regardless of grain sizes, can easily be split with both hard and soft hammers; the detached spalls and shatters have sharp edges and are quite acceptable for processing. The main disadvantage of Taman dolomites


*Fig. 2.* View of the Taman complex from a quadcopter. 2022. *Photo by V.V. Titov*.
*1* – the site of Bogatyri/Sinyaya Balka, excavation area; *2* – the site of Rodniki-2; *3* – landslide cirque at Rodniki-1; *4* – scree at Rodniki-3; *5* – scree at Beregovoye (Rodniki-4); *6* – Cape Bogatyr, collapse of the sand column; *7* – fissures in sediments that will lead to further shore collapse; *8* – road to the beach constructed in 2021 in a large landslide cirque.

is their fragility. The excavations have shown that some fragile stones can fall apart spontaneously in the layer. At Bogatyri/Sinyaya Balka, local dolomites of various structures were used, which explains the different states of preservation of the artifacts. The items in the collection, with the exception of some artifacts from layers 1 and 2, are not rounded, and retain sharp edges and ribs. All the artifacts are patinated to varying degrees and have undergone strong chemical weathering (Ibid.).

Currently, the collection of lithic artifacts includes 593 specimens, more than half of which are tools (Table 1). Notably, 352 artifacts (59.4 %), including 212 (64.24 %) tools, come from unredeposited layers 1–4. Primary reduction at the Oldowan technological stage of the Early Paleolithic was determined primarily by the quantity and quality of available raw materials. At the site under consideration, they were abundant, easily accessible and occurred in tabular pieces, which was favorable for ancient knappers. As early as 1 million years ago, they not only simply split flattened pieces of dolomite and detached flakes with sharp edges—the so-called flake-like spalls—but also invented a technique of “marginal knapping of dolomite tablets”. This technique was used for the detachment of spalls retaining crust on their flaking platforms and distal ends. Almost all such spalls show non-conical proximal ends (Ibid.). Core knapping is illustrated by only a few available cores. Therefore, very few spalls have been interpreted as intentional; there are only 51 of them in the unredeposited layers, and most are small, up to 5 cm long. At the initial stage of the studies at the site, many fragments with a kind of a conchoidal fracture on one of the surfaces were classified as “flake-like spalls”. Later, with the increasing number of the observed cases of dolomite pieces cracking into fragments and chatters, the attribution of spalls began to be treated with more caution. Now, a piece can be identified as a flake only in the case where it shows the whole set of features: striking platform with a point of percussion, percussion bulb or non-conic proximal end, recognizable distal end, and identifiable ventral and dorsal surfaces. Accordingly, the number of identified flakes has decreased in recent years of excavations.

The composition of the Bogatyri/Sinyaya Balka toolkit (without finds from the screes) has remained generally the same during all the years of excavations (Table 2) (Ibid.). The most numerous are choppers (Fig. 3, *5*). These flattened tools were made from fragments of various sizes of dolomite slab. All the choppers in the collection are single-sided, with straight, convex, or concave working edges; there are tools with two opposite cutting edges. Accommodation treatment included the careful selection of fragments with the shape ensuring a better hold in the hand.

Over the years of studies, a representative collection of very large and robust choppers has been assembled; therefore, at present, the weight of the items is used to distinguish between these tools. The borderline between choppers and gigantolite-choppers (11 spec.) is a mass of 2.5 kg. The group of super-heavy items, along with choppers, also includes large coarse chopping tools (Table 2) (Kulakov, 2018a).

The category of end-scrapers is the second largest in the collection (Table 2). Notably, out of 47 items, only five were fashioned on spalls; all these are small, up to 3 cm long. The morphology of the end-scrapers is diverse, but largely it was determined by the shape and robustness of the original blank. The main feature for their identification is the semicircular scraping working-edge prepared through fine trimming and multifaceted retouch. All the end-scrapers on shatters are carinated forms, including a group (13 spec.) of core-like ones. Very expressive are the end-scrapers on thin tablets with semicircular working-edges treated over a significant part of the margins (5 spec.) (Fig. 3, *1*).

The category of points is also numerous in the collection (Table 2). This category comprises small items, including three specimens made on flakes, a great number of medium-sized points (7–10 cm), and large robust points exceeding 10 cm (Fig. 3, *4*). All these items are attributed to one category by the presence of a retouched

*Table 1.* **Distribution of lithic artifacts**

| Place of discovery | Core-like | Spalls | | Tools | Total |
|---|---|---|---|---|---|
| | | Large | Small | | |
| Layer 1, 2, sq. 59/1–2 | – | 1 | 7 | 5 | 13 |
| Layer 3, sq. 59/3–8; 60/1–8 | 9 | 17 | 41 | 98 | 165 |
| Layer 4, sq. 61/1–7; 62/1–6 | 14 | 20 | 31 | 109 | 174 |
| Layer 5, 6, sq. 63/1–6; 64/1–5; 65/1–4 | 8 | 21 | 18 | 47 | 94 |
| Scree | 11 | 29 | 36 | 71 | 147 |
| *Total* | 42 (7.1 %) | 88 (14.8 %) | 133 (22.4 %) | 330 (55.6 %) | 593 |

*Table 2.* **Distribution of tools**

| Place of discovery | Choppers | Coarse chopping tools | Side-scrapers | End-scrapers | Points | Notched-denticulate tools | Beak-shaped tools | Retouched flakes | Retouched fragments |
|---|---|---|---|---|---|---|---|---|---|
| Layer 1, 2, sq. 59/1–2 | 3 | – | 1 | 1 | – | – | – | – | – |
| Layer 3, sq. 59/3–8; 60/1–8 | 26 | 2 | 8 | 19 | 20 | 3 | 2 | 1 | 17 |
| Layer 4, sq. 61/1–7; 62/1–6 | 32 | 2 | 17 | 21 | 15 | 2 | 4 | 1 | 15 |
| Layer 5, 6, sq. 63/1–6; 64/1–5; 65/1–4 | 16 | – | 11 | 6 | 6 | 1 | – | 1 | 6 |
| Scree | 29 | – | 7 | 13 | 9 | 4 | – | 9 | – |
| *Total* | 106 (32 %) | 4 (1 %) | 44 (13.3 %) | 60 (18.2 %) | 50 (15.1 %) | 10 (3 %) | 6 (1.8 %) | 12 (3.6 %) | 38 (11.5 %) |

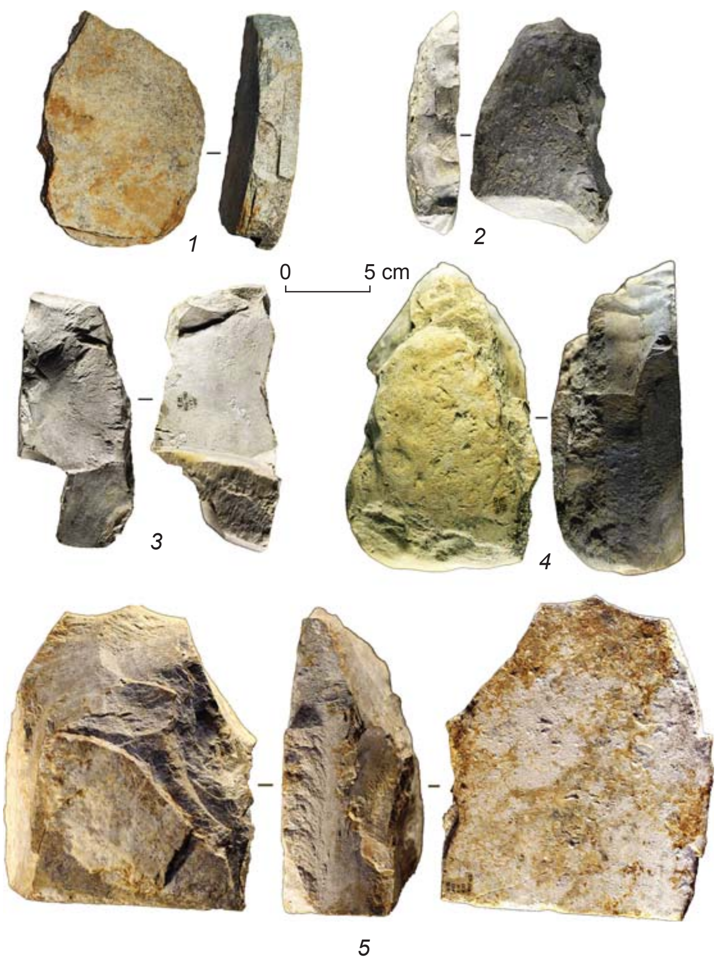


*Fig. 3.* Dolomite tools from Bogatyri/Sinyaya Balka.
*1* – end-scraper on tablet; *2* – side-scraper on fragment; *3* – "chopper-like scraper" on fragment; *4* – robust point ("pick") on fragment; *5* – chopper on tablet.
*2–4 – photo by E.Y. Girya.*

sharp protrusion (spur) shaped on the most convenient end of a dolomite fragment.

A significant number of side-scrapers has been identified (Table 2). These were also fashioned on dolomite fragments; only four items were prepared on small flakes. Most of these tools are medium-sized (7–10 cm). The common feature of the side-scrapers is a fairly long straight or slightly concave working-edge on one of the sides, prepared through fine trimming and multifaceted retouch (Fig. 3, *2*, *3*).

Few notched-denticulate and beak-shaped tools have been identified (Table 2). All of them were made on tablets. Three small retouched flakes were recovered. Dolomite fragments bearing minor areas of retouch are numerous (Table 2), but do not form any morphological series.

Thus, a long-term study of archaeological materials from Bogatyri/Sinyaya Balka confirms the initial definition of the lithic industry as a Taman variety of the Oldowan stage with a specific feature representing the "influence produced by local raw materials on the manufacturing technology and shape of tools" (Shchelinsky et al., 2010a: 18–19).

The mentioned recent destruction of the coast in the vicinity of the Taman Paleolithic complex is unfavorable for research; but at the same time, the situation provides the opportunity of simultaneously getting new information on the stratigraphy of sites, and the composition and morphology of

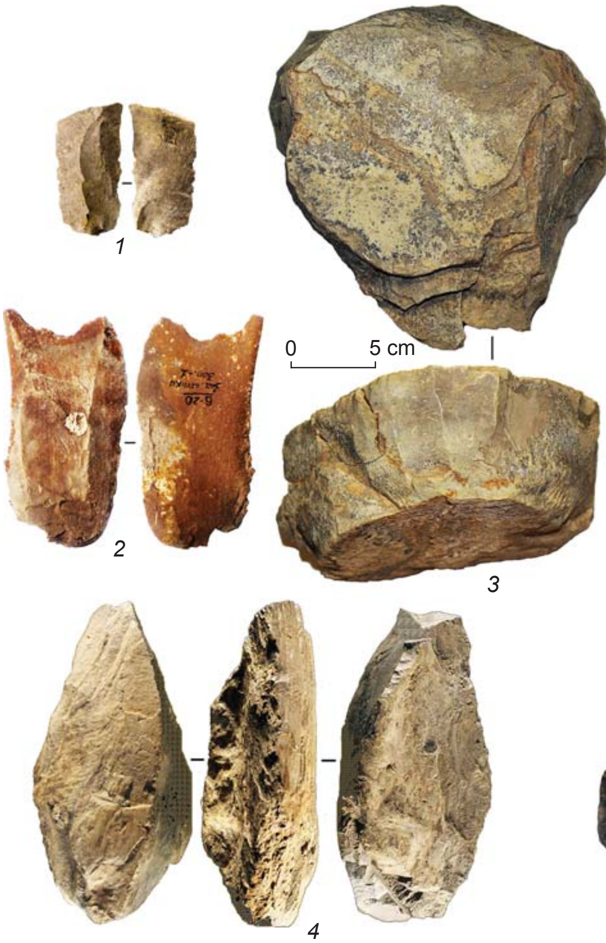


*Fig. 4.* Dolomite artifacts from the screes under the sites of Bogatyri/Sinyaya Balka and Rodniki-1.
*1*, *2* – laminar flakes; *3* – tabular core with circular flaking surface; *4* – tool with bifacial working – proto-handaxe (?) on fragment (*photo by E.Y. Girya*).

artifacts. Starting from 2017, the huge screes formed on the coast, mainly on the western side of Cape Bogatyr and at the Rodniki-1 excavation site, made it possible to assemble a representative collection of lithic artifacts (55 spec.) designated as "artifacts from the screes" (Fig. 4). These artifacts were produced from the same local mixed-quality tabular dolomites as those from the excavation, but the former were manufactured from the highest quality fine-grained varieties of dolomite.

The first peculiar feature of this collection was the presence of well-prepared cores (4 spec.) therein. Especially expressive are the cores made from robust dolomite tablets, with half-circle flaking surfaces (Fig. 4, *3*). Genuine nuclear knapping is confirmed by the available flakes (26 spec.); some of these are really large, up to 10 cm long. True laminar flakes (Fig. 4, *1*, *2*), removed only through marginal knapping, are the most remarkable.

The toolkit is basically similar to that in the excavation's collection. Choppers with convex blades are prepared on large and flattened dolomite fragments (8 spec.); one of them is a gigantolite weighing more than 5 kg. Single-edged side-scrapers (7 spec.) are made on fragments of dolomite tablets of various sizes. End-scrapers (3 spec.) and points (2 spec.) are also fashioned on variously-sized, but more robust dolomite fragments. Denticulate and beak-shaped tools on fragments are few. A large subtriangular dolomite fragment, with traces of bifacial treatment, was the most unexpected find (Fig. 4, *4*); it was discovered in the scree at Rodniki-1 in 2006. This tool was

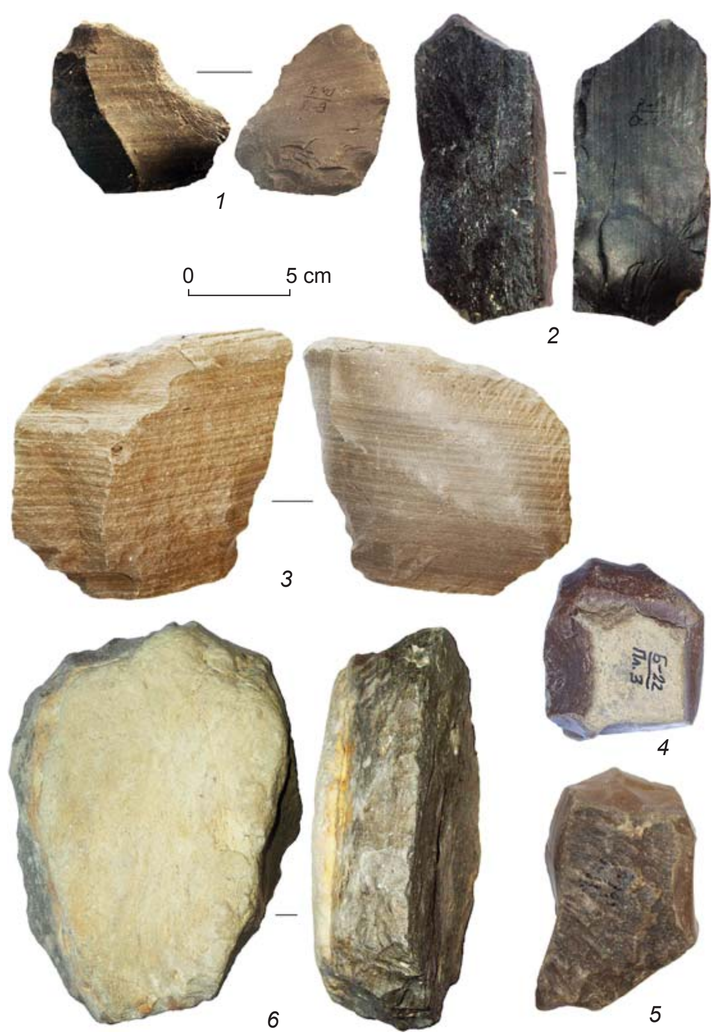


*Fig. 5.* Dolomite artifacts from the beach under the sites of Bogatyri/Sinyaya Balka and Rodniki-1.
*1*, *3* – flakes; *2* – primary laminar flake; *4* – core-like end-scraper on fragment; *5* – "chopper-like scraper" on fragment; *6* – chopper on fragment.

interpreted as a "pick" (Ranniy i sredniy paleolit…, 2022: Fig. 34), but in view of other artifacts from the screes it can now be considered a proto-handaxe. The refined flakes collected on the cape during the first visit to the site in 2002 can also be included into this collection (Bosinski, 2003: Abb. 7); the same can be said of the distinct side-scraper found in the scree in 2003 (Shchelinsky et al., 2010a: Fig. 13, *3*). Formerly, the interpretation of these artifacts was unclear as compared to the items from the main Bogatyri/Sinyaya Balka collection.

When the talus deposits of the destroyed site of Rodniki-1 and the western slope of Cape Bogatyr reached the beach and were washed with the seawater, it became possible to collect artifacts from the sand's surface, especially after strong storms. The collection from the beach currently includes 32 items. The artifacts from the beach are distinguished by a brown, gray or gray-brown patina, as well as roundness (Fig. 5). The composition of the beach collection is generally similar to that of the scree assemblage. There is a distinctive core with a half-circle flaking surface, and expressive spalls (10 spec.), including laminar flakes (Fig. 5, *2*), very large flakes (Fig. 5, *3*), and an indisputable flake with trimming on the bulb of percussion—a convergent side-scraper (Fig. 5, *1*). The beach collection is dominated by choppers (11 spec.); two of these are gigantolites weighing ca 5 kg. These tools are made from large tabular fragments of dolomites. The choppers with extended convex blades (Fig. 5, *6*) look especially well-prepared. For the first time, a bifacial chopper was found on the beach. Points of various sizes on robust dolomite fragments (4 spec.) form the second-largest category. The core-shaped end-scraper (Fig. 5, *4*) and the "chopper-like scraper" (Fig. 5, *5*) are typical, but heavily rounded.

## Conclusions

The collection of artifacts from Bogatyri/Sinyaya Balka is replenished with new finds each field season; the new finds always confirm the interpretation of this industry as the specific Taman variety of the Oldowan technological stage of the Early Paleolithic. Finds from the screes suggest that somewhere around the excavation area or, most likely, over it, there were deposits containing different artifacts. This assumption is well documented by the stratigraphic scheme recently proposed by a group of geologists from the Geological Institute, Russian Academy of Sciences (Moscow). The proposed stratigraphic sequence reveals three strata of sediments between the villages of Peresyp and Za Rodinu, on the northern coast of the Taman Peninsula (Tesakov et al., 2020: 8). The lower and middle strata belong to the Early Pleistocene. The middle stratum contains all the stratified sites of the Taman Paleolithic complex, while the upper one has not yet been dated and may well contain younger lithic artifacts (Ibid.: Fig. 2).

The artifacts from the screes differ considerably from the finds from the excavation. They were made from the same local raw materials, but have a different morphological appearance. A distinctive feature of surface-collected materials is the presence of typical cores with a specific morphology of flaking surfaces and genuine intentional spalls, including very large ones. But most importantly, the surface collection includes a tool with bifacial treatment of the working edges. Such a technique has not been recorded on the artifacts from the excavation. At the moment, it seems that the collections assembled in the screes and on the beach can be preliminarily combined into one complex and identified as the industry of the subsequent Acheulean stage of the Early Paleolithic.

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# Gazma Cave—A Final Middle Paleolithic Site in Azerbaijan: Paleogeography, Chronology, Archaeology

*This article describes the Middle Paleolithic industry of Gazma Cave in the Nakhchivan Autonomous Republic of Azerbaijan. We present data on the stratigraphy, paleontology, chronology, and archaeology of the site. Six lithological layers were identified, three of which (IV–VI) contain abundant archaeological material. The chronology of the site is based on a series of luminescence ages. The deposition of layers IV–VI formed ~55–40 ka BP. Paleontological, pollen, and grain size analysis offer the possibility of reconstructing Late Pleistocene environments around the cave. Faunal analysis indicates steppe, semi-steppe, and wooded mountains, with riparian forests and reeded areas in the floodlands. The analysis of 896 artifacts attests to the predominance of Levallois and parallel reduction. The share of Levallois blanks is high. The most common artifacts are Levallois and Mousterian points and side-scrapers; there are also limaces, knives, and a few indistinct Upper Paleolithic types such as end-scrapers and borers. Ventral basal trimming of points and ventral or dorsal thinning of side-scrapers were widely used. All the main indicators show the Gazma industry corresponds to the final Middle Paleolithic assemblages currently known in the Southeastern Caucasus.Gazma is an expressive MIS 3 example of the Taglar industry.*

Keywords: *Azerbaijan, Middle Paleolithic, paleontology, palynology, OSL-dating, Levallois.*

## Introduction

Currently, several hundred sites are known in the Caucasus, which preserve archaeological materials from the Middle Paleolithic. However, only a handful of these sites have artifacts found *in situ* that make it possible to provide more precise characteristics of the lithic industries, their chronology, and their progression (Lyubin, 1989; Dzhafarov, 1999; Golovanova, Doronichev, 2003; Lyubin, Belyaeva, 2006; Guseinov, 2010; Pinhasi et al., 2012; Stone Age…, 2014). Hence, all development schemes for the Middle Paleolithic of the Caucasus are based on collections from a small number of well-known sites, primarily located in the southern and northwestern regions and often associated with rock shelters. These sites have proven to be particularly informative in shaping our knowledge of this period in the Caucasus (Lyubin, 1989). In Azerbaijan, the most famous sites of this type are Azykh and Taglar caves (Dzhafarov, 1999; Guseinov, 2010). For a significant period of time, Paleolithic sites remained undiscovered in Nakhchivan. However, in 1983, the Gazma Cave site was finally unearthed there. Decades of research conducted within the cave have provided valuable insights into the cultural processes that took place during the final stages of the Middle Paleolithic in the region. The article is intended to present a comprehensive overview of the scientific knowledge pertaining to this subject of study.

## Background

Gazma Cave is located in the Sharur District of the Nakhchivan Autonomous Republic (Azerbaijan), on the southwestern spurs of the Daralagez Ridge, 3 km southeast of the village of Tananam (Fig. 1). It is located on the left slope of a dry valley, in the basin of the Arpachay River, 30 m above the river level (1500 m above sea level) (Fig. 2, *1*).

The karst cavity is near a remnant of the Triassic limestone, and belongs to the caves of the corridor-grotto type, specifically of the branching subtype (Fig. 2, *2*). It extends along the NW-SE axis by 32 m, with a maximum width of up to 6 m. At 12 m from the drip line, it is divided into two narrow arms (Fig. 2, *3*). The total area of the cave is ca 60 $m^2$. The entrance faces the Gazma Gorge (northwest exposure) (Zeynalov, Veliev, Tagieva, 2010).

As an archaeological site, Gazma Cave was explored in 1987–1990 (under supervision of A.K. Dzhafarov and A.A. Zeynalov) and 2008–2011, 2013 (under supervision of A.A. Zeynalov). An area of ca 24 $m^2$ was unearthed at the site for the entire thickness of loose deposits (Fig. 2, *3*) (Zeynalov, 2013, 2016). In 2021,


*Fig. 1*. Schematic map of the study area.

the Russian-Azerbaijani geoarchaeological expedition collected a sample core near the entrance of the cave for OSL-dating (Anoikin et al., 2021) (Fig. 3).

## Stratigraphy

The sequence of deposits of the site, approximately 3 m thick, includes the following lithological units, listed from top to bottom (Zeynalov, 2016) (Fig. 3).

*Layer I*. Modern humus, dark gray, loose, pulverulent. Thickness 0.1–0.25 m. Contains single fragments of pottery, and bones.

*Layer II*. Light loam, light yellow, contains carbonaceous layers and lenses of greenish-gray sandy loam (up to 0.3 m). Thickness 0.2–0.6 m.

*Layer III*. Gray-yellow, dense sandy loam. Includes an insignificant amount of limestone fragments (crushed stone, rarely grus). Thickness 0.5–1.3 m. Contains abundant paleontological material.

*Layer IV*. Light loam, dark gray-yellow. Includes a large amount of small and medium crushed stone. Thickness 0.4–0.5 m. Contains abundant archaeological and paleontological material.

*Layer V*. Light, gray-brown, dense loam, with thin layers of greenish-gray silty material. Includes a large amount of small and medium crushed stone. Thickness 0.3–0.4 m. Contains abundant archaeological and paleontological material. Two fire pits were recorded in the layer (Ibid.: 77–78).

*Layer VI*. Medium, gray-brown, dense loam. Includes a large amount of fine and medium clastic material, the concentration of which decreases towards the bottom of the layer. Thickness 0.4–0.95 m. Contains abundant archaeological and paleontological material. A hearth with a stone lining and a fire pit were recorded in the layer (Ibid.: 78–79).

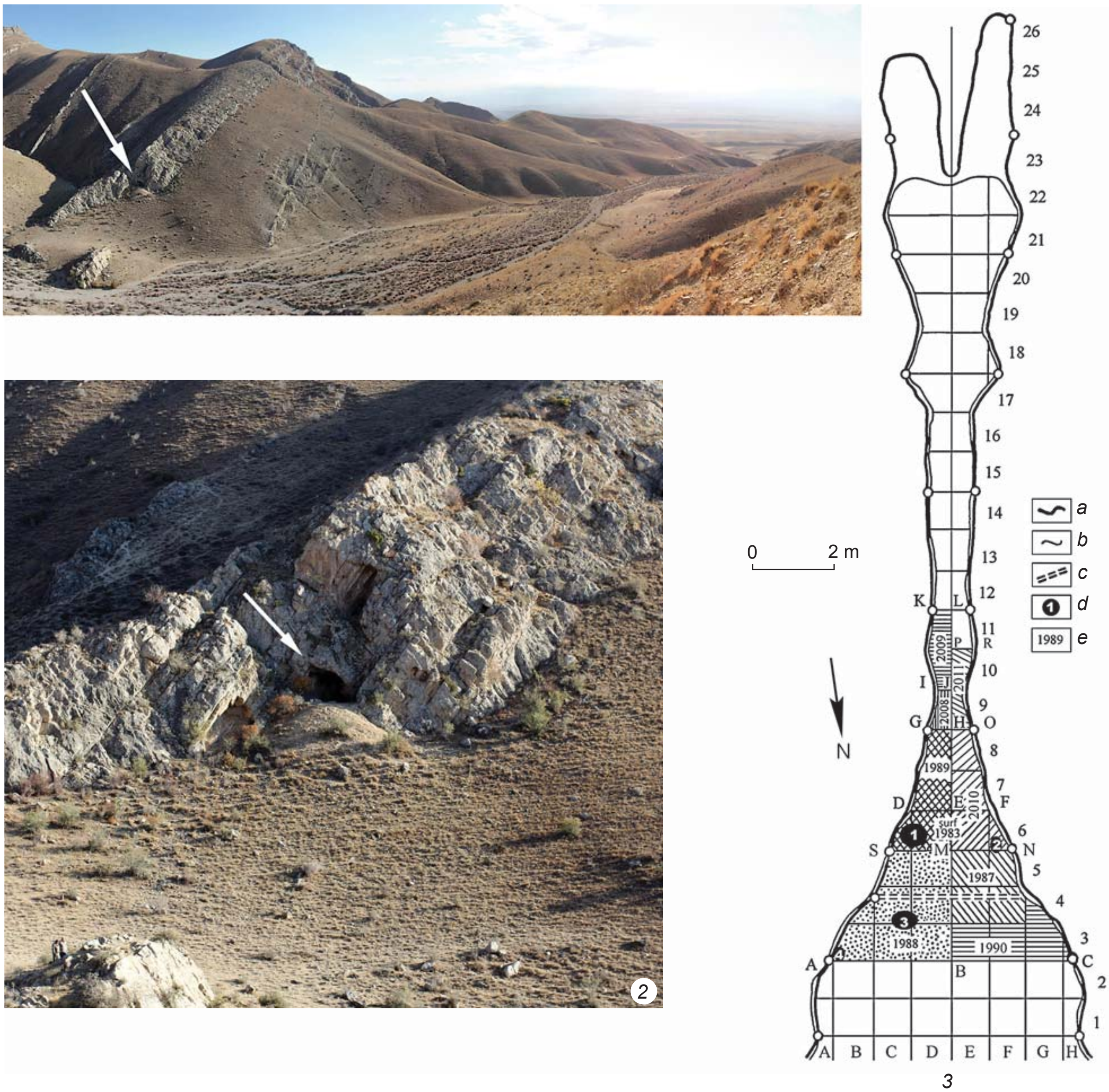


*Fig. 2*. Gazma Cave.
*1* – Gazma Gorge and view of the Arpachay River valley from the north; *2* – view of Gazma Cave from the north; *3* – plan of Gazma Cave with indication of excavation areas.
*a* – boundary of the karst cavity; *b* – boundary of the karst cavity along the zero reference line; *c* – drip line; *d* – firepits and hearth; *e* – work areas by years.

## Paleontological data

The faunal collection of the site includes about 22.5 thousand fragments of remains of mammals, birds, and amphibians (Zeynalov, Veliev, Tagieva, 2010; Zeynalov, 2016), with the vast majority (~90 %) occurring in layers IV–VI, containing abundant archaeological material.

These layers yielded many bones of Pleistocene horse (*Equus caballus L.*), gazelle (*Gazella subgutturosa Guld.*), red deer (*Cervus elaphus L.*), Pleistocene donkey (*Equus hidruntinus Reg.*), and bezoar goat (*Capra sf. Aegagrus*). There are also remains of primeval bull (*Bos primigenius Boj.*), bison/auroch (*Bison* sp.), wild boar (*Sus scrofa L.*), and wild ram (mouflon?) (*Ovis* sp.). The composition of the commercial species commonly found at the site is generally representative of Paleolithic sites in Transcaucasia. For example, the remains of the Pleistocene donkey and caballoid horse were found in the caves of Taglar, Dashsalakhly (Azerbaijan) and Yerevanskaya (Armenia). Some of them contained bones

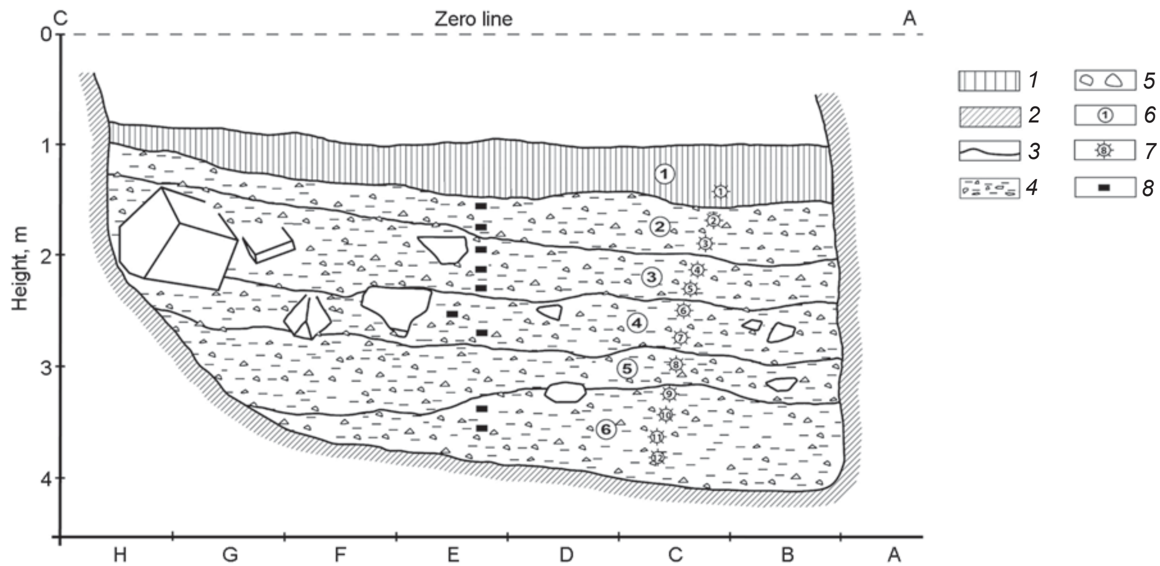


*Fig. 3*. Stratigraphic situation in Gazma Cave, northern wall of excavations of 1988 and 1990 (line A–C).
*1* – layer of humus; *2* – cliff boundary; *3* – layer boundary; *4* – loam with crushed stone; *5* – large fragments of limestone; *6* – layer number; *7* – sampling site for pollen analysis; *8* – sampling site for OSL-dating.

of bezoar goats, mouflons, deer, and wild boars (Lyubin, 1989). Remains of predators, such as cave lion (*Felis spelaeus Goldf*.), steppe cat (*Felis libyca Schreber*), cave bear (*Spelaearctos spelaeus Ros*.), fox (*Vulpes vulpes L.*), and badger (*Meles meles L.*), are scarce in Gazma, and were recorded in some of the layers (Zeynalov, Veliev, Tagieva, 2010; Zeynalov, 2016). Certain bones exhibited gnawing marks, although the occurrence of such remains within the entire faunal collection is relatively low. The abundance of paleontological remains, especially those of medium and large ungulates, and the prevalence of tubular bone fragments and small fragments can be attributed to human hunting activities.

The species composition of the fauna indicates that in the Late Pleistocene, natural zones of steppes, semi-steppes, and wooded mountains coexisted in the cave area; and in the floodplains of the Arpachay and Araks rivers, there were riparian forests and reeded areas.

## Pollen data

Detailed information on the Late Pleistocene paleogeographic settings in the area of the cave is provided by pollen analysis. The relevant material was taken from two sections: in the entrance zone of the cave (12 samples) (Fig. 3) and on the 40-meter terrace of the Arpachay River, a few kilometers away from the site (9 samples) (Zeynalov, Veliev, Tagieva, 2010). The samples yielded a limited amount of pollen, but oak (*Quercus*) and alder (*Alnus*) pollen were identified. Near the cave, the dominant pollen types among herbaceous plants were hazeweeds (*Chenopodiaceae*), grasses (*Poaceae*), and wormwoods (*Artemisia*). In the Arpachay valley, the spectra included Asteraceae (*Asteraceae*), heather (*Ericaceae*), grapes (*Vitis*), and juniper (*Juniperus*). Both forb and riverbank-water cenoses were present, with a higher prevalence of the latter and also of sedge species (Ibid.; Zeynalov, 2016).

The obtained data suggest the existence of sparse oak forests in the area of the cave in the Late Pleistocene, formed by frost- and drought-resistant oriental oak (*Quercus macranthera*). Light-colored oak forests with xerophilic herbs were combined with arid juniper open woodlands on rocky slopes. In addition, the general composition of the flora corresponds to more humid natural conditions than modern ones. The evidence of less arid environments is further supported by the results of a granulometric analysis of the composition of the Late Pleistocene cave deposits (Ibid.).

## Chronology of the site

Initially, the chronology of the site was based on the correlation between the position of the cave and the level of river terraces in the Lesser Caucasus, within the framework of the Khvalynian transgression of the Caspian Sea (MIS 3–2). However, the Middle Paleolithic appearance of the lithic industry allows for the time frame of the site to be the Early Khvalynian stage (not earlier than the period corresponding to MIS 3). The radiocarbon date of 26,867 ± 143 BP (29,090 ± 165 cal BP (95.4 %, IntCal 20)), obtained from the combined collection of bones from layers IV–VI, did not go beyond the period corresponding to MIS 3 (Zeynalov, 2016); however, in the context of archaeological materials, it looked unreasonably young.

A series of samples were taken from the cave for OSL-dating in 2021. At present, three determinations have been obtained at the Nordic Laboratory for Luminescence Dating Riso (Denmark). Comparisons of dates for quartz and potassium feldspars showed their high correlation ($IKSL_{290}$/OSL ratio: 1.03 ± 0.04), which indicates the reliability of the final age determinations for quartz (Kurbanov et al., 2021). The time of layer VI formation at the initial stages of MIS 3 is determined by two dates: 53.6 ± 4.7 ka BP (No. 218208) and 51.7 ± 3.2 ka BP (No. 218209). Using a sample from the layer IV roof, a date of 41.9 ± 2.4 ka BP was obtained (No. 218205).Taking into account dating results, as well as data on the chronology of other Middle Paleolithic sites of the South Caucasus (Pinhasi et al., 2012; Stone Age…, 2014), it can be proposed that the rock shelter was actively used by prehistoric humans in the range of ca 55–40 ka BP.

## Archaeological materials

The collection of artifacts from layers VI–IV includes 896 specimens: 385 spec. from layer VI, 362 spec. from layer V, and 139 spec. from layer IV. Ten items were found during the slide of the walls, without an exact binding to the layer. Finds from all the layers show similar use of mineral resources. The main raw material was obsidian (~89 %). Flint and chert were significantly more rare. The nearest modern sources of obsidian in bedrock outcrops are located in the upper reaches of the Arpachay River, on the Kelbajar volcanic highlands. The prehistoric inhabitants of the cave were probably finding it in the alluvium of the river, about 15 km from the rock shelter. Flint was sourced in the Devonian-Carboniferous deposits, with its outcrops available in the area of the cave (Zeynalov, 2016).

The stratified distribution of archaeological materials, categorized by primary reduction techniques and types of tools, indicates that all the artifacts belong to a single industry and can be regarded as components of the same complex (Tables 1, 2).

Primary reduction is characterized mainly by the parameters of flakes, since there are only 3 cores found, and they appear to be very exhausted. The industry exhibits several notable characteristics, such as an exceptionally low proportion of cores (0.3 %) and their extensive reduction, the absence of primary spalls, and the scarcity of items retaining pebble cortex. These distinctive features allow the following conclusions to be made:

1) the cores were shaped and used mainly outside the cave, possibly directly at the places of collection of raw materials;

2) most likely, ready-made tools or flake-blanks were brought to the site; the production process focused mainly on tools shaping and rejuvenation;

3) the cores brought to the site were used until the complete exhaustion, which was probably due to the remoteness of the sources of raw materials; in addition, they could have served as chisel-like tools.

An analysis of the flake industry shows that its main parameters change little over the layers. One of the most widespread and distinctive categories within the assemblage is that of Levallois flakes, consisting of a significant proportion of triangular-elongated specimens. These flakes are either completed target blanks or unsuccessful removals. In terms of morphology, numerous triangular flakes are close to them, having no signs of convergent dorsal scar pattern or fine rejuvenation of the striking surface. It can be assumed that the main purpose of the primary reduction was the manufacture of pointed spalls using the Levallois technology. Additionally, the utilization of the parallel flaking technique to acquire numerous elongated blanks has been observed. The dominance of Levallois reduction is indicated by the corresponding indices: average IL for all the layers is 29, and taking into account some of the technical spalls, possibly removed by the recurrent

*Table 1.* **Composition of the Gazma Cave lithic industry**

| Layer | Cores | | Blades | | Flakes | | Triangular flakes | | Levallois flakes | | Shatters, chunks, chips | | Total | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | Spec. | incl. tools | |
| | Spec. | % | Spec. | % | Spec. | % | Spec. | % | Spec. | % | Spec. | % | | Spec. | % |
| IV | – | – | 20 | 14.4 | 39 | 28.1 | 12 | 8.6 | 24 | 17.3 | 44 | 31.7 | 139 | 41 | 29.5 |
| V | 2 | 0.6 | 44 | 12.2 | 57 | 15.7 | 32 | 8.8 | 62 | 17.1 | 165 | 45.6 | 362 | 100 | 27.6 |
| VI | 1 | 0.3 | 30 | 7.8 | 83 | 21.6 | 24 | 6.2 | 52 | 13.5 | 195 | 50.6 | 385 | 91 | 23.6 |
| *Total* | 3 | 0.3 | 94 | 10.6 | 179 | 20.2 | 68 | 7.7 | 138 | 15.6 | 404 | 45.6 | 886 | 232 | 26.2 |

*Table 2*. **Tool forms of the Gazma Cave lithic industry**

| Tool type | Layer IV | Layer V | Layer VI | Total | |
|---|---|---|---|---|---|
| | Spec. | Spec. | Spec. | Spec. | % |
| Points: | 12 | 26 | 31 | 69 | 29.7 |
| Levallois | 4 | 2 | 3 | 9 | 3.9 |
| Levallois, with retouch | 1 | 3 | 7 | 11 | 4.7 |
| Mousterian | 7 | 20 | 19 | 46 | 19.8 |
| with retouch | – | 10 | 2 | 13 | 5.2 |
| Limaces | – | 7 | – | 7 | 3.0 |
| Side-scrapers: | 8 | 17 | 12 | 37 | 15.9 |
| longitudinal | 2 | 8 | 8 | 18 | 7.8 |
| double longitudinal | 1 | – | 1 | 2 | 0.9 |
| transverse | – | 3 | – | 3 | 1.3 |
| convergent | 3 | 3 | 1 | 7 | 3.0 |
| angular | 2 | 3 | 2 | 7 | 3.0 |
| End-scrapers | 3 | – | 2 | 5 | 2.2 |
| Borers | 1 | 6 | 1 | 8 | 3.4 |
| Knives | 2 | 4 | 6 | 12 | 5.2 |
| Chisel-like | 1 | 3 | 3 | 7 | 3.0 |
| Retouched flakes | 9 | 13 | 16 | 38 | 16.4 |
| Tool fragments | 5 | 15 | 20 | 40 | 17.2 |
| *Total* | 41 | 100 | 91 | 232 | 100 |

method to obtain convergent blanks, is 38. IFlarge of striking surfaces of flakes (148 spec.) is 82, IFstrict is 68. Along with the faceted (including *chapeau de gendarme*) and dihedral striking surfaces, there are also the plain ones (17.6 %). Dorsal pattern of the flakes is radial, convergent, or subparallel; all presented in equal proportions. There are approximately 22 % of artifacts resembling blades in terms of proportions (Fig. 4, *12*). Length of about 95 % of flakes is less than 5 cm. The small size of most artifacts can also be explained by the remoteness of the sources of raw materials and/or the small size of raw pieces, by the production of flakes outside the rock shelter, and by intensive use of blanks (possibly with their repeated trimming/rejuvenation) *in situ*. In addition to retouch, which is nearly always dorsal, ventral thinning of blanks is widely used in the industry, mainly in the proximal part. The ventral thinning is observed in about 20 % of Mousterian points and side-scrapers (Fig. 4, *9*; 5, *4*). Sporadic employment of transverse truncation through fine flaking can also be identified.

The composition of the toolkit almost does not vary throughout the layers (Table 2). Its main categories are points (Levallois and Mousterian) and side-scrapers; they make up 75 % of the typologically expressed tools (see Fig. 4, *4*, *6*, *10*, *11*; 5, *1*, *5*, *9–11*; 6, *1–3*, *5*, *6*). Among side-scrapers, 2/5 of the items are convergent, including angular ones (see Fig. 4, *13*; 5, *2*; 6, *7*). Longitudinal varieties were in most cases made on elongated subrectangular blanks (see Fig. 4, *8*, *14*; 5, *3*, *6*, *8*). As noted above, these categories of tools are characterized by both ventral and dorsal thinning (see Fig. 6, *8*). Retouched knives and a few items of the Upper Paleolithic type, such as chisel-like tools, borers, and end-scrapers, were found in all the layers (see Fig. 4, *5*, *7*; 6, *4*). Chisel-like tools are of small size, single- and double-edged, with opposite blades (see Fig. 5, *7*). The borers have distinct shoulders, often symmetrical, and an elongated, carefully retouched point. End-scrapers are of different sizes, larger ones are lateral, small ones are with the signs of processing along the perimeter. An impressive type of tools, occurring in layer V only, are limaces; these are small, narrow, strongly elongated items, two-pointed, with intense modifying retouch along the perimeter (see Fig. 4, *1–3*).

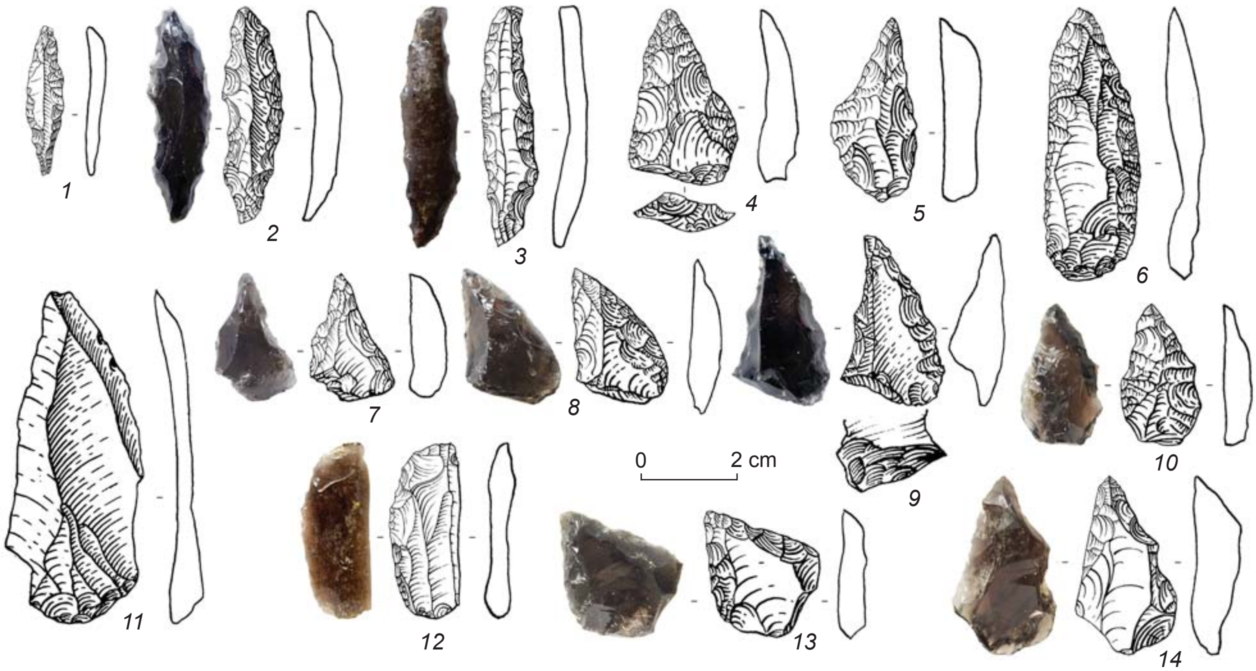


*Fig. 4*. Tools from Gazma Cave, layer V.
*1–3* – limaces; *4*, *6*, *10* – Mousterian points; *5*, *7* – borers; *8*, *14* – longitudinal side-scrapers; *9* – Mousterian point with traces of basal trimming; *11* – Levallois point; *12* – retouched blade; *13* – angular side-scraper.

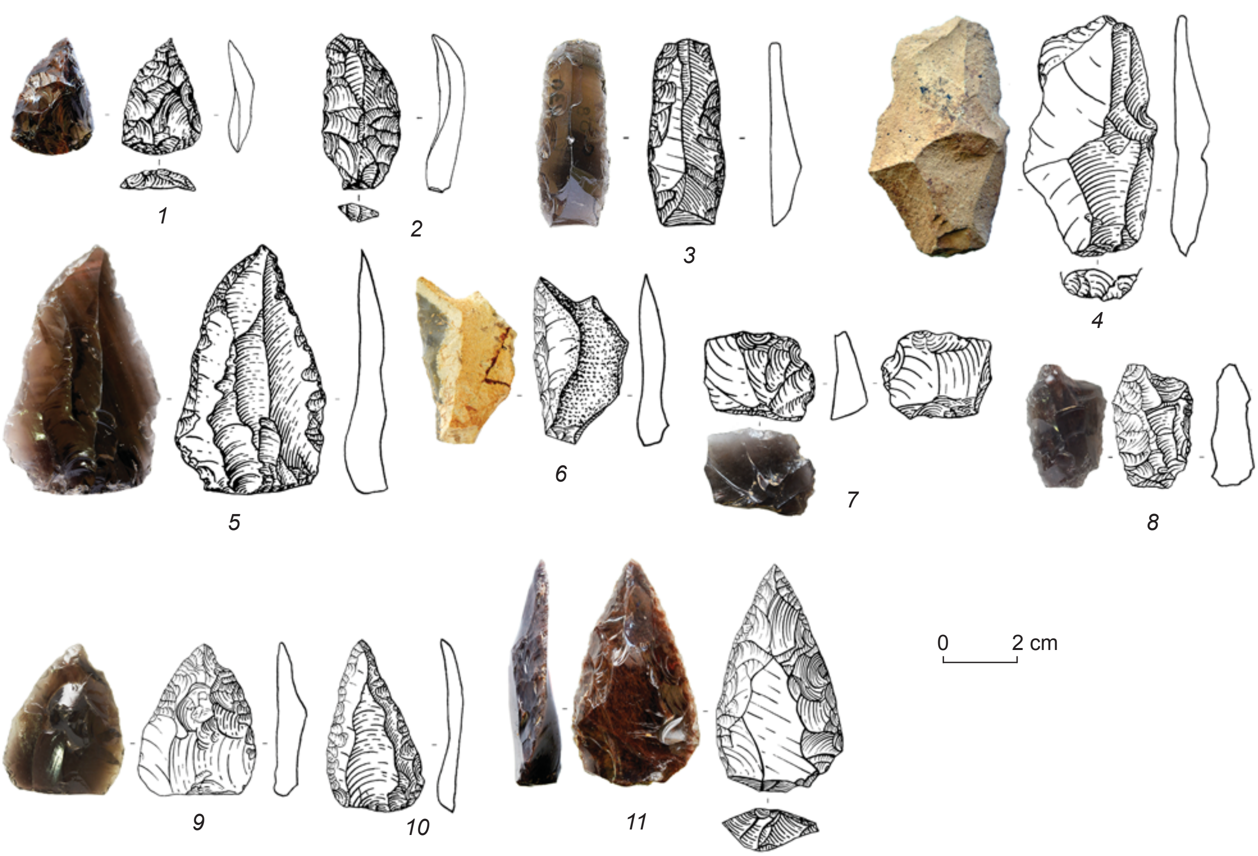


*Fig. 5*. Tools from Gazma Cave layers V (*6–11*) and VI (*1–5*).
*1*, *9*, *11* – Mousterian points; *2* – convergent side-scraper; *3* – double longitudinal side-scraper; *4* – flake with traces of trimming; *5*, *10* – retouched Levallois points; *6*, *8* – longitudinal side-scrapers; *7* – chisel-like tool.

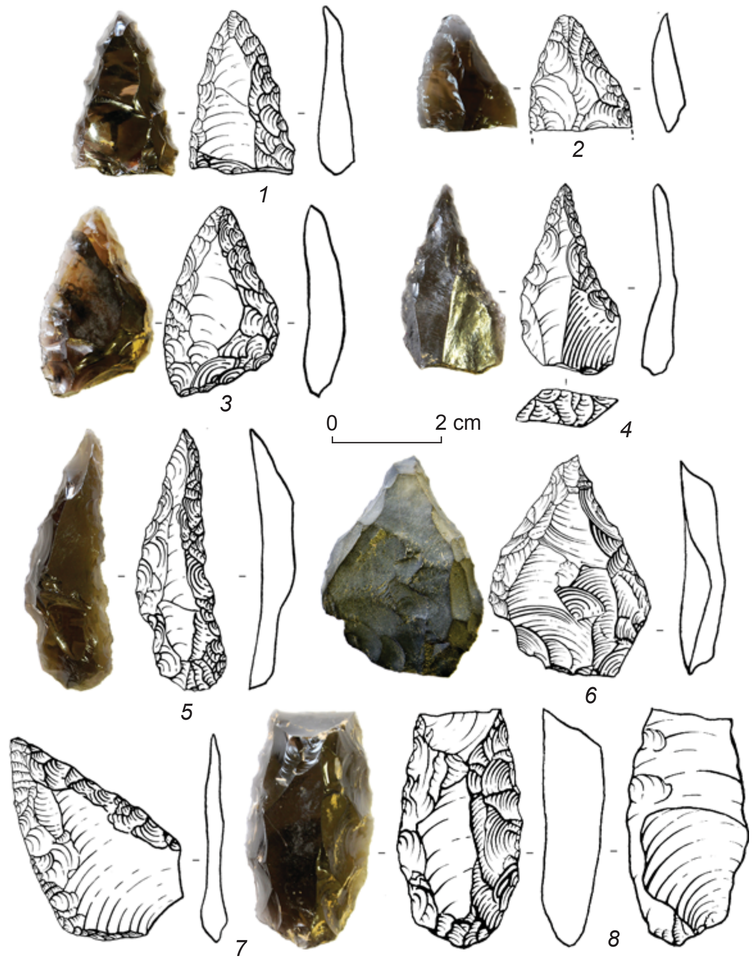


*Fig. 6*. Tools from Gazma Cave layer IV. *1–3*, *5*, *6* – Mousterian points; *4* – borer; *7* – angular side-scraper; *8* – longitudinal side-scraper.

## Discussion and findings

In the South Caucasus, the industries of the cave sites located in the eastern part of the Lesser Caucasus (Taglar, Dashsalakhly, Buzeir) are chronologically and spatially closest to the Gazma materials (Lyubin, 1989; Dzhafarov, 1999; Guseinov, 2010).

In Taglar, six layers with Middle Paleolithic industries have been identified, whose chronology, according to the set of biostratigraphic data, is determined by a range of about 70–35 ka BP (Late Khazarian to Early Khvalynian transgression). Flint, silicified schist, and less commonly obsidian were used as raw materials. Archaeological materials (5863 spec.) belong to the same industry. Cores are few, and they are mostly radial and parallel single-platform and single-faced. Layers 2 and 3 contain isolated subprismatic cores. IL is ~48, IFlarge is ~66, IFstrict is ~35. At the Taglar site, just as at Gazma, the primary reduction, aimed at obtaining pointed blanks, was based on the Levallois strategy, while that for the production of elongated subrectangular spalls, on parallel flaking (Dzhafarov, 1983, 1999).

Most tools are Levallois and Mousterian points, as well as side-scrapers (~90 % of the total number of tools). There are also end-scrapers, knives, denticulate-notched tools, and limaces. Burins and borers are single. The ventral thinning of points and side-scrapers was often used. The latter were sometimes thinned along the entire ventral face (“Taglar-type” side-scrapers) (Ibid.).

The materials from Dashsalakhly Cave (326 spec.) are also close to the described industries. Flint, silicified schist, and, more rarely, obsidian served as raw materials for the inhabitants of the site. The cores are mostly radial, but there are many Levallois flakes. IL is ~45, IFlarge is ~85, IFstrict is ~40. The tools are dominated by side-scrapers, Levallois and Mousterian points, including those with ventral thinning. There are also knives and denticulate-notched forms (Dzhafarov, 1999; Guseinov, 2010).

Sixty-one lithic artifacts have been recorded in the Pleistocene layers of Buzeir Cave. The raw materials are flint, chert, and obsidian. The cores are few; all of them are radial or severely exhausted. The tools are Levallois points and single-edged side-scrapers, including those with ventral thinning. One burin is also recorded (Dzhafarov, 1999).

In Armenia, the most representative complex of the Final Middle Paleolithic is the industry of the Yerevanskaya I Cave site (layers 1–4) (Yeritsyan, 1970; Stone Age…, 2014). For layers 3 and 4, a series of uncalibrated AMS-dates was obtained in the range of >49–32 ka BP (Stone Age…, 2014). The cores are Levallois (for points and flakes) and those with a parallel flaking pattern. There are Levallois flakes, including elongated ones, while there are only a few laminar blanks. IFlarge is ~35, IFstrict is ~20 (Yeritsyan, 1970). The tools are dominated by side-scrapers. There are many Levallois and Mousterian points, some knives and notches. Materials of the Upper Paleolithic types are scarce: chisel-like tools, end-scrapers, and burins (Yeritsyan, 1970; Stone Age…, 2014). Bifacially processed tools and limaces were identified. Specific types include points with rejuvenated bases (“Yerevan-type” points), truncated-faceted items, and side-scrapers with thinned body, i.e. artifacts with direct parallels in the contemporaneous industries of Azerbaijan (Yeritsyan, 1981; Lyubin, 1989; Dzhafarov, 1999; Liagre et al., 2006).

Materials from the main cultural layers of Lusakert I Cave (B, CI, CII, and D), according to a series of AMS-and OSL-dates, have the age of ca 40–30 cal ka BP (Adler et al., 2012; Stone Age…, 2014). The collection, showing the predominance of Levallois flaking, contains many elongated Levallois spalls; IFlarge is ~50. Points (mostly Levallois) and side-scrapers dominate the toolkits; there are many denticulate-notched pieces and natural-backed knives. Artifacts of the Upper Paleolithic types are rare (chisel-like tools, inexpressive end-scrapers, burins). The widespread use of ventral thinning is recorded; there are points with basal trimming. Some finds can be considered truncated-faceted items (Yeritsyan, 1975; Liagre et al., 2006; Adler et al., 2012; Stone Age…, 2014).

The researchers also attribute lithic artifacts from layers 7 and 6 of the Kalavan-2 site to the Late Middle Paleolithic. For layer 7, a radiocarbon date of 37.7 ± ± 0.9 cal ka BP was obtained (Ghukasyan et al., 2010; Stone Age…, 2014). The primary reduction was dominated by the Levallois strategy, which produced both points and blades. Within layer 6, in addition to these artifacts, radial cores were also found. Among the tools, Levallois points, Mousterian points, and side-scrapers are the most abundant. Upper Paleolithic tools, on the other hand, are infrequent and inexpressive, comprising end-scrapers, chisel-like tools, and burins. While truncation techniques were employed, there are no artifacts displaying ventral thinning (Ghukasyan et al., 2010).

The Gazma collection is fully consistent with the industries of these sites in terms of primary reduction, toolkit composition, specific shaping of some types of products, as well as raw material preferences. For these complexes, a number of researchers proposed the designation "Taglar-type industry", which refers to the name of the most representative and well-studied site of the Final Middle Paleolithic of the region (Golovanova, Doronichev, 2003). Importantly, the experts, while analyzing the archaeological materials of this time from the territory of Azerbaijan and Armenia as a whole, note their proximity to the Zagros Mousterian complexes, which testify to the combination of Levallois and parallel reduction strategies and include radial/disk-shaped cores (Varvasi, Kunji caves, etc.) (Dzhafarov, 1983; Lyubin, 1989; The Paleolithic Prehistory…, 1993; Doronicheva et al., 2023). The toolkits of Iranian sites are also dominated by side-scrapers and points (Levallois and Mousterian; angular side-scrapers, etc.), often elongated; truncation of blanks is widely represented; the number of truncated-faceted pieces and tools with basal trimming is noticeable (The Paleolithic Prehistory…, 1993; Dibble, McPherron, 2007; Tsanova, 2013; Heydari-Guran et al., 2021; Doronicheva et al., 2023).

## Conclusions

In Azerbaijan, the Middle Paleolithic industries appeared during the Late Khazarian period. The most ancient artifacts have been documented in the upper layers of Azykh Cave, their age corresponds to MIS 6 and 5 (Guseinov, 2010; Azokh Cave…, 2016). The subsequent stages of the Middle Paleolithic, particularly the final ones, are well represented by the materials from several stratified sites, also associated with rock grottoes (Taglar, Dashsalakhly, etc.), and have been studied in more detail. The lithic industry of Gazma, dating back to the first half of MIS 3, is a good example of a "Taglar-type" technocomplex (Golovanova, Doronichev, 2003). Determining the precise chronology of these materials remains one of the most challenging aspects of their study. Recently, a large series of ages have been obtained for the sites in Georgia and Armenia. However, for the Azerbaijan sites, there is only a small series of ESR ages (for the deposits of Azykh Cave) (Azokh Cave…, 2016). With this in mind, the new OSL ages for Gazma Cave should be considered key for the region, since they mark the upper boundary of the Middle Paleolithic in the eastern part of the South Caucasus.

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# Variability in the Sibiryachikha Assemblages of the Altai Mountains (Based on Materials from Okladnikov Cave Layer 2)

*This article, based on new data from comprehensive studies of assemblage from Okladnikov Cave layer 2, explores the variability of Middle Paleolithic Sibiryachikha variant of the Altai Mountains. Using methods such as scar pattern analysis, experimental use-wear analysis, attributive analysis, etc., we specify the characteristics of the assemblage by extending the nomenclature of technical flakes relating to radial flaking, evaluating the share of the bifacial component including bifaces, their fragments, and bifacial technical flakes, revising the typology of the tools. The Sibiryachikha assemblage of Chagyrskaya Cave layer 6c/1 is correlated with that of Okladnikov Cave layers 1 and 2, revealing not only common features but also differences in primary and secondary reduction. At Okladnikov Cave, unlike Chagyrskaya, the reduction cycle is incomplete, the tools are smaller, and the share of convergent scrapers and chips resulting from the processing of bifaces is higher. We conclude that the distinctive feature of Okladnikov industry is a considerably more intense modification of raw materials owing to their less availability. Because Okladnikov Cave is situated in the immediate vicinity of the sources of raw material, implying its abundance, we suggest that pebbles of suitable quality and size were less available. As a result, rejuvenation of lithic tools was more intense, and bifacial thinning flakes were used as tool blanks. The Okladnikov Cave industry reveals the complex behavioral models, previously unknown, among eastern Neanderthals, which do not rule out the import of bifacial tools or blanks made of high-quality raw material.*

Keywords: *Middle Paleolithic, Sibiryachikha variant, Altai Mountains, bifacial technology, model of raw material use, Neanderthals.*

## Introduction

In recent years, the studies of Paleolithic assemblages of North and Central Asia have been largely focused on the behavioral models of various species of ancient hominins over vast regions in various periods, on their migrations, and on the related changes in subsistence systems (Khatsenovich et al., 2019; Derevianko, 2020; Zolnikov et al., 2020; Barzilai et al., 2022). Important information about ancient populations is provided by the results of studies of human habitation in various ecological niches and adaptation to local paleoenvironmental conditions (Delagnes, Rendu, 2011; Turq et al., 2017; Rybin et al., 2022). Such studies often explain the technical and typological variability within a particular cultural community. They involve revisions of the known data and supplementary research using modern techniques; this helps not only to evaluate the findings in a new way, but also to obtain additional information (Uthmeier, 2013; Shalagina, Kolobova, Krivoshapkin, 2019; Kolobova et al., 2019).

Okladnikov Cave, located on the left bank of the Sibiryachikha River in the Anuy valley, can be a source of new information about the behavioral patterns of Neanderthals. The karst cavity, with a southern exposure, is located at an altitude of 368 m above sea level (Derevianko, Markin, 1992). The site was discovered by A.P. Derevianko and V.I. Molodin in 1984, and has been studied under the supervision of A.P. Derevianko, S.V. Markin, and V.T. Petrin for four years. By 1992, it had been excavated almost completely; the materials from the site were described in detail in the same year (Ibid.: 4). On the basis of several stratigraphic sections of the cave deposits, nine lithological layers were identified, among which five (layers 1–3, 6, and 7) contained cultural remains. The recent chronometric studies have shown that the age of Neanderthal remains from layers 2 and 3 of the cave is >40,000 and >44,000 BP (Vernot et al., 2021). In 2013, the Okladnikov Cave lithic industry, together with materials from Chagyrskaya Cave, were classified as the Sibiryachikha variant of the Altai Middle Paleolithic, which technical and typological characteristics differ from those of the Denisova and Kara-Bom variants of the region. The following features are specific to the Sibiryachikha variant: the predominance of radial flaking, the use of modifying secondary reduction, the dominance of side-scrapers of the déjeté type, scraper-knives, points, and bifaces in numerous toolkits, and a small proportion of Levallois spalls (Derevianko, Markin, Shunkov, 2013).

The present paper is focused on reconstructions of the behavioral models of Eastern Neanderthals by determining the features of the internal variability of the Sibiryachikha assemblages.

## Results

The assemblage from Okladnikov Cave layer 2 is a classic set of the Sibiryachikha lithic industry: like other industries of the cave, it shows radial and Levallois flaking, a high percentage of tools, with a dominance of déjeté-type side-scrapers, and a large amount of production waste (Derevianko, Markin, 1992).

*Table 1.* **Composition of the lithic industry from Okladnikov Cave layer 2**

| Artifact type | Spec. | % | %, omitting unidentifiable |
|---|---|---|---|
| Cores | 4 | 0.31 | 0.66 |
| Bifacial tools | 10 | 0.79 | 1.65 |
| Spalls: | 590 | 46.38 | 97.20 |
| blades | 14 | 1.10 | 2.31 |
| flakes | 410 | 32.23 | 67.55 |
| technical flakes | 164 | 12.89 | 27.02 |
| unidentifiable debitage | 2 | 0.16 | 0.33 |
| tools | 174 | 13.68 | 28.67 |
| Percussion-abrasive tools | 3 | 0.24 | 0.49 |
| Shatters | 163 | 12.81 | – |
| Chips | 502 | 39.47 | – |
| *Total* | 1272 | 100 | 100 |

The lithic industry includes 1272 artifacts, of which 52.3 % are production waste (Table 1). Primary reduction was targeted at the production of flakes (67.6 % of the total number of artifacts, excluding production waste) of trapezoidal*, triangular, and rectangular forms (44.9 %), in which the artifact's long axis most often coincides with the flaking axis (65.6 % of flakes). The assemblage contains four cores for the production of flakes: orthogonal, Levallois centripetal (Fig. 1, *1*), radial (Fig. 1, *2*), and narrow-faced. Three of these cores demonstrate the terminal stage of exhaustion. The 3D models were analyzed by Artifact 3D software (Grosman et al., 2022).

This set of cores corresponds well to the set of technical flakes (27 %), which is dominated by lateral flakes from radial cores (44 spec., 26.8 % of all technical flakes) (Fig. 1, *3*, *4*), lateral cortical (16.5 %), and lateral flakes (24.4 %) (Fig. 1, *5*). In the set of cores from Okladnikov Cave layer 2, numerous bifacial thinning flakes were identified, which were used in a plano-convex bifacial reduction sequence (22 %) (Fig. 1, *6*). Among the single technical flakes, the following forms

*Blanks for two bifacial tools are included in the flake category.

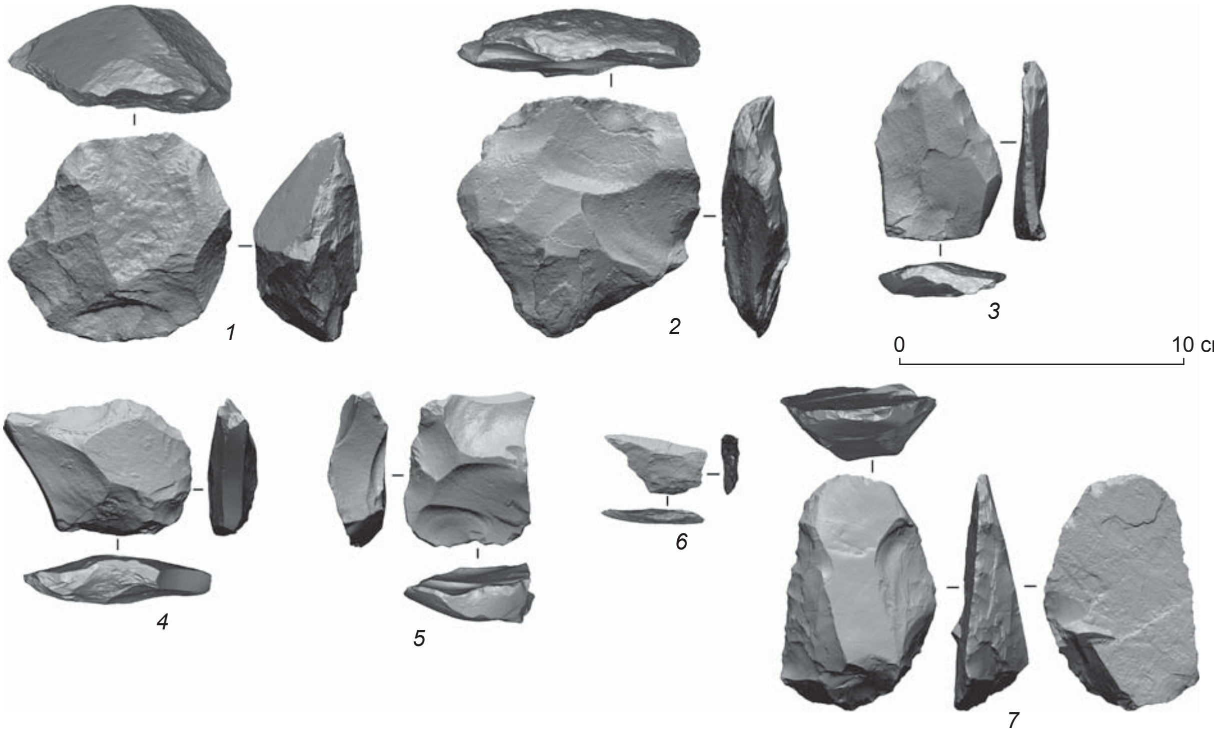


*Fig. 1.* Cores (*1*, *2*) and technical flakes (*3–7*) from the assemblage of Okladnikov Cave layer 2.
*1* – Levallois core; *2* – radial core; *3* – sub-leaf side-scraper on lateral flake from radial core; *4* – lateral flake from radial core; *5* – lateral flake; *6* – perforator on a bifacial thinning flake; *7* – sub-ovoid side-scraper on a split pebble.

were identified: technical flakes (*Kantenabschläge* – 2 spec.) (Fig. 2, *1*), associated with the preparation of striking platforms on radial cores; semi-crested and crested flakes (11 spec.) (Fig. 2, *14*); and citron flakes (2 spec.).

In addition to the signs of core and bifacial flaking, there were traces of pebble knapping on anvil, as well as the manufacture of tools on the resulting blanks (see Fig. 1, *7*) (Kharevich, 2022).

The paucity of primary flakes (38 spec., 6.1 % of all the spalls) and spalls retaining cortical dorsal surfaces over 75 and 50 % (17 and 25 spec.) suggests that the decortication of cores and, possibly, bifacial tools was carried out beyond the cave.

Most of the flakes, including those where the long axis coincides with the technical flaking axis, have unidirectional dorsal pattern (164 spec., 27.7 %). A significant share of flakes have orthogonal (42 spec., 7.1 %), semi-crossed and radial (67 items, 11.3 %), lateral and bilateral (23 spec., 3.9 %) scar patterns.

Among the identifiable residual striking platforms of the spalls, plain platforms (238 spec., 63.8 %) dominate; faceted platforms of various shapes (73 spec., 19.6 %) and dihedral/polyhedral platforms (45 spec., 12.1 %) are also numerous. At the same time, faceted platforms more often occur on flakes (25.2 %) than on technical flakes (11.9 %). Platforms of target spalls (blanks for the manufacture of tools) were faceted twice as often (31.3 %) than of those that were not fashioned into tools (15 %).

The toolset is dominated by convergent side-scrapers (Table 2) of various shapes (semi-crescent, semi-trapezoidal, sub-trapezoidal, sub-crescent, and sub-triangular), including those retouched along the entire perimeter of the blank (48.5 % of all formal tools) (see Fig. 2, *3–8*). Less numerous are simple side-scrapers (see Fig. 2, *2*, *11*), retouched points (see Fig. 2, *9*, *12*), and bifacial tools (Fig. 3, *1–3*). The toolkit demonstrates various types of modifying retouch, including the Quina type (see Fig. 2, *5*, *7–9*, *12*).

Bifacial tools from the layer 2 toolkit are noteworthy. There are 10 bifacial tools in total: 6 complete items, 3 fragmented items, and 1 blank (see Fig. 3, *1*). More than half of the tools were made on spalls; for other tools, blanks are indeterminate, since they were subjected to extensive processing. Complete tools can be subdivided into trapezoidal (see Fig. 3, *2*), leaf-shape (see Fig. 3, *3*), crescent, and triangular in shape. According to the results of the scar pattern analysis (Shalagina, Krivoshapkin, Kolobova, 2015), all bifacial tools from layer 2 were shaped using the plano-convex technique. Notwithstanding that blanks were often

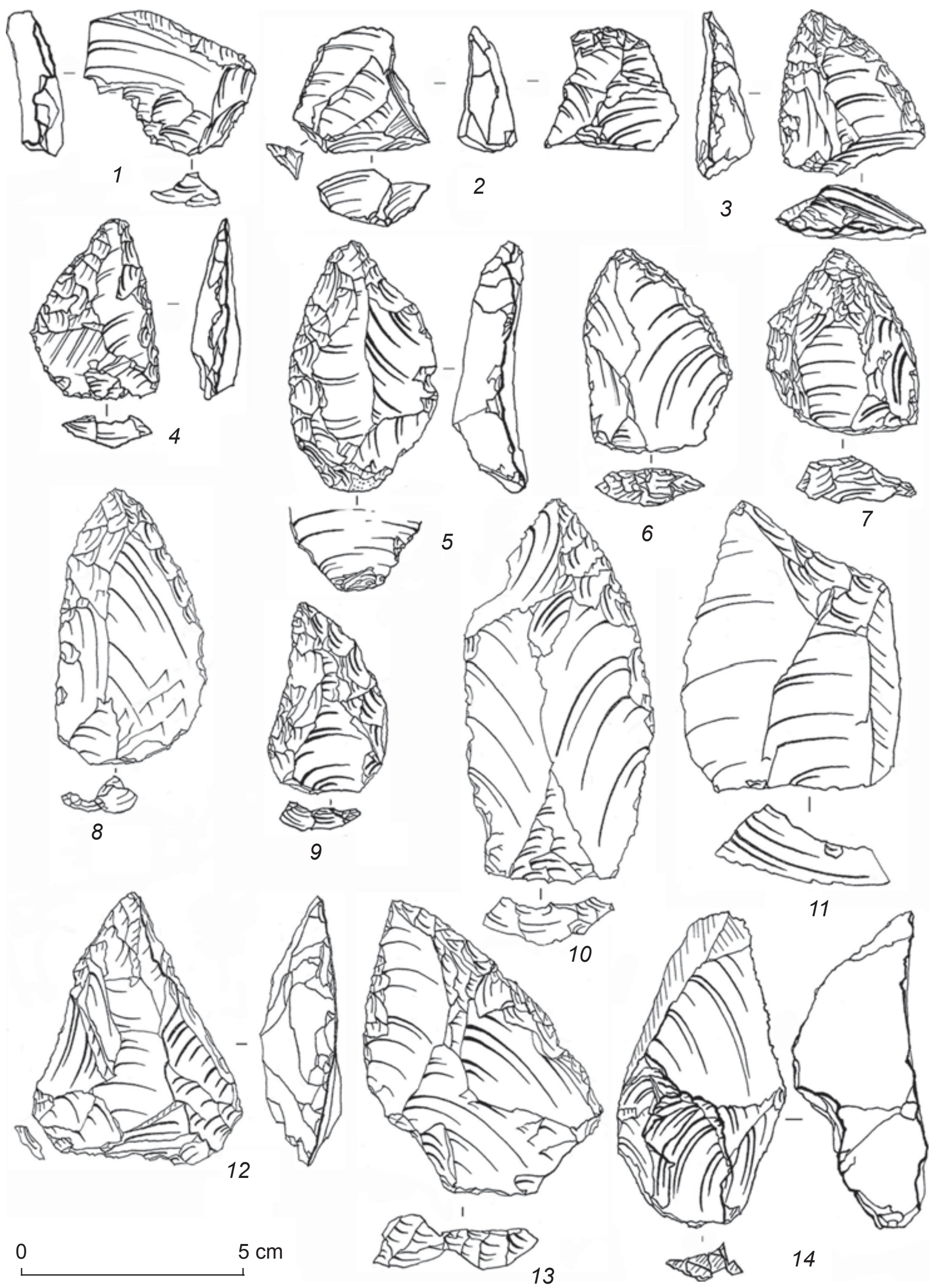


*Fig. 2.* Technical flakes (*1*, *14*) and tools (*2–13*) from the assemblage of Okladnikov Cave layer 2.
*1* – technical flake (*Kantenabschläge*); *2* – transversal side-scraper on a lateral flake from radial core; *3*, *7* – sub-triangular side-scrapers; *4*, *6*, *13* – sub-trapezoidal side-scraper; *5* – leaf-shape side-scraper, alternative; *8* – sub-leaf side-scraper; *9* – sub-leaf point; *10* – longitudinal convex side-scraper; *11* – diagonal side-scraper; *12* – triangular point; *14* – crested spall.

flakes (see Fig. 3, *2*), both faces of most items show extensive processing following the "long" reduction sequence (see Fig. 3, *3*). Both ventral and dorsal surfaces of the flakes were treated equally extensively.

The share of the bifacial thinning chips makes up 35.8 % of the identifiable chips in the assemblage (88 spec.). Six artifacts in the toolkit were fashioned on bifacial thinning flakes (see Fig. 1, *6*).

Use-wear analysis of pebbles, slabs, and shatters from Okladnikov Cave layer 2 made it possible to identify three lithic percussion-abrasive tools: a hammerstone and two anvils for the retouch of lithic tools (see Fig. 3, *4*).

*Table 2*. **Type list of the lithic industry from Okladnikov Cave layer 2**

| Tool types | N | % | %, omitting unidentifiable |
|---|---|---|---|
| Retouched points | 15 | 8.15 | 9.09 |
| Side-scrapers: | 132 | 71.74 | 80.00 |
| simple | 37 | 20.11 | 22.42 |
| convergent | 80 | 43.48 | 48.49 |
| unidentifiable | 15 | 8.15 | 9.09 |
| Bifacial tools | 10 | 5.43 | 6.06 |
| Truncations | 2 | 1.09 | 1.21 |
| Notches | 1 | 0.54 | 0.61 |
| Perforatores | 5 | 2.72 | 3.03 |
| Retouched flakes | 14 | 7.61 | – |
| Retouched blades | 3 | 1.63 | – |
| Unidentifiable tools | 2 | 1.09 | – |
| *Total* | 184 | 100.00 | 100 |

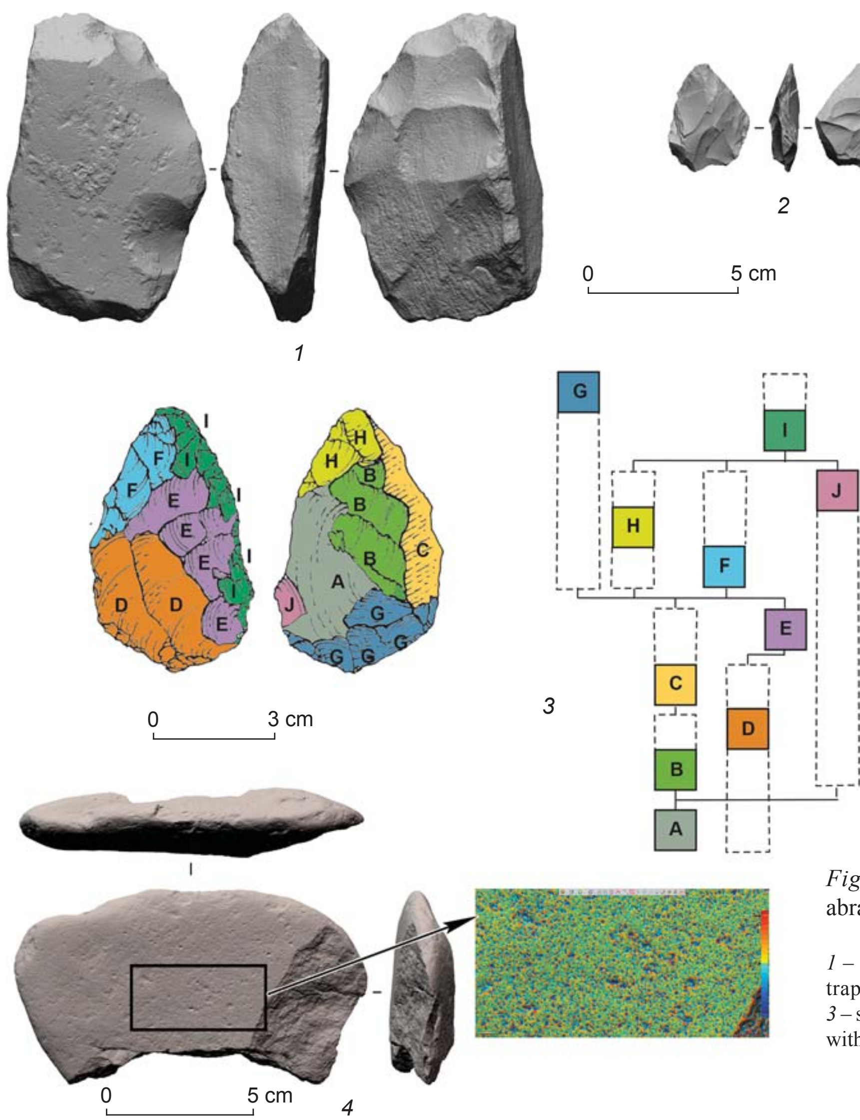


*Fig. 3*. Bifacial (*1–3*) and percussion-abrasive (*4*) tools from the assemblage of Okladnikov Cave layer 2.
*1* – blank of bifacial tool with back; *2* – semi-trapezoidal bifacial side-scraper with back; *3* – scar pattern analysis of sub-leaf side-scraper with back; *4* – anvil for the retouching of lithic tools.

## Discussion

Archaeological materials from Okladnikov Cave layer 2 indicate that the primary knapping was aimed at the detachment of trapezoidal, rectangular, and triangular flakes from radial, orthogonal, and Levallois cores. The typology of technical flakes corresponds to the reduction of cores through radial and, possibly, narrow-faced knapping techniques. This conclusion is supported by the scar patterns, mainly unidirectional and orthogonal/sub-cross/radial. The presence in the collection of six bifacial side-scrapers, fragments, and blanks of bifacial tools suggests plano-convex bifacial processing. This technique is illustrated by 22 % of bifacial thinning flakes and 35.8 % of bifacial thinning chips. This study, for the first time for this industry, has revealed evidence of pebble knapping on anvil, as well as the anvils for retouching tools, and a hammerstone.

The complexes of the Okladnikov and Chagyrskaya caves constitute the Sibiryachikha variant in the Middle Paleolithic of the Altai Mountains; the variant is characterized by a combination of core and bifacial knapping, the dominance of radial flaking, the production of flakes with mismatched flaking and long axes, and numerous toolkits dominated by various side-scrapers including déjeté varieties (Derevianko, Markin, Shunkov, 2013).

A recent comparative analysis of the Sibiryachikha industries at a qualitatively new level has provided additional data on their internal variability. The assemblages from layers 1 (Kolobova et al., 2022) and 2 from Okladnikov Cave, as well as layer 6c/1 of Chagyrskaya Cave (Mezhdistsiplinarniye issledovaniya…, 2018) were compared. The analysis of the components of these industries showed that the primary knapping was dominated by radial and orthogonal techniques, while the total number of cores was small. The Okladnikov Cave assemblages yielded the Levallois cores that were atypical of the Chagyrskaya Cave collection (see Fig. 1, *1*), and the associated spalls (Derevianko, Markin, 1992; Kolobova et al., 2022). Technical flakes were identified, with a predominance of lateral flakes from radial cores and various core-edge flakes (Mezhdistsiplinarniye issledovaniya…, 2018). The industries under study illustrated the use of the technique of pebble knapping on anvil and the subsequent use of the obtained blanks for the production of uni- and bifacial tools (Shalagina et al., 2020). In general, all the industries were aimed at the detachment of trapezoidal, rectangular, and triangular flakes with plain and faceted straight striking platforms.

The analysis of the axis of scar pattern has shown a significant difference between the industries of the Okladnikov and Chagyrskaya caves. The materials of Chagyrskaya Cave are dominated by spalls with mismatched long and flaking axes (60.9 %); in contrast, both lithic assemblages of Okladnikov Cave contain spalls with coinciding axes (layer 1 – 59.2 %; layer 2 – 65.6 %).

In the Chagyrskaya Cave assemblage, flakes without cortex make up 56.5 %, and primary flakes 11.4 %; on this basis, it was preliminarily concluded that the site represents a complete sequence of primary reduction, from decortication to the manufacture and rejuvenation of tools (Mezhdistsiplinarniye issledovaniya…, 2018). The Okladnikov Cave industries are characterized by their smaller share of primary flakes (layer 1 – 9.3 %, layer 2 – 6.1 %), which suggests that the processes of decortication were carried out beyond the site.

All the Sibiryachikha industries show a significant bifacial component: bifaces made using plano-convex technique; bifacial thinning flakes; tools on bifacial thinning flakes (see Fig. 1, *6*); and bifacial thinning chips. However, in the Chagyrskaya collection, only 18 % of identifiable chips are the products of bifacial thinning, while the relevant share in Okladnikov Cave layer 2 is 35.8 %, suggesting more intense processes of treatment and rejuvenation of working edges of tools. In all the assemblages, bifacial thinning flakes range from 18 to 22 %.

Among the tools on flakes, side-scrapers dominate in all the assemblages, including convergent ones (from 70.9 % in Chagyrskaya Cave layer 6c/1 to 80 % in Okladnikov Cave layer 2). The Chagyrskaya collection is dominated by simple types of side-scrapers, mainly single-edged (54.2 %); while in the Okladnikov Cave assemblages, convergent forms prevail, i.e. those with working edges prepared over 1/2 or a greater part of the tool perimeter (layer 1 – 57.8 %, layer 2 – 60.6 %). In addition, the Okladnikov collections contain more tools fashioned on bifacial thinning flakes (3 spec. in layer 1 and 6 spec. in layer 2) than the Chagyrskaya collection (1 spec.).

The comparison of the toolkits of the studied collections by their numbers of simple, convergent side-scrapers and bifacial tools has shown that the Okladnikov Cave assemblages contain a greater proportion of convergent side-scrapers and a slightly larger proportion of bifaces, which numbers significantly exceed those of Chagyrskaya Cave (Fig. 4). A Kruskal-Wallis test of metric indicators of the tools in all the three complexes (since the samples are not normally distributed) did not reveal any differences in the lengths of tools, but showed a width mismatch: the tools from Okladnikov Cave are narrower than those from Chagyrskaya Cave (H – 10.42, $p$ – 0.005). This discrepancy is most likely due

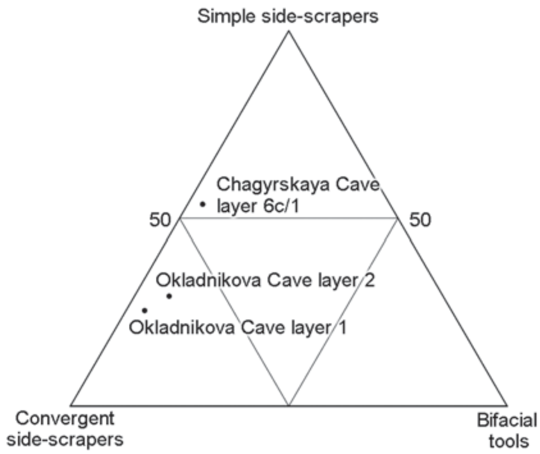


*Fig. 4*. Ternary plot displaying the proportions of simple, convergent side-scrapers and bifacial tools in the Sibiryachikha assemblages.

to the greater intensity of utilization and rejuvenation of tools in Okladnikov Cave. The calculations were carried out in the PAST3 software (Hammer, Harper, Ryan, 2001).

The study has shown that bifacial tools from Okladnikov Cave layer 2 correspond to the general trends in the production of bifaces in the Sibiryachikha variant of the Altai Middle Paleolithic (Kharevich, 2022). At the same time, the differences between this collection and that of Chagyrskaya Cave are noteworthy. The Okladnikov tools were subjected to a more intense processing. This is evidenced by the results of scar pattern analysis and the tools' morphology. In addition, bifacial tools from Okladnikov Cave, unlike those from Chagyrskaya, are represented mainly by the items with multiple retouched edges or with traces of continuous treatment along the margins. Notably, the Okladnikov bifaces are much smaller than those from Chagyrskaya Cave (see Fig. 3, *2*).

## Conclusions

The attributive analysis has provided significant details concerning the lithic industry from Okladnikov layer 2. For example, an important bifacial component was identified, including plano-convex tools (10 spec.), bifacial thinning flakes (1/4 of the technical flakes), bifacial thinning chips (1/3 of all chips), and tools made on bifacial thinning flakes (6 spec.). The technique of pebble knapping on an anvil and the subsequent manufacture of tools on the resulting spalls have been recorded. Three percussion-abrasive tools were found, including two anvils for the retouch of lithic tools. The technical flake category comprises lateral flakes from radial cores, typical of the prevailing radial flaking technique.

The comparison between the Sibiryachikha assemblages under study revealed not only similar features—for example, in the primary reduction, a set of technical flakes, toolkit, etc.—but also specific traits: in the primary reduction technique, there is the dominance of spalls with coinciding long and flaking axes in the Okladnikov Cave and spalls with mismatched axes in the Chagyrskaya. Unfortunately, a comparison of the bone industries from these sites is impossible, because the Okladnikov bone collection is missing; however, it can be assumed that it contained a significant number of bone retouchers (Baumann et al., 2020).

The characteristics of the Okladnikov Cave assemblages, such as a large number of convergent side-scrapers, small size of tools on spalls, occurrence of tools made on the bifacial thinning flakes and those reshaped after breakage, a high degree of modification and small size of bifacial tools, and a great number of thinning flakes from bifaces/scrapers, indicate a shortage of raw materials.

The petrographic data from previous studies suggest that most of the tools from Okladnikov and Chagyrskaya were made from local raw materials—primarily high-quality Zasurye jasperoids. The inhabitants of Okladnikov Cave used pebbles from the alluvium of the Sibiryachikha and Sibiryachonok rivers. The Neanderthals selected Zasurye jasperoids, sandstones, and sandy siltstones. In the cave lithic collection, 2–12 % of artifacts were made of effusive rocks of the Anuy type, occurring in the Anuy River bed, 3 km from the site (Derevianko et al., 2015). Judging by the archaeological data, inhabitants of Okladnikov Cave brought there predominantly ready-made tools or blanks, because there was probably less raw material of suitable quality and size in its vicinity than near Chagyrskaya Cave. Most of the heavily modified tools were made from Zasurye jasperoids; apparently, the pebbles of this rock were rare.

The shortage of raw materials in the area around Okladnikov Cave determined its more economical use, more thorough modification of lithic pieces, and more frequent rejuvenation of tools than in the Chagyrskaya lithic industry. This influenced the size of the tools and the typological structure of the toolkits. Tools were manufactured from any suitable blanks, including numerous spalls detached during biface manufacturing, specific chips resulting from tool rejuvenation, and anvils for retouching.

The internal variability of the Sibiryachikha assemblages is the result of the adaptation of the ancient population of Okladnikov Cave to the scarcity of raw materials; it is reflected in various technological characteristics of the assemblages, such as the coincidence of the technological axis of most flakes with the long axis, and signs of the use of Levallois technique. To understand the essence of this variability, further careful studies of the archaeological collections from Chagyrskaya and Okladnikov caves are required.

The Altai Middle Paleolithic sites, in contrast to the contemporaneous complexes of other regions (Middle East, Europe), are located near sources of lithic raw materials (Postnov, Anoikin, Kulik, 2000; Rybin, Kolobova, 2009). This excludes the possibility of conducting classic research on the export-import of raw materials or tools and tracing the links between separate regions. The Okladnikov lithic industry shows that even in the proximity of raw materials sources, Neanderthals practiced quite complex behavioral patterns of, which did not preclude the possibility of transporting tools or blanks to the site.

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# Spatial Structures of the Initial/Early Upper Paleolithic at Tolbor-21, Northern Mongolia

*This article describes the spatial structures of archaeological horizon 4 at Tolbor-21 in northern Mongolia, on the basis of data from 2015–2017. The presence of non-utilitarian items, faunal remains with traces of human impact, and the use of fire render this site near outcrops of raw materials promising for the reconstruction of the spatial organization of Early Upper Paleolithic sites in northern Mongolia. Spatial analysis included visual observations and statistical procedures (clustering with two algorithms) aimed at identifying patterns in the distribution of finds in various areas. The influence of natural processes on the distribution of artifacts was evaluated with fabric analysis based on the positions of the long axes of finds. As a result, it was found that solifluction variously affected the archaeological horizon in different parts of the slope. The effect was strongest in excavation 2, where two possibly overlapping episodes of fire-related activity have been reconstructed. Nevertheless, it is possible to separate two complexes differing in terms of finds, including significantly modified tools and bones with traces of human impact ("fireplace 1") and a concentration of small artifacts ("fireplace 2"). In the upper part of the slope (excavation 4), near the stone structure, an accumulation of cores at the advanced reduction stages is reconstructed, as well as an area where ungulate carcasses were butchered. An area associated with primary reduction has been separated in excavation 1. The differential use of the camp area by its inhabitants seems to be an important feature of the subsistence strategy of the population of northern Mongolia during the initial stages of the Upper Paleolithic.*

Keywords: *Northern Mongolia, Initial Upper Paleolithic, Early Upper Paleolithic, spatial analysis, fabric analysis, spatial clusterization.*

## Introduction

Archaeological data derived from the open-air sites in northern Mongolia (Tolbor-4, -16 and -21, Kharganyn-Gol-5) indicate that this area was inhabited by the humans producing the lithic industries of the initial stages of the Upper Paleolithic (Derevianko et al., 2013; Khatsenovich et al., 2017; Zwyns et al., 2019; Rybin et al., 2020). Dozens of sites along the Tolbor and Kharganyn-Gol rivers (tributaries of the Selenga River) share such common features as the proximity of outcrops of silicites suitable for making tools and the geomorphological position on the gentle slopes of southern exposure (Rybin, 2020: 129). Similar environmental features raise the question of identification of the subsistence strategy of the ancient population of the region. Along with the proximity to the outcrops of raw materials, the presence of non-utilitarian items, well-prepared tools, and traces of the use of fire (Rybin, 2020: 141, 169; Khatsenovich et al., 2017; Gallo et al., 2021) suggests a more complex organization of sites rather than workshops.

Spatial analysis of the sites of the Tolbor group is hampered by the noted features of disturbances of archaeological horizons. Deposits were formed on gentle slopes under the conditions of low sedimentation rate and high soil acidity, and were often affected by solifluction and diluvial-proluvial processes (Kolomiets et al., 2009; Zwyns et al., 2019; Rybin et al., 2020; Gallo et al., 2021). This paper presents the analysis of the spatial distribution of artifacts within archaeological horizon 4 (hereinafter AH4) at Tolbor-21. The influence of the natural processes on the distribution of artifacts, as well as the patterns of the ancient human behavior, have been assessed through statistical methods.

## Materials and methods

The multi-layered site of Tolbor-21 is located in the middle reaches of the Tolbor River (49.26306 N, 102.95778 E), at an altitude of 1089 m above sea level (Fig. 1). The site was discovered in 2011 (Tabarev et al., 2012); excavations have been ongoing since 2014. We examined materials from excavation 1 (hereinafter E1) in the medial part of the slope, and excavations 2 and 4 (E2 and E4) at the eastern side of the slope (Fig. 1); the analysis of the artifact collections from these excavations have been completed (2015–2017).

Archaeological horizon 4 (AH4) was identified within a layer of laminar loess-like deposits over the entire area of the site (Fig. 2). The calibrated radiocarbon dates obtained on collagen from bones from various parts of the layer are in the range of 42.4–41.9 ka BP (OxCal 4.4, IntCal20) (Rybin et al., 2020). The lithic industry, aimed at the production of large and medium blades, included the tools marking the Initial Upper Paleolithic and belonged to the boundary between its initial and early stages (Rybin, 2020: 149–159). The faunal materials represent steppe biota (Rybin et al., 2019).

The study of the state of preservation of the archaeological horizon included, apart from geological data, the assessment of the orientation of the long axes of the finds (lithic artifacts and bones) using "fabric analysis" (Bertran, Texier, 1995), which was carried out with R code by S. McPherron (2018) in the R core software (R Core Team, 2023).

For spatial analysis, the finds were subdivided into seven categories (see *Table*). Target (blanks) and non-target spalls were distinguished by metric features with respect to the basic specifics of the spall assemblage (Rybin, 2020: 153–157, tab. 83–85). The tools were classified according to the degree of modification, taking into account two parameters: 1) length of the margins processed with retouch; 2) degree of modification of the primary area: minor (facets occupy <2 mm from the edge), moderate (2–4 mm), and heavy (>4 mm) (Kolobova, 2004: 37–39). This classification served as the basis for establishing groups of tools according to their degree of surface modification through secondary working: from minor to heavy. The analysis was based on two clustering algorithms. The clustering tendency of the finds was tested through Hopkins statistic, which determines the measure of their spatial randomness (Adolfsson, Ackerman, Brownstein, 2019). The k-means method was used to establish the distribution patterns (Kintigh, Ammerman, 1982). The "unconstrained clustering" algorithm (Whallon, 1984) identifies adjacent grids with similar proportions of artifact categories. The significance is tested through an estimate of the probability of formation of a cluster of the same size in random data.

## Results

The analysis of the geological structure of the profiles revealed traces of solifluction in the deposits at all the three excavations (Rybin et al., 2020). The analysis of orientations of AH4 (see Fig. 1) in E1 showed no post-depositional disturbances: there is no dominant

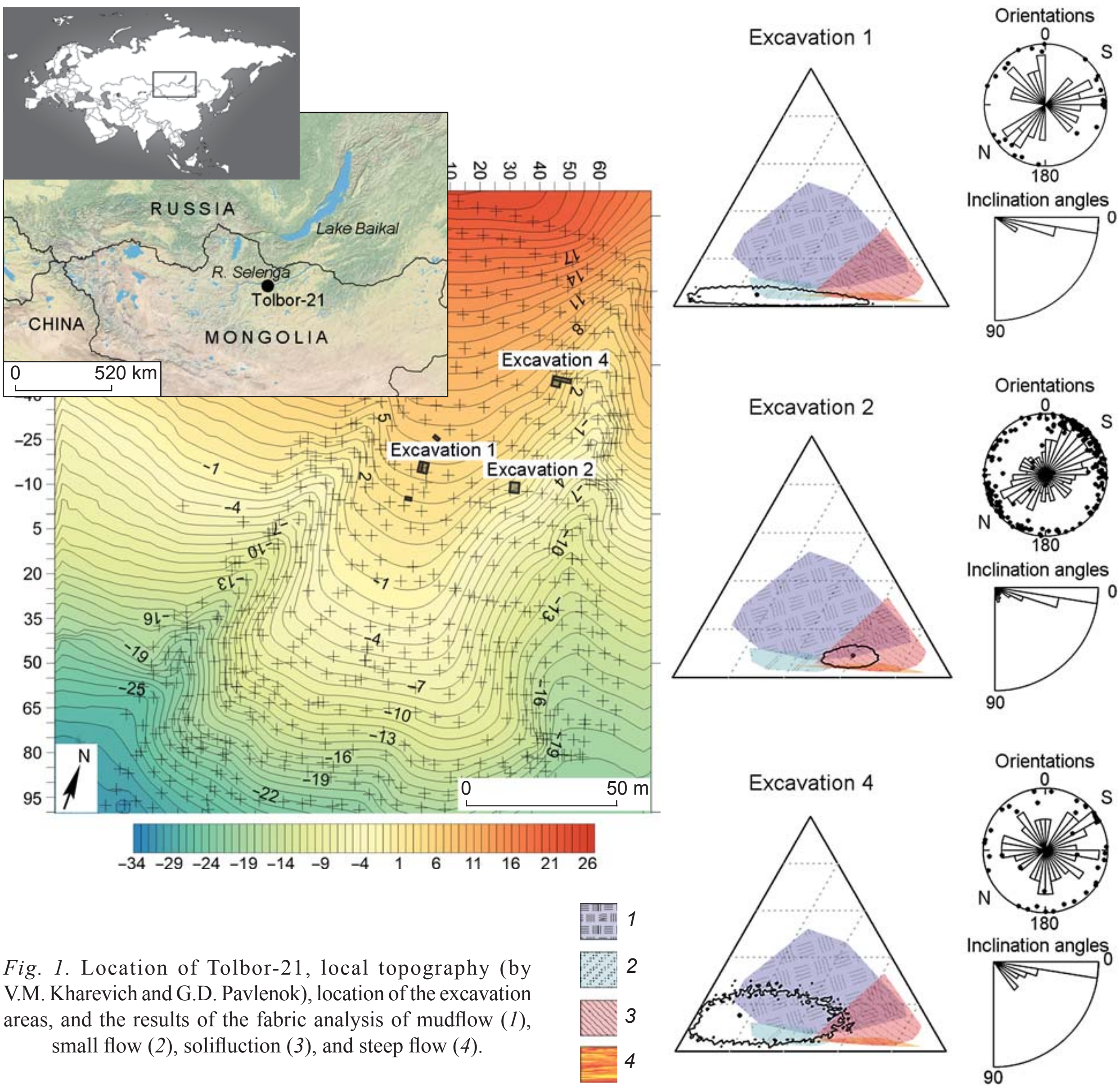


*Fig. 1*. Location of Tolbor-21, local topography (by V.M. Kharevich and G.D. Pavlenok), location of the excavation areas, and the results of the fabric analysis of mudflow (*1*), small flow (*2*), solifluction (*3*), and steep flow (*4*).

orientation of the elongated finds; the median angle of the artifacts' inclination is consistent with the general inclination of the horizon. In E2, the impact of solifluction is evident. In E4, the suspended position of the finds in the profile indicates a significant effect of slope processes. Shifting is also traced in the form of a line of elongated artifacts with large angles of inclination (D2, E2, E3), stretching across the slope (see Fig. 2, *c*).

The spatial analysis showed a low density of finds and no tendency for their clustering in E1 (see *Table*). The "unconstrained clustering" algorithm revealed a homogeneous composition of the finds (cluster I, $p = 0.02$). The different composition of the finds along the D-line is probably explained by the less detailed recording in this plot, without a tachymeter (Fig. 3, *a*).

In E2, the density of solitary finds is 3 times higher and the density of small (<2 cm) artifacts is more than 5 times higher than in E1 and E4 (see *Table*). Two complexes of traces of burning have been distinguished here: a layer of sandy loam with charcoal lenses of a total thickness of 5–10 cm, and a thin (≈1 cm) calcined layer. The former layer is located lower on the slope—in grids N12 and M11, the latter upper layer—in grids M10, M11, N10 (see Fig. 2, *b*). The above dates have been generated on the bones located at the borders of these complexes, along with other things, which indicates a narrow chronological range for their use.

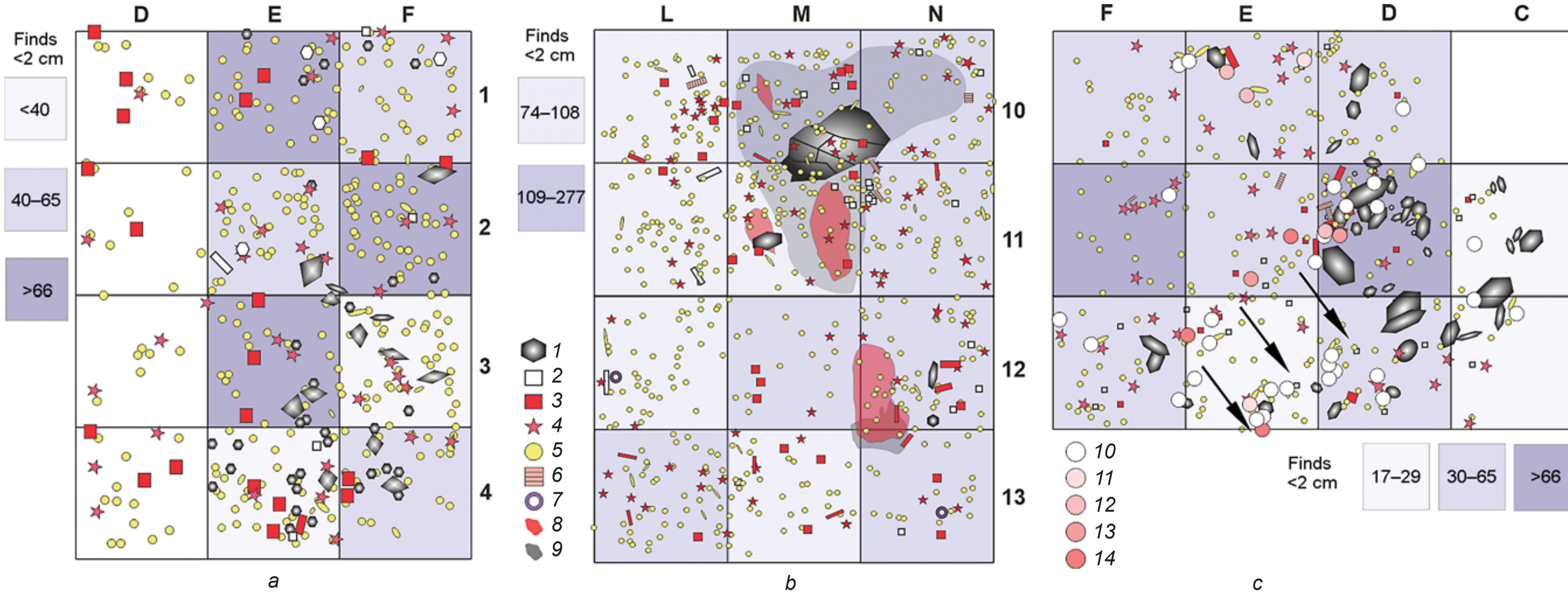


*Fig. 2.* Patterns of distribution of finds in E1 (*a*), E2 (*b*), and E4 (*c*) by categories.
*1* – large stones; *2* – bones; *3* – cores; *4* – tools; *5* – other lithic artifacts; *6* – bones with traces of human impact; *7* – non-utilitarian items; *8* – burnt soil; *9* – carbonaceous spot; *10–14* – elongated finds with various inclination angles (in degrees): *10* – 0–10; *11* – 10–20; *12* – 20–30; *13* – 30–40; *14* – 40.0–49.9. Arrows show the direction of finds' shifting.

**Number of finds in excavations and the tendency towards spatial clusterization according to Hopkins statistics (*H*)**

| Excavation | Cores | | Pre-forms | | Core-trimming elements | | Non-target spalls | | Target spalls | | Tools | | Bones | | Total number of solitary finds | | Study area (m²) | Density of distribution of solitary finds | Small artifacts (<2 cm) | *H* value |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total | % | Total | % | Total | % | Total | % | Total | % | Total | % | Total | % | Total | % | | | | |
| E1 | 17 | 6.67 | 5 | 1.96 | 22 | 8.63 | 95 | 37.25 | 76 | 29.80 | 35 | 13.73 | 5 | 1.96 | 255 | 100 | 12 | 21.25 | 433 (from 8 m²) | 0.48 |
| E2 | 28 | 2.73 | 14 | 1.36 | 110 | 10.71 | 431 | 41.97 | 269 | 26.19 | 130 | 12.66 | 45 | 4.38 | 1027 | 100 | 12 | 85.58 | 3753 | 0.48 |
| E4 | 19 | 6.93 | 5 | 1.82 | 36 | 13.14 | 73 | 26.64 | 88 | 32.12 | 36 | 13.14 | 17 | 6.20 | 274 | 100 | 12 | 22.83 | 559 | 0.46 |

*Note. H* values around 0.5 imply an even distribution of data; $H < 0.3$ indicates the tendency towards clusterization of data.

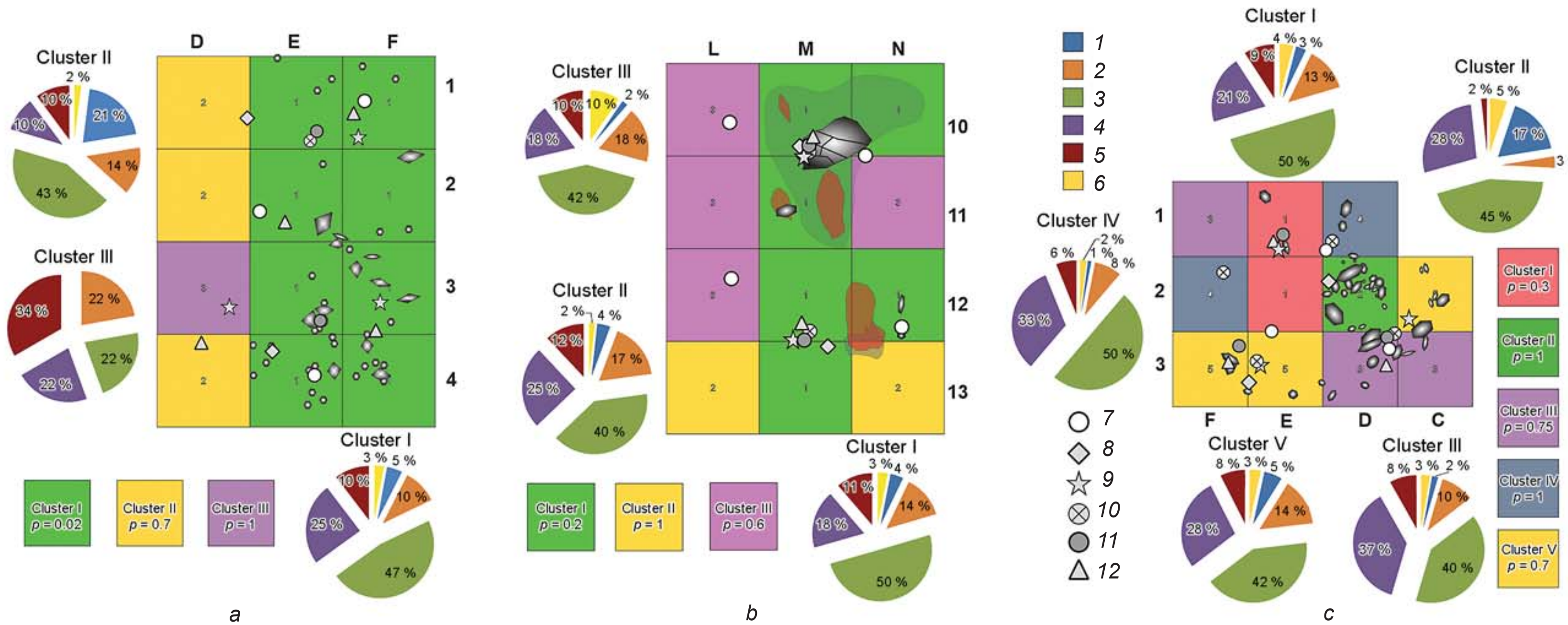


*Fig. 3*. Clusterization results in E1 (*a*), E2 (*b*), and E4 (*c*).

Pie charts show the percentage composition of clusters with unconstrained clustering: *1* – cores; *2* – core-trimming elements; *3* – non-target spalls; *4* – target spalls; *5* – tools; *6* – bones. Symbols on the plans indicate the centers of clusters generated using the k-means algorithm of the following categories of finds: *7* – bones; *8* – cores; *9* – core-trimming elements; *10* – non-target spalls; *11* – target spalls; *12* – tools.

No trend towards clustering of the finds has been noted in E2 (see *Table*); k-means clustering did not reveal any differences in the distribution of artifact categories: the centers of clusters of most categories coincide (see Fig. 3, *b*).

In E4, a stone structure, including two elongated stones (lying perpendicular to one another) and several smaller stones, has been recorded (see Fig. 2, *c*, sq. D2). Given a low density of finds (see *Table*), artifacts and a few bones are grouped near the stone concentration. The analysis showed that four of the five found ungulate bones bearing traces of human impact were concentrated at the fireplace. The most common type of impact is indentations resulting from bone-breaking in order to extract bone marrow and fat; these traces suggest a butchering zone here (Rybin et al., 2019). Clustering by category showed that only cores formed a cluster centered in sq. D2 (see Fig. 3, *c*). Eleven out of 24 cores in E4 were concentrated near the stone structure.

## Discussion

The analysis of the state of preservation of the archaeological horizon has shown that solifluction was the dominant process, but the degree of its effect on the distribution of artifacts, orientations, and angles of inclination of elongated artifacts is different in different parts of the solifluction lobe (Nelson, 1985; Bertran, Texier, 1995). The various states of preservation of AH4 depend on the position of the excavations in the frontal (E2) or middle/distal (E1) part of the solifluction "tongue".

Excavation 2 did not reveal any clear spatial structure, which fact could be explained by solifluction, or by the overlapping of traces of several episodes of human habitation. The high concentration of finds and the overlapping of one complex of traces of burning by another testify to a palimpsest, which is an obstacle to deciphering the distribution pattern (Leonova, 1994: 132). Solifluction could have caused the deformation of the original spatial distribution of the finds; however, some accumulations cannot be explained by this process (concentration of bones in sq. M11, N11, tools in sq. L10; see Fig. 2, *a*). In addition, the traces of burning, although deformed, retain their internal structure (carbonaceous interlayer and calcination). Therefore, we assume that spatial structures associated with the use of fire were not destroyed by solifluction. Taking into account the small area of the overlapping traces of burning (line 11), these complexes can be distinguished. The upper one ("fireplace 1") includes the bulk of the finds from sq. L–N/10–11, with a concentration of bones and tools, including heavily modified artifacts; the lower complex ("fireplace 2") includes most of the finds from sq. L–N/12–13, with a significant proportion of small artifacts and bones.

In E4, despite the fact that the artifacts might have been concentrated at the stone structure owing to slope shifting, the composition of the assemblage indicates an anthropogenic origin. An accumulation of bones with butchering marks and cores among natural blocks of raw materials, showing signs of pre-testing and discarded *in situ*, a small number of core-trimming elements and crust-retaining flakes (most pieces have no crust, several specimens have it on only 40 % of the surface, and only one retains the crust over 90 % of the surface), as well as tools, distinguishes this plot from the rest of the E4 area. Thus, the stone structure was a storage place for the prepared cores, which were partially knapped outside. The concentration of ungulate bones with traces of butchering (Rybin et al., 2019) suggests subsistence activities.

Comparison of cores by the areas retaining natural crust on the flaking-surfaces has shown that in E4 the proportion of cores at the initial reduction stages is higher than in other excavations. In E1, cores show various stages of reduction; 15 % of spalls (including tools) retain >40 % of crust (greater than in E2 and E4), and spalls without crust make up the smallest percentage as compared to other excavations. In E2, cores at the terminal reduction stages account for the largest share (46 % of cores without crust on the flaking surface); the share of spalls without crust is larger (71 %) than in other areas. The intensity of stone reduction (Rybin, 2020) in E2 is the lowest: six unretouched spalls per tool (8:1 and 10.4:1 in E1 and E4, respectively).

Thus, Tolbor-21 shows an example of the evident zoning of the site and implies the prospects of spatial investigation of the Tolbor sites. Owing to the poor conditions of preservation, these studies are quite few now; but the available data indicate traces of spatial organization also at other sites of the region (Tolbor-15 (Khatsenovich et al., 2015), Tolbor-4 (Marchenko, Rybin, Khatsenovich, 2020)). The southern part of Western Transbaikalia, connected with northern Mongolia through a passageway along the Selenga valley, reveals a similar development of material culture (Rybin, 2020: 372); this area seems to be promising in terms of searching the parallels in the spatial organization of ancient sites. At the Transbaikalian sites of the initial and early Upper Paleolithic, researchers have described accumulations of stone tools and bones, hearths of various designs, stone structures, and buried household objects (Konstantinov, 1994: 49–50; Lbova, 2000: 46–47, 107; Tashak, 2016: 48–70).

## Conclusions

As a result of the study, a differentiated effect of solifluction was revealed in various parts of the Tolbor-21 site. Spatial analysis showed zones of different activities in AH4. E1 is the area with spatially unstructured traces of core reduction. E2 is a continuous accumulation of artifacts, deformed by solifluction, yet showing traces of burning, partially overlapping one another. In the upper part of the slope (E4), closer to the rocky outcrops, the activity was arranged around a small stone structure, which was probably used to store cores at the advanced reduction stages and associated with the butchering of animal carcasses. The involvement of a wider range of methods, primarily traceological analysis, will make it possible to clarify the functional specifics of the selected areas.

The differential use of the area seems be an important feature of the organization of activities at the sites near the outcrops of raw materials. Separation of production zones (E1) from economic ones associated with heating and, probably, food consumption (E2), as well as zone for butchering and storing prepared cores (E4), suggests a developed subsistence strategy of the population producing the Initial/Early Upper Paleolithic industry in northern Mongolia; this strategy was adapted to the conditions of raw material delivery and availability of game animals.

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# A Complex of Stratified Upper Paleolithic Sites in the Foothills of the Northern Tien Shan: General Data and Research Perspectives

*This article examines the key cultural trends and events in the evolution of the Upper Paleolithic in the foothills of the Northern Tien Shan (Zailisky Alatau, Kazakhstan). It outlines the history of Paleolithic studies in southeastern Kazakhstan. We describe the geographic characteristics of the region, the geomorphological positions of sites, and features of sedimentation that influenced the preservation of cultural remains in situ. Archaeological materials from key Upper Paleolithic sites are reviewed, including those from stratified sites—Maibulak, Rakhat, and Uzynagash-1, -2. Lithic industries and absolute dates suggest that Maibulak was permanently inhabited during the Early, Middle, and probably Late Upper Paleolithic, materials from the early stages being the most expressive. Early Upper Paleolithic industries display Aurignacian-like characteristics and are paralleled by certain Western Eurasian industries of the same age. The multicomponent site of Rakhat was peopled during the end of the Early Upper Paleolithic, in the Middle Upper Paleolithic, and at the beginning of the Late Upper Paleolithic, documenting the evolution of Upper Paleolithic cultures during the ~30–23 cal ka BP interval. The industries of Rakhat include an Aurignacian-like one, a Middle Upper Paleolithic complex with micro-Gravette-like points, and one with geometric artifacts shaped as scalene triangles. For the first time, results of excavations and prospects of future studies at the new sites Uzynagash-1 and -2, dating to the late Early Upper Paleolithic, are outlined. We conclude that Upper Paleolithic cultures (or industries) of the foothills of the Northern Tien Shan are original, while following a single vector with the Upper Paleolithic of Western Eurasia.*

Keywords: *Northern Tien Shan, Upper Paleolithic, Maibulak, Rakhat, Uzynagash, loess, lithic industry.*

## Introduction

Before the early 2000s, isolated Upper Paleolithic sites with buried cultural layers were known in East, Central, and South Kazakhstan. They were widely separated from one another. Experts regarded the materials of each Upper Paleolithic site as a distinct cultural entity. The pattern of the lithic industries appeared mosaic, and no single evolutionary vector was seen behind it, all the more so because the vast majority of other sites were exposed, chronologically diverse, and could not be viewed as a single whole.

Paleolithic studies in southeastern Kazakhstan have a short history. Before the year 2000, only one site was known there: the open-air Middle Paleolithic site of Aktogai, located in the Charyn River valley. The reason for this situation lay in the almost complete absence of reconnaissance surveys. Starting from the early 21st century, archaeological studies have been intensified there. The most significant event of the last two decades was the discovery of a cluster of Upper Paleolithic sites in the foothills of the Zailisky (Trans-Ili) Alatau Range (Northern Tien Shan). This includes Maibulak, Rakhat, Uzynagash-1, -2, Kyzylauz-1–4, Saryzhazyk-1, -2, and others (Taimagambetov, Ozherelyev, 2009: 124–140; Ozherelyev, Dzhasybaev, Mamirov, 2021; Ozherelyev, Lev, Stolpnikova, 2023; Ozherelyev, Uspenskaya, Taimagambetov, 2023; Kunitake, 2019; Iovita et al., 2020). Almost all of these are multilayered sites located in similar geomorphological contexts. Culture-bearing horizons are incorporated into covering loess sediments, which are characterized by a chronologically distinct stratigraphic sequence. Within separate sites, the existence and succession of various Upper Paleolithic complexes can be traced. Given the sedimentation pattern, various cultural levels evidencing settlement, and the homogeneity of the archaeological material, stratified sites in the Northern Tien Shan foothills acquire an interregional significance.

## Geographical location

In terms of geography, culture, and history, southeastern Kazakhstan is known as Semirechye or Zhetysu (Seven Rivers), named after seven largest rivers flowing there. The region occupies the southern part of the Balkhash Lake basin—the largest in Central Asia (Fig. 1). The study area with the cluster of Upper Paleolithic sites is located in the Zailisky Alatau—one of the ranges in the Northern Tien Shan. The northern slopes of the range have a stepped structure represented by two terrace-like ledges. Almost all the sites known to date are located on the lower terrace, at an altitude of 950–1150 m above sea level. Most cultural horizons consist of ancient occupation layers containing coaly spots, charred earth lenses, and remains of fireplaces and hearths, as well as lithic artifacts and rare bone remains. We will now briefly describe the principal sites and their materials.

## Preliminary findings

**Maibulak.** The site is located 34 km west of Almaty (Zhambylsky District of the Almaty Region), on the right side of the mouth of the Maibulak River gorge (Fig. 1). The true altitude is 1050 m above sea level. Culture-bearing deposits are incorporated into a loess remnant on the lower terrace ledge in the Zailisky Alatau foothills. The thickness of loess in the site's area is at least 9 m (the depth of the excavation). The site was discovered in 2004. It was studied intermittently up to 2021. The most extensive excavations were carried out in 2004–2006 (Taimagambetov, Ozherelyev, 2009: 124–140). At that time, the total excavated area measured 130 m$^2$. The maximal depth of the excavation was 9.0 m from the conventional zero level. Seven cultural layers were recorded. Finds from the lower layer 7 (108 spec.) showed a combination of Middle and Upper Paleolithic traits. No absolute dates are available.

Layer 6 contained unusual lithic finds (238 spec.) based on microblade knapping. The collection includes subprismatic, narrow-faced, carinated core-scrapers and core-burins, small blades, and retouched bladelets, as well as points on straight or slightly curved bladelets (Fig. 2, *1–5*). Two charcoal samples from layer 6 generated dates within limits of ~41,300–39,500 cal BP (Feng et al., 2011; Fitzsimmons et al., 2017; Ozherelyev, Uspenskaya, Taimagambetov, 2023). It is assumed that this developed microblade industry was imported to the foothills of the Northern Tien Shan. The migration


*Fig. 1.* Location of Upper Paleolithic sites in the foothills of the Northern Tien Shan (Zailisky Alatau).
*1* – Rakhat; *2* – Maibulak; *3* – Uzynagash-1 and -2.

was part of a cultural impulse that extended over western and central Eurasia ~41,000–39,000 cal BP. Its epicenter was probably the Early Ahmarian of the Levant. Similar (though not identical) industries form a wide stratum in the western part of Eurasia (Proto-Aurignacian, Fumanian, Krems-Hundssteig, Early Kozarnikian, Spitsynian, Early Baradostian, Rostamian) (Tsanova, 2013; Dinnis et al., 2019; Ozherelyev, Uspenskaya, Taimagambetov, 2023). Industries of this circle spread out fast. One of them, associated with the Early Baradostian, penetrated into the Tien Shan foothills via the Iranian Plateau. Stratigraphic materials of layer 6 underlay a more "archaic" lithic industry.

Lithic artifacts from layers 3–5 (1830 spec.) contained Aurignacian-like implements: blades with scalar retouch, carinated core-scrapers, shouldered scrapers, and others (Fig. 2, *6–8*). At the same time, there are artifacts of Middle Paleolithic character: discoid and "Levallois" cores, side-scrapers, and backed knives. According to the results of OSL-dating, the age of loess from layer 5 varies from 30 to 35 ka years. Two radiocarbon dates were obtained for layer 4: ~35,000–32,800 cal BP. One date within the limits of ~32,000–31,100 cal BP was generated for layer 3 (Ozherelyev, Uspenskaya, Taimagambetov, 2023). The archaeological complex from layers 5–3 appears homogeneous. Chronologically, it coincided with the Early and Classic Aurignacian of Europe, differing from it in many respects.

The collection from layer 2 comprises 120 artifacts. According to the results of OSL-dating, the age of loess from this layer varies from 24,000 ± 2000 to 25,300 ± ± 2600 years. The excavated area of layer 1 does not exceed 10 m$^2$. Lithic artifacts (77 spec.) were scattered over the loess deposit. No reliable absolute dates are available. The collection contains few diagnostic forms. On a number of grounds, the lithics can be attributed to the Late Upper Paleolithic or even to a later period. Generally speaking, Maibulak is the first Upper Paleolithic site discovered in the region. At present, it is part of the industrial development area.

Starting from 2018, on the basis of a cooperation agreement, investigations in southeastern Kazakhstan are carried out by the joint expedition from the Institute of Archaeology RAS (Moscow) and the Margulan Institute of Archaeology (Almaty). The works are focused on excavation of the previously known site of Rakhat, as well as on a search of new Upper Paleolithic localities.

**Rakhat.** This site is located 32 km east of Almaty (Enbenshikazakhsky District of the Almaty Region) (see Fig. 1). The true altitude is 952 m above sea level. We discovered this site in 2006 in an exposure of a quarry. However, we started the first archaeological excavations there only as late as 2018. The excavations

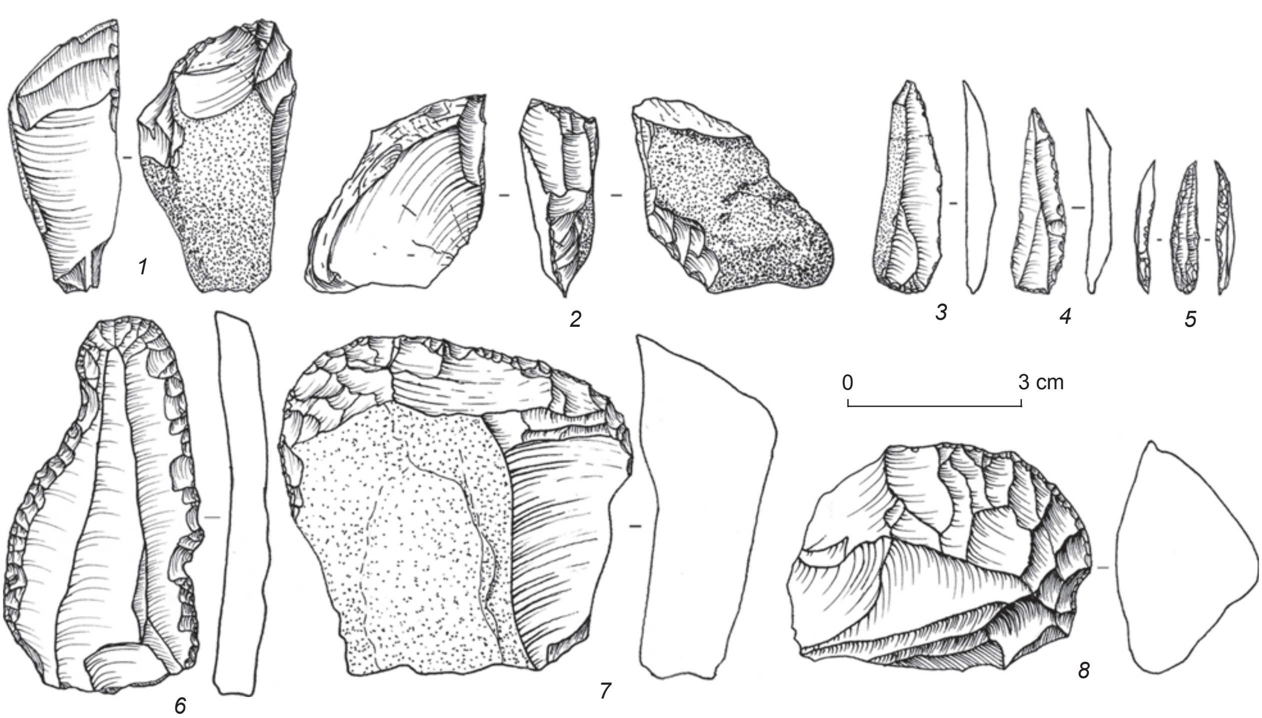


*Fig. 2.* Lithic artifacts from Maibulak.
*1*, *2* – carinated core-burins; *3–5* – points; *6*, *7* – end-scrapers; *8* – carinated core-scraper. *1–5* – layer 6; *6–8* – layers 5–3.

are still in progress. Over five years, the whole culture-bearing deposit over the area of approximately 60 $m^2$ has been examined. Fifteen cultural layers were identified. They are located at different levels of 13-meter-thick loess deposits overlying Late Pleistocene river-bed shingle. The layers contain lithic artifacts, rare animal bones, numerous charred earth lenses, coaly spots, and hearth pits. The number of lithics exceeds 8000 spec., including small debitage pieces. The materials from Rakhat allow us to trace the cultural transformation that proceeded before and right after the Last Glacial Maximum. The site mirrors the transition from the end of the Early Upper Paleolithic, with typical carinated core-scrapers (layer 12), to the Middle Upper Paleolithic (layers 7–11), with peculiar points (Fig. 3, *1–11*). These tools display some morphological similarity with micro-Gravette-like points of the initial Middle Upper Paleolithic. Finds from layers 7–11 date to ~29,500–27,700 cal BP (dates for Rakhat are indexed as $IGAN_{AMS}$) (Ozherelyev, Lev, Stolpnikova, 2023). A lithic industry with such points appears separate from other industries of the area. At the same time, it may be culturally and stadially related to the industry of Kulbulak layers 2.1 and 2 (Kolobova et al., 2013). After a gap, which occurred ~27,500–24,300 cal BP and probably coincided with one of the first cycles of the Last Glacial Maximum, Rakhat layers 1–5 display a different industry, indicating the beginning of a new technological stage within the Upper Paleolithic (Fig. 3, *12–23*). The main feature of it is the appearance of geometric implements in the form of asymmetrical scalene triangles. According to the results of radiocarbon dating, this culture existed at Rakhat ~24,000–23,000 cal BP (Ozherelyev, Lev, Stolpnikova, 2023). Parallels are traceable in the materials of Dodekatym-2 (Middle Asia) (Krivoshapkin, Kolobova, Kharevich, 2009), Epipaleolithic industries of Zagros (Zarzian), and in the final Upper Paleolithic to Early Epipaleolithic assemblages of the Levant (Masraquan, Early Kebaran) (Olszewski, 2012; Belfer-Cohen, Goring-Morris, 2014; Nadel, 2017). Interestingly, the appearance of industries known for mass production of microliths in the Levant (Ohalo II) and in the Northern Tien Shan chronologically coincides. The late stage of the Upper Paleolithic, following the period mentioned above, is still insufficiently documented by materials from the Northern Tien Shan. At the same time, important new sites with abundant materials relating to various stages of the Upper Paleolithic are being discovered.

**Uzynagash-1 and -2.** The cluster of Uzynagash sites was discovered in 2021. It is located 52 km west-south-west of Almaty (Zhambylsky District of the Almaty Region) (see Fig. 1). The sites are located on the lower terrace ledge of the piedmonts. In relation to the river, this level corresponds to the first fluvial terrace. The true altitude is 1120 m above sea level. Nine loci of surface finds were recorded. The first excavations were conducted in 2022.

At Uzynagash-1, a 19 $m^2$ large excavation was cut into the slope. Within loess-like sediments, at a depth of 6.05–6.80 m, three cultural layers with numerous lithic artifacts (4390 spec., including fragments, chips, and scales) were found. The collection includes cores, core preforms, hammerstones, flakes, blades, curved and curved-twisted bladelets (Fig. 4, *1*, *15–17*). The toolkit comprises numerous end-scrapers on blades and flakes of various shapes, carinated core-scrapers and core-burins, retouched blades, rare lateral burins, and solitary specimens of bladelets with ventral retouch (Fig. 4, *2–14*). Tools had been manufactured from various stones derived mostly from the Uzynagash River bed. Typical habitation objects were also discovered at the site: two deepened hearths, a charred earth lens, and a utility pit. Judging by the appearance of the lithics, the site can be attributed to the Early Upper Paleolithic. Technological and typological features of the industry from layers 1–3 suggest that it is homogeneous, displaying a markedly Aurignacian-like component. Those three layers may evidence three stages in the peopling of the place. If, on the other hand, we speak of a single culture, then it can be subdivided into stages. The site can be interpreted as a long-term residential base-camp.

At Uzynagash-2, the pilot step-trench revealed two layers with different industries (layer 1 at a depth of 5.5–5.7 m, and layer 2 at a depth of 7.5–7.6 m). Lithic artifacts from layer 1 resemble those from Uzynagash-1. The collection from layer 2 includes a few stone implements (27 spec.) distinguished by their small sizes. Most forms are undiagnostic.

Although the excavations at the Uzynagash cluster of sites are in the initial stage, they have already demonstrated that these sites are new and informative, revealing an expressive archaeological material deposited *in situ*. Noteworthy are the sites such as Kyzylauz-1–4 (studied by S. Kunitake); Tikenekty and Yntymak (studied by R. Iovita); and Saryzhazyk-1 and -2 (studied by D.V. Ozherelyev and T.B. Mamirov), located in various regions of the Zailisky Alatau foothills. The study of these localities

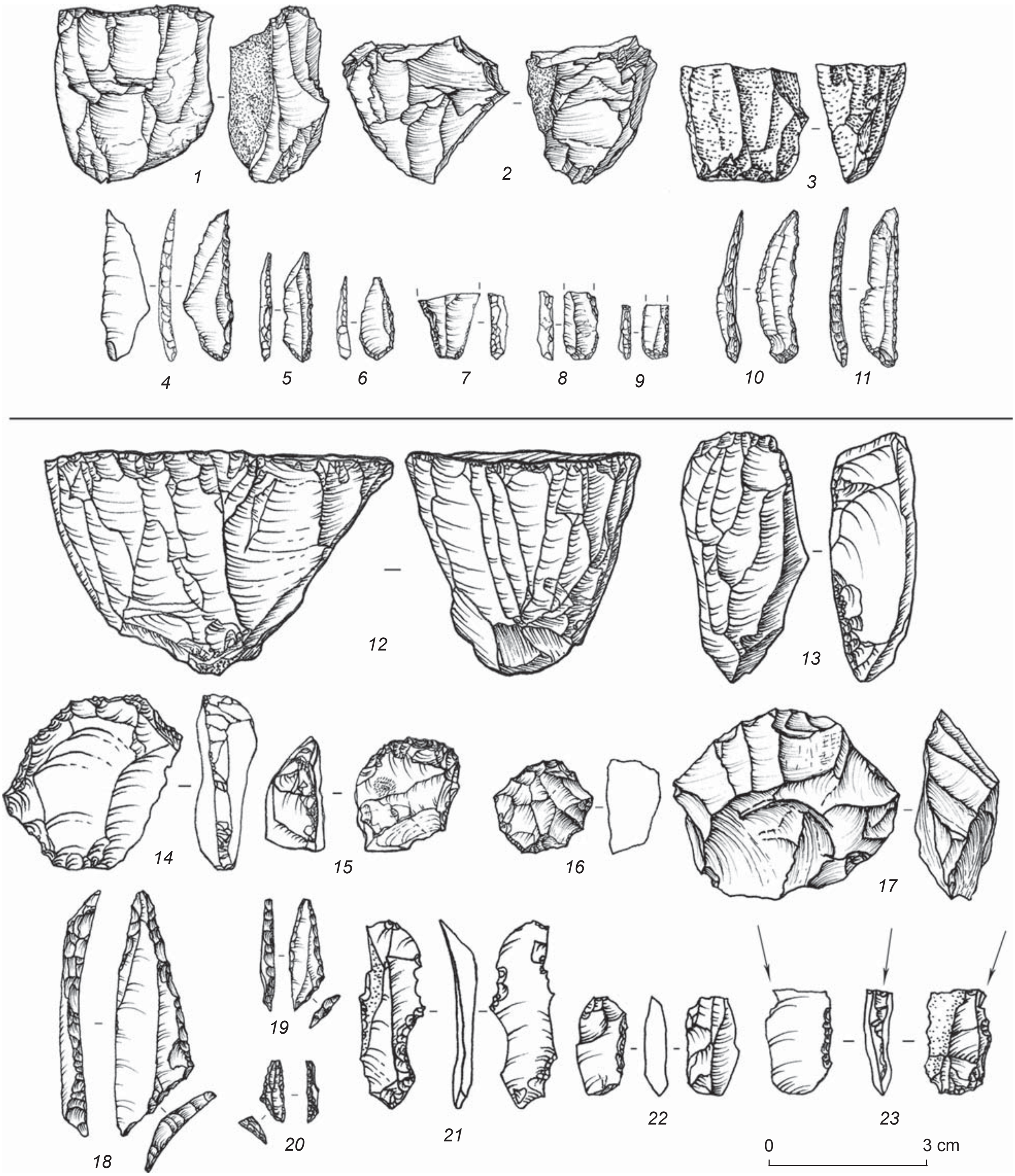


*Fig. 3.* Lithic artifacts from Rakhat.
*1–9* – from layers 7, 8/1: *1–3* – cores, *4–6* – points, *7* – fragment of a point, *8*, *9* – backed bladelets; *10*, *11* – points from layers 9, 10; *12–23* – from layers 2–4/3: *12*, *13*, *17* – cores, *14–16* – end-scrapers, *18–20* – asymmetrical scalene triangles, *21* – notched bladelet, *22* – chisel-like tool, *23* – burin.

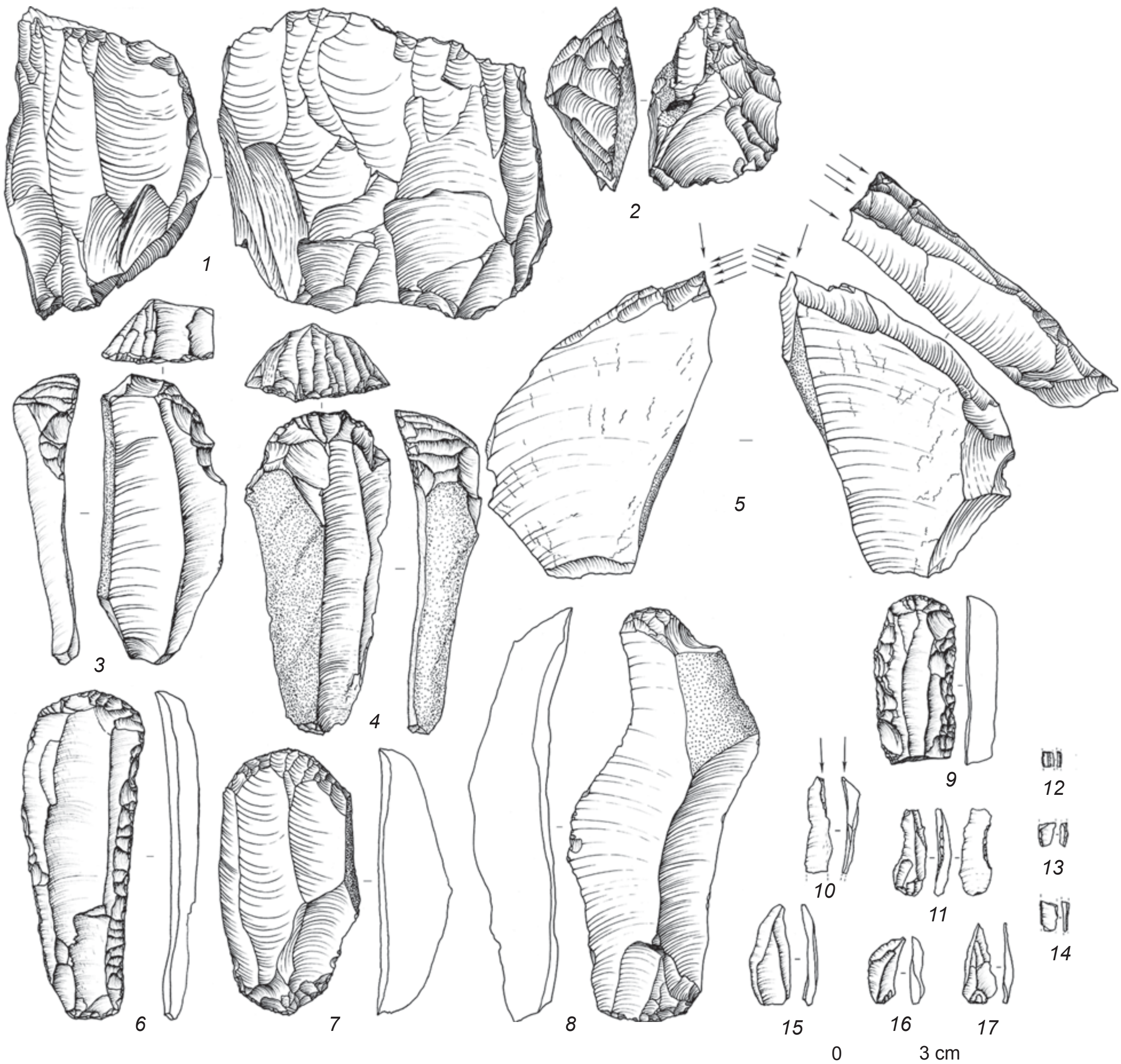


*Fig. 4.* Lithic artifacts from Uzynagash-1 and -2.
*1* – core; *2* – carinated nosed core-scraper; *3*, *4* – carinated core-scrapers on blades; *5* – carinated core-burin; *6–9* – end-scrapers; *10* – burin; *11*, *13*, *14* – bladelets with ventral retouch; *12* – fragment of a microblade with dorsal retouch; *15–17* – bladelets.

is also at an early stage. These sites might belong to different stages of the Upper Paleolithic.

## Conclusions

At the present time, systematic studies have demonstrated that the piedmont regions of the Northern Tien Shan are a major center documenting the evolution of the Upper Paleolithic in western Central Asia. Most known Upper Paleolithic sites were discovered in the northern foothills of the Zailisky Alatau; however, there are also sites located in the area of adjacent ranges (Kurama, Byuirukbastau-Bulak) (Chargynov, 2015; Kunitake, Taimagambetov, 2021). The sites in the Zailisky Alatau are multicomponent, embracing different stages of the Upper Paleolithic. The earliest dated evidence of the Upper Paleolithic there belongs to ~35,000 BP (41,000–40,000 cal BP). In our view, its appearance was caused by a single process of human dispersal linked with the spread of closely related cultures such as Proto-Aurignacian, Fumanian, Early Baradostian, etc., preceding the Aurignacian. The most abundant sites in the region are those dating to the Early Upper Paleolithic and early Middle Upper Paleolithic. It was here that a culture with a distinctly Aurignacian component (Maibulak, Uzynagash-1 and -2, and Rakhat layer 12) originated and evolved. This suggests that the ties between the humans of the Northern Tien Shan and the Aurignacians living west of Central Asia were closer than previously believed. A study of this industry and its changes seems to be quite important for the future. Tentative findings and observations agree with the idea of an *in situ* transformation of the Aurignacian cultural tradition into Middle Upper Paleolithic industries such as those of Rakhat layers 7–10 and Maibulak layer 2. Recent discoveries point to the effect of the Last Glacial Maximum upon the peopling of the region and the evolution of the local Upper Paleolithic. The pattern of lithic industries in ~25,000–23,000 BP (~29,500–27,700 cal BP) is mosaic, which may be caused by the southward shift of landscape and climatic zones and the arrival of humans bearing different cultural traditions to the Northern Tien Shan. The ~23,000–20,000 BP (~27,500–24,300 cal BP) interval was marked by a gap in the cultural sequence, evidently resulting from the highly adverse environmental conditions of the first half of the Last Glacial Maximum. This is indirectly evidenced by the data relating to Late Pleistocene moraines of the Inner Tien Shan (Narama et al., 2009). The key event at the beginning of the Late Upper Paleolithic was the emergence of an innovative lithic industry with the first geometric microliths and similar points (scalene triangles) between ~20,000–19,000 BP (~24,000–23,000 cal BP). This industry is attested by Rakhat layers 1–5. Its appearance may be a technological response to the environmental challenges of the Last Glacial Maximum. The further evolution of the Upper Paleolithic cultural traditions in the region is poorly known. Climatic conditions following the Last Glacial Maximum might have contributed to a more intense peopling not only of the piedmont but also of intermontane troughs and gorges of the Inner Tien Shan.

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# Late Pleistocene Environments of East Kazakhstan (Based on Ushbulak Site Materials)

*We reconstruct environmental conditions at various stages of the Late Pleistocene and Early Holocene of East Kazakhstan. The reconstructions are based on materials from the stratified Ushbulak site in the Shilikta Valley, spanning a period from the Early Upper Paleolithic to the Bronze Age. Climatic changes were evaluated using natural science methods—mineralogical, ZooArchaeology by Mass Spectrometry (ZooMS), OSL- and AMS-dating,*

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*etc. Sevaral stages, relating to environmental changes, are evaluated. The first period (~52–37 ka BP) was period of moderately warm and relatively humid climate, with predominantly forest-steppe, meadow-steppe, and semi-desert landscapes. The second period (~25–21 ka BP) coincided with a transition from a moderately warm to a very cold and more arid climate dominated by steppes. The third period (~18–16 ka BP) was transitional from the glacial maximum to the postglacial interstadial, with a relatively cool and arid climate and mostly steppe and forest-steppe landscapes. The fourth period (~15–14 ka BP) was characterized by the warmest climate in the Late Pleistocene; steppe and forest-steppe vegetation dominated. During the latest, Early Holocene period, the climate was warm and humid, with savanna-like landscapes. The analysis of natural-climatic conditions allows us to conclude that the early stage of the site's functioning, characterized by the highest intensity of settlement, was optimal for ancient man.*

Keywords: *East Kazakhstan, paleoclimate, paleontology, ZooMS, litho-chemical analysis, mineralogical and geochemical analyses.*

## Introduction

Until recently, Late Pleistocene environments of East Kazakhstan were reconstructed on the basis of paleofaunal collections from several localities and of surface materials from the Bukhtarma and the Middle Irtysh valleys in the northern part of the region (Kozhamkulova, 1981; Kozhamkulova, Pak, 1988). The discovery of the stratified site of Ushbulak in the southern part of East Kazakhstan in 2016 enhanced paleogeographic studies of this region (Anoikin et al., 2019). In recent years, the study of the Ushbulak archaeological materials has been carried out through a complex of methods—mineralogical, geochemical, isotope, and zooarchaeology by mass spectrometry (ZooMS), as well as OSL- and AMS-dating. Correlation of the obtained results with the data on the main episodes of site occupation during the Upper Paleolithic provides base for reconstructions of the environmental and climatic conditions in the Shilikta Valley during MIS 3–1. The environmental changes, effects on the composition of faunal communities, and the specific economic activities of the ancient population have been considered.

## General information

The site of Ushbulak is located at the foothills (1500 m above sea level) of the northeastern end of the Shilikta Valley, in the upper reaches of the Vostochny Stream (Fig. 1).

During the field work, two adjacent archaeological pits and 15 test pits covering a total area of ~50 $m^2$ have been excavated at the site. The stratigraphic profile of the site was ~7 m thick and revealed eight main sedimentary layers, some of which were additionally subdivided into horizons (Fig. 2). The


*Fig. 1.* Location of the site of Ushbulak.

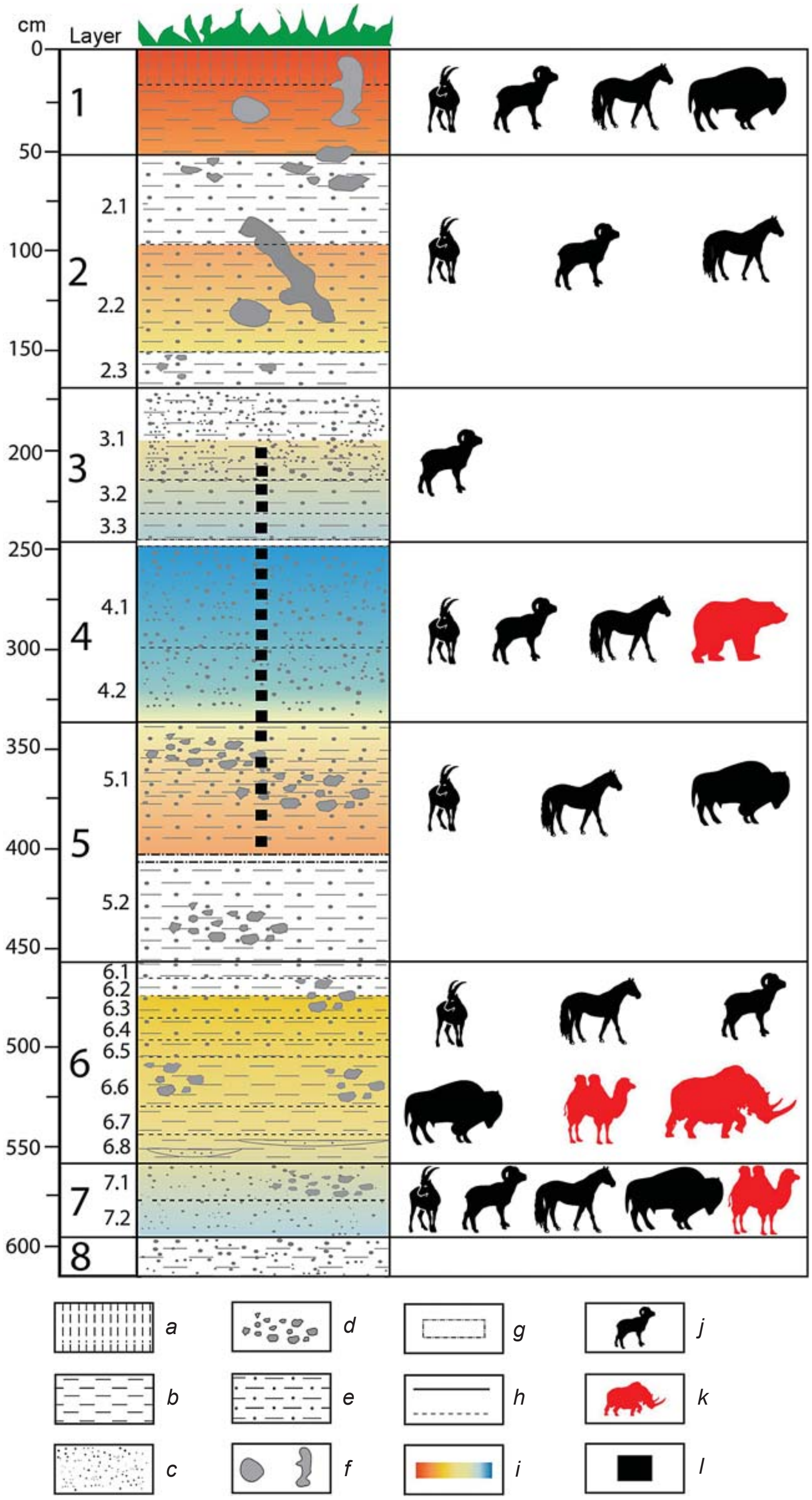


*Fig. 2.* Scheme of climatic changes in the Ushbulak area, reconstructed by the set of the science-based data.

*a* – heavy loams; *b* – loams; *c* – sand; *d* – breccia; *e* – sandy loam; *f* – sink holes; *g* – sedimentation hiatus; *h* – borderlines between layers, horizons; *i* – relative fluctuations in annual average temperatures; *j* – animal species previously identified at the site; *k* – animal species found at the site for the first time; *l* – points of collecting samples for X-ray fluorescence analysis.

lowermost layer 8 is composed of granules and grus of proluvial-mudflow origin, with inclusions of cobbles and heavy loamy matrix. Layer 7 (7.2, 7.1) is a granule and grus stratum with sandy-loam matrix. Layer 6 (6.8–6.1) consists of two sedimentary units. The lower unit is heavy loams with lenses of coarse-grained sands; the upper one is heavy sandy loams with inclusions of light humic loams. The formation of layers 7 and 6 was is connected with the activity of a small stream, which reworked proluvial-slope material from the nearby areas. The upper part of the profile (layers 5–2 (5.2, 5.1; 4.2, 4.1; 3.3–3.1; 2.3–2.1)) consists of proluvial and subaerial sediments, with a significant contribution of eolian material—sands and sandy loams with grus-sand interlayers. Layer 1 is a modern soil profile (Ibid.).

Archaeological material was recorded in layers 7–1. The collection of artifacts from layers 7.2–6.1 includes more than 16,000 items representing a single lithic industry (Kharevich et al., 2022). The upper layers yield significantly less archaeological materials (~1300 spec.) than the lower layers. According to the technical and typological characteristics of the artifacts and their stratigraphic positions, four main cultural and chronological complexes were identified: the Initial Upper Paleolithic (layers 7.2–6.1), the Middle Upper Paleolithic (layers 5.1–4.1), the Late Upper Paleolithic (layers 3–2), and the Late Bronze Age (layer 1) (Anoikin et al., 2019).

The chronological attribution of the site was made on the basis of a series of 20 OSL- and 5 AMS-dates. According to the Bayesian age model, layers 7.2–6.1 were most likely accumulated ~52–37 ka BP, layers 5.1–4.1 in the range of ~25–21 ka BP, and layers 3 and 2 ~18–14 ka BP (Ulyanov et al., in press).

## Research methods

Paleoclimatic fluctuations in the area of the site at various stages were studied using multiple natural science methods. In addition to the taphonomic and paleoecological assessment of the faunal species' composition using the classic paleontology techniques, we carried out a ZooMS analysis of a series of unidentifiable mammalian bone fragments. Sample preparation for the ZooMS analysis followed the protocol proposed by M. Buckley (Buckley et al., 2009) and updated by C. Brown (Brown et al., 2020; Shnaider et al., 2022). The findings were interpreted using the database of reference taxa (Welker et al., 2016). Litho-chemical studies of the deposits uncovered in the stratigraphic sequence of the site were based on the results of X-ray fluorescence analysis (ARL-9900-XP spectrometer) converted to litho-chemical indices CIA, CIW, and ICV (Nesbitt, Young, 1982; Cox, Lowe, Cullers, 1995).

The study of faunal remains also involved a wide range of modern mineralogical methods (Silaev et al., 2017, 2022): thermal and chemical analyses; determination of $C_{org}$ content by coulometric titration; X-ray fluorescence analysis (XRD-1800 Shimadzu); optical microscopy (OLYMPUS BX51 complex); X-ray diffractometry (XRD-6000); analytical scanning electron microscopy (JSM-6400 Jeol; Tescan Vega); determination of nanoporosity by nitrogen adsorption/desorption kinetics (Nova 1200e, Quantachrome Instruments); analysis of the elemental composition of collagen (EA 1110 (CHNS–O)) and the composition of amino acids in collagen (GC-17A Shimadzu with a flame ionization detector); inductively coupled plasma mass spectrometry (NexION 300S Perkin Elmer); infrared spectroscopy (FT-2 Infralum); mass spectrometric analysis of the isotopic composition of C and O in bioapatite and C and N in bone collagen (Delta V. Avantage with the analytical complex of Thermo Fisher Scientific).

## Litho-chemical analysis of sediments

For litho-chemical analysis, in trench 1, 19 samples were collected from the sediment column with a step of ~0.1 m (Fig. 2). Changes in the values of CIA- and ICV-indices and the depth-depending proportion of CaO are shown in Fig. 3, *1*.

A gradual increase in CaO concentrations takes place in the middle part of the selected interval (horizon 4.1), reaches its maximum values at a depth of ~2.5 m (boundary between layers 4.1 and 3.3), and then gradually decreases. This indicates the accumulation of readily soluble and mobile forms of calcium (mainly carbonates), which is typical of dry and cold climatic conditions. In the lowermost part of trench 1 (layers 5.1–4.2), CaO concentrations vary insignificantly, which suggests wetter and warmer environments during sedimentation.

The CIA and ICV indices are well correlated with the distribution of CaO along the profile. For example, layers 5.1–4.2 show relatively warm environments, with a slight shift in conditions and intense accumulation of clay minerals; these change sharply in the upper part of horizon 4.1, indicating the coldest conditions. Thus, the upper part of the selected

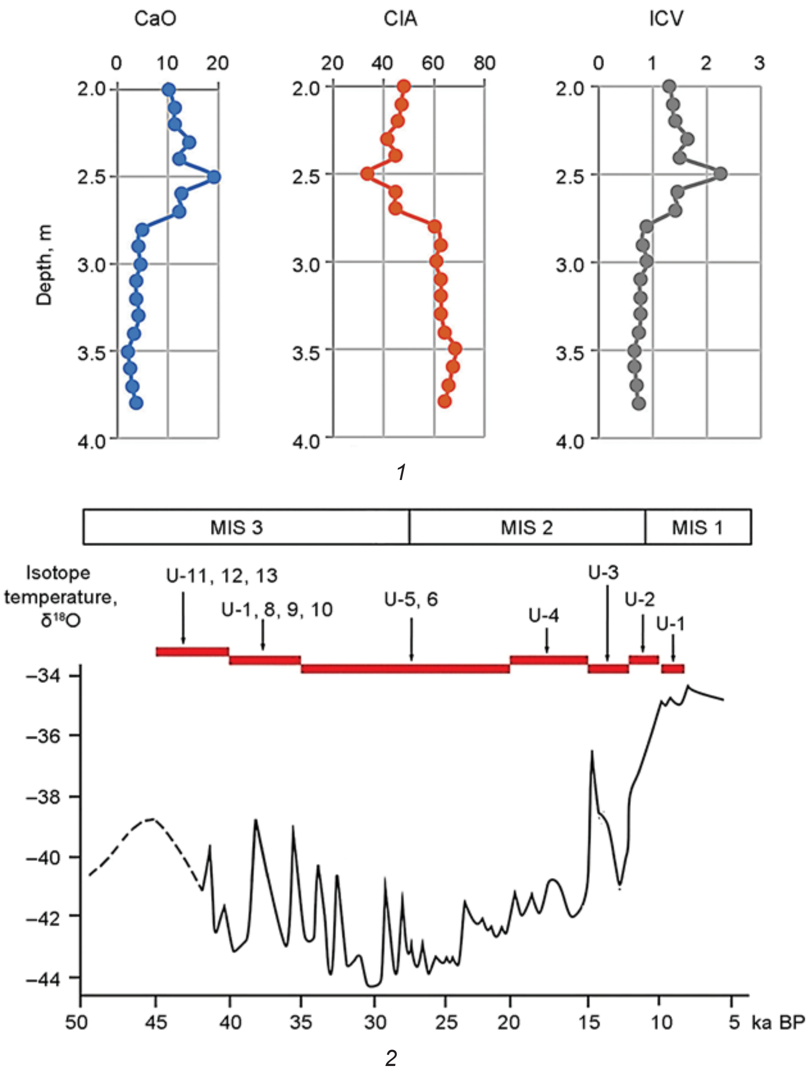


*Fig. 3.* Geochemical indicators of sedimentation conditions in Ushbulak layers 5.1–3.1 (*1*), correlation of the age of fossil bone detritus from Ushbulak (U) with the isotope temperature of living environment of the animals on the modern diagram of Late Pleistocene climatic periodization (after (Silaev et al., 2022)) (*2*).

portion of the geological profile (depths 2.7–2.0 m, layers 4.1–3.1) is markedly different in its geochemical composition, which suggests environmental changes during this period of sedimentation. The study of litho-geochemical indicators revealed an intense accumulation of carbonates and a simultaneous decrease in the proportion of clay minerals during this period, corresponding to drier and cooler climatic conditions. In layers 5.1–4.2, the geochemical composition is more monotonous, with an increased content of clay minerals and lower content of CaO, which is typical of a warmer climate.

### Analysis of faunal remains

More than 500 bone fragments were recovered from the Pleistocene layers in excavation trenches 1 and 2. The majority of bone fragments do not exceed 50 mm in size. Identifiable remains (21 spec.) are mainly teeth or fragments thereof. The lower layer yielded bones of *Bison priscus* (primordial bison), *Equus ferus* (wild horse), *Equus hemionus* (kulan), *Ovis ammon* (argali), and *Capra sibirica* (mountain goat) (see *Table*). The remains of argali and horses are the most numerous. Horizon 5.1 contains solitary

**Composition of identifiable fauna at Ushbulak, spec.**

| Species, family | Layer | | | | | | | Subtotal |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | |
| *Identified to the species level (visually)* | | | | | | | | |
| *Equus ferus* | – | 1 | – | – | 1 | 4 | 1 | 7 |
| *Equus hemionus* | – | – | – | – | – | – | 1 | 1 |
| *Ovis ammon* | – | – | 1 | – | – | 5 | 3 | 9 |
| *Capra sibirica* | – | – | – | – | 1 | 1 | – | 2 |
| *Bison priscus* | – | – | – | – | – | 1 | 1 | 2 |
| *Identified to the subfamily / genus level (ZooMS)* | | | | | | | | |
| *Ursus* sp. | – | – | – | 1 | – | – | – | 1 |
| *Equus* sp. | – | 1 | – | 5 | – | 20 | 1 | 27 |
| *Coelodonta* sp. | – | – | – | – | – | 1 | – | 1 |
| Camelidae | – | – | – | – | – | 2 | 1 | 3 |
| *Ovis* sp. | 1 | 1 | 2 | 2 | – | 1 | – | 7 |
| Ovis/Capra | 2 | 2 | – | 3 | – | 10 | 2 | 19 |
| *Bison priscus/Bos primigenius* | 1 | – | – | – | 1 | 14 | 9 | 25 |
| *Identified to the family level (ZooMS)* | | | | | | | | |
| Bovidae | – | – | – | – | – | 2 | – | 2 |
| Bovidae/Cervidae | 1 | – | – | – | – | – | 1 | 2 |
| *Saiga/*Cervidae | – | – | – | – | – | 1 | 1 | 2 |
| *Ovis/Saiga/*Cervidae | – | 1 | – | – | – | – | – | 1 |
| *Ovis/Capra/Saiga/*Cervidae | – | 3 | – | 1 | – | – | – | 4 |
| *Total* | 5 | 9 | 3 | 12 | 3 | 62 | 21 | 115 |

teeth of *Equus ferus* and *Capra sibirica*; horizon 3.1 contains *Ovis ammon*.

## ZooMS-analysis

The ZooMS analysis was carried out for the selected unidentifiable bone fragments over 20 mm in size, found *in situ*. In total, 122 samples were taken from layers 7–1.

94 samples were identified during the study (see *Table*). All the samples show a high degree of taxonomic identification. For 27 samples from layers 7.2–4.1, six to nine peptides with m/z were identified: 1105.6; 1182.6; 1198.6; 1427.7; 1550.8; 1649.8; 2145.1; 2883.4; and 2899.5, which suggest their attribution to *Eguus* sp. Among the identifiable bones from the same layers, remains of *Equus ferus* and *Equus hemionus* were recorded; hence, the bones under analysis belonged precisely to these equine species. The 25 samples collected from layers 7.2–5.2 represented large animals of the Bovidae family; these showed from 6 to 11 peptides with m/z: 1105.6; 1192.6; 1208.7; 1427.7; 1580.8; 1648.8; 2131.1; 2792.3; 2853.4; 2869.4; 3017.5; and 3033.5. Taking into account the paleo-landscape reconstructions, in the Pleistocene this territory might have been inhabited by *Bison priscus* (steppe bison) and *Bos primigenius* (primitive aurochs) (Kozhamkulova, 1969: 79). The paleontological collection also includes teeth of *Bison priscus* from horizons 6.8 and 7.1; most likely, the remains of Bovidae belonged to this species. Seven samples revealed peptides with m/z: 1105.6; 1196.6; 1427.7; 1580.8; 1648.8; 2131.1; 2883.4; 2899.4; 3017.5; and 3033.5, which suggests genus *Ovis*. 19 samples, containing from 6

to 10 peptides with the m/z values of 1105.5; 1180.6; 1196.6; 1427.7; 1580.8; 1648.8; 2131.1; 2792.1; 2883.4; and 2899.4, indicate *Ovis/Capra*. The bones of *Ovis/Capra* were recovered from layers 7.1–2.1. According to regional reconstructions, *Ovis ammon* and *Capra sibirica* dominated in the local fauna during the Upper Pleistocene (Kozhamkulova, 1981). Four bone samples (three from horizons 2.2 and 2.1, one from horizon 4.2) were identified as *Ovis/Capra/Saiga/*Cervidae by 6–8 peptides with m/z: 1105.6; 1180.6; 1196.6; 1427.7; 1648.7; 2131; 2883.4; and 2899.4. One specimen from layer 2 was identified as *Ovis/Saiga/*Cervidae; it reveals a set of peptides with m/z: 1105.6; 1180.6; 1196.6; 1427.7; 1648.8; 2131.1; 2883.1; and 3017.7. Two samples from layers 7.1 and 1 contained peptides with m/z: 1105.6; 1427.7; 1648.8; 2131.1; 2792.4; 2883.4; 2899.4; 3017.5; and 3033.5, and were identified as Cervidae/Bovidae. Three samples from layers 6.5 and 7.1 contained peptides with m/z: 1105.6; 1221.7; 1443.7; 1550.8; 1634.8; 2131.1; and 2,883.4 which showed the Camelidae. One sample from layer 4.2 contained peptides with m/z: 1105.7; 1217.7; 1233.7; 1453.8; 2163.2; and 2957.8, corresponding to *Ursus* sp. During the Late Pleistocene, the bears in the region could have been represented by *Ursus arctus* (brown bear) or *U. Savini* (cave bear). One sample from horizon 6.4 contained peptides with m/z: 1105.5; 1182.6; 1198.6; 1427.7; 1649.7; 2145; and 2869, and referred to rhinoceros. According to regional reconstructions, it may have been *Coelodonta antiquitatis* (woolly rhinoceros). Two samples from horizons 6.5 and 6.3 contained peptides with m/z: 1105.6; 1427.7; 1580.7; 1648.8; 2131.1; and 2883.4, which are characteristic of Bovidae. The morphological analysis has shown that these tubular bones, with a significant thickness of the diaphysis walls, belonged to large representatives of the Bovidae family. Two samples from horizons 6.5 and 7.1 contained peptides with m/z: 1105.6; 1180.6; 1196.6; 1427.7; 1550.8; 1648.8; 2131.1; and 2883.4, which may correspond to *Alces* sp./*Cervus elaphus*/*Saiga* sp./*Capreolus capreolus*. According to the data on the paleoecological situation, *Cervus elaphus* (red deer) and *Saiga* (saiga) could have inhabited the region during that period (Ibid.).

The results of the ZooMS-analysis provide a significant supplement to the data on the faunal collection of the site (Fig. 4). For layers 7 and 6, a much larger proportion of remains of primitive bison was recorded, in comparison with the overlying

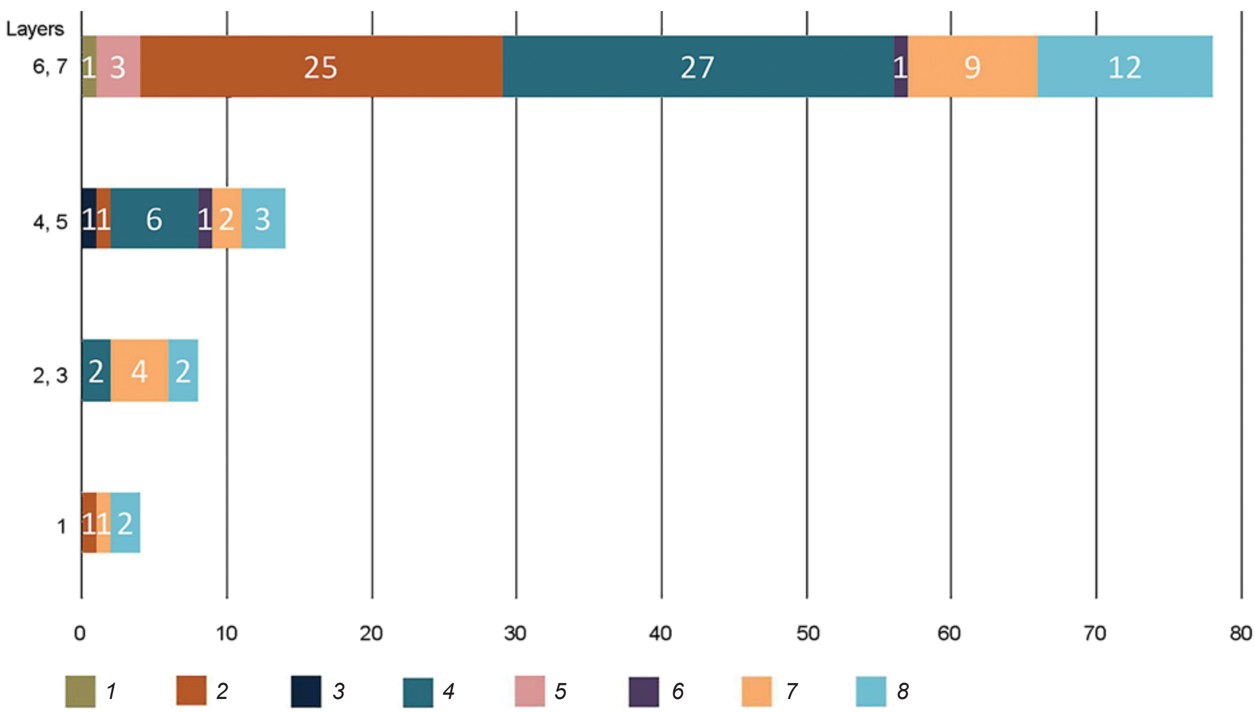


*Fig. 4.* The composition of the identifiable fauna established through taxonomic and ZooMS analysis in the main lithological units.
*1 – Coelodonta* sp.; *2 – Bison priscus/Bos primigenius*; *3 – Ursus* sp.; *4 – Equus* sp.; *5 – Camelus* sp.; *6 – Capra sibirica*; *7 – Ovis* sp.; *8 – Ovis/Capra*.

deposits; these remains, together with horse bones, occur in almost all horizons of these layers. The materials analyzed contain an insignificant share of bones of small ungulates (*Ovis/Capra*). Remains of previously unreported large ungulate mammals (camel and woolly rhinoceros) have been recorded. Layer 4 also contains numerous remains of horse and, probably, argali. A bone from a brown or cave bear of the species that had not been previously noted at the site was found. The faunal composition of the Upper Pleistocene layers 3 and 2 is dominated by the remains of sheep (argali?), and almost lacks bones of larger ungulates. Layer 1, attributed to the Holocene, demonstrates a similar situation, according to the ZooMS data, but its faunal complex might have also included domesticated animals.

## Mineralogical and geochemical studies

A sample of 13 bones and teeth of ungulate mammals from different archaeological horizons of layers 7–1 were subjected to mineralogical and geochemical analyses. Chronologically, these horizons are fairly evenly distributed in the range between early MIS 3 and MIS 1.

The microstructure of the remains, the composition of the illuviated mineral impurities, epigenetic minerals, the composition of microelements, the crystalo-chemical properties of bioapatite, the thermal properties, and the elemental and amino acid composition of the bone collagen were analyzed. The patterns of changes in the properties of fossil bones in the process of their fossilization were revealed; the isotopic compositions of C and O in bioapatite, and C and N in bone collagen, were analyzed; paleoclimatic and paleoecological reconstructions were proposed (Silaev et al., 2022).

The bone remains (fragments of tubular bones, cervical vertebrae, and teeth of the upper jaw of argali, kulans, and wild horses) under study revealed 52 microelements, including 12 essential elements, 18 physiologically active elements, and 22 antibiont elements. The total concentration of the microelements varies in the range of 419–2711 g/t, growing up with the age of the fossils. The proportion between the group concentrations of essential elements and antibionts in the bones under study varies from the youngest to the oldest in the range of 6.54–0.08. This pattern is confirmed by the ratio of the content of essential zinc to the content of physiogenically active copper, which varies from 33.33 to 0.35. Thus, the proportion between essential microelements and antibionts is a reliable criterion for assessing the degree of fossilization and, accordingly, the relative age of fossil bones. In addition, it further confirms the consistent deposition of paleontological and archaeological materials at the site. Another reliable indicator is the total concentration of lanthanides accumulating in the bones as a result of their interaction with the enclosing soils. It varies from 4 g/t in the youngest bone to 171–188 g/t in the oldest ones. The degree of crystallinity of bone bioapatite, determined by X-ray diffraction patterns and IR-spectroscopy data, also shows the correct chronological sequence. As the organics become older, the values of X-ray crystallinity indices increase by 55–100 %, i.e. the degree of crystallinity of bioapatite increases 1.5–2 times (Ibid.).

The elemental composition of collagen in the studied bones (wt%) is: C = 60–65; N = 20–25. The atomic ratios of C/N are 3.39–3.91, which suggests satisfactory preservation of the chemical composition of bone organic matter. The revealed isotopic composition of carbon and nitrogen in bone collagen indicates that the analyzed samples generally correspond to herbivorous animals. The most ancient animals lived in a relatively cold and dry climate in meadow-steppe and forest-steppe landscapes; their diet was based on plants of the C3 type. The younger populations were steppe animals with a mixed C3–CAM diet; they lived in a relatively cool climate. The even younger mammals lived in the warm climatic conditions of the transition from steppe to savannah environments. Finally, the population of the Early Holocene existed in steppes and savannahs with a warm arid climate; it had a transitional diet from CAM to C4 (see Fig. 3, *2*).

## Discussion and findings

Information on the current environmental conditions in the area of the site will add to a better understanding of paleogeographic reconstructions. According to the Köppen classification (Beck et al., 2018), the climate here is identified as cold steppe (Bsk). The climate of the Shilikta Valley is desert-steppe dry, while in the surrounding mountains, including the plateau-like tops of the Saur ridge, the climate corresponds to the alpine tundra-meadow zone. In the valley, summers are dry and hot, winters are cold and severe. The average annual precipitation is 281 mm; the average annual air temperature is -4 °C. The main mammal species recorded in the Pleistocene layers of the site are argali, Siberian ibex, brown bear, and others; these species still inhabit the region nowadays. Domesticated horses, bulls, and camels are also present.

The data of the litho-chemical and mineralogical-geochemical analyses correlate well with each other; on the basis of these data and the established chronology and stratigraphy of the site, the following paleoecological reconstructions can be proposed (see Fig. 2).

The earliest stage (~52–37 ka BP) falls in the Middle Zyrian (Middle Valdai within Moershufd-Hengelo) Interglacial, with a moderately warm and relatively humid climate. Unfortunately, the available data do not provide sufficient information to identify any smaller fluctuations of climate within this long period. At the same time, these data show a general trend of some increase in average annual temperatures, and possibly an increase in aridity. It is generally believed that the composition of animal communities in northeastern Kazakhstan at that time was similar to the classic mammoth faunal complex (Kozhamkulova, 1981; Kozhamkulova, Pak, 1988). The complex includes woolly rhinoceros and bison/aurochs; fossils of these animals were recovered from the lowermost layers of the site. Bone remains of kulan/wild horse and camel, which species are characteristic of the Late Pleistocene fauna of the northern parts of Central Asia, have also been recorded. According to the Pleistocene fauna of the region, the latter was most likely Knobloch's camel (*Camelus knoblochi*), which was widespread in Kazakhstan, southern Transbaikalia, and northwestern China at that time (Klementiev et al., 2022). Taking into account the climatic settings, the data from the mineralogical and geochemical analysis, and the species composition of the fauna, it can be assumed that forest-steppe, meadow-steppe, and semi-desert landscapes existed in the valley during that period.

The second stage began with a break in sedimentation and the probable destruction of some deposits in the period preceding the formation of horizon 5.1. This stage is represented by layers 5.1–4.1 and corresponds to the range of ~25–21 ka BP. This period is characterized by a transition from relatively warm and possibly humid environments to the coldest settings identified at the site. According to climatic reconstructions for the northern regions of Kazakhstan, it was a period of gradual aridization (Kozhamkulova, 1981; Kozhamkulova, Pak, 1988). Climatically, this was a transition from the terminal stages of the Lipovsko-Novoselovo (Bryansk/Denekamp) interstadial to the early stages of the Last Glacial Maximum. The deposits corresponding to the cooling peak were probably not preserved in the site's sequence. The faunal composition remained virtually unchanged; only the remains of camel are missing, which may be due to the change in hunting strategies during this period, since local taphocenosis was most likely formed by the anthropogenic activities (absence of gnawing marks on the bones and predator remains s). During that period, the site was surrounded by the predominantly steppe landscapes. The occurrence of bear bones in the faunal collection should not be considered the evidence of forest taphocenoses, since the brown bear inhabited the Eastern European and Kazakh steppes as late as in the 16th–18th centuries (Kozhamkulova, Pak, 1988). Perhaps, during the LGM, the climate in the Shilikta Valley corresponded to the Dwc type (subarctic continental climate). Notably, horizon 4.1, which is associated with the coldest conditions, contains almost no archaeological material.

The third stage, identified at the site after a certain sedimentation hiatus (layer 3, ~18–16 ka BP), corresponds to the transition from the LGM to the late glacial interstadial, with its relatively cool and dry climate, when temperature and humidity gradually increased. The available data do not provide enough information on the faunal composition, but it had hardly undergone any radical changes. Most likely, it corresponded to steppe and forest-steppe environments.

The period of sedimentation of layer 2 (~15–14 ka BP) is marked by one of the warmest climatic conditions recorded at the site in the Pleistocene. Climatically, this was the Belling-Allered/Nyapan/Sopkey interstadial. The identified species do not give an idea of the entire faunal diversity; however, the paleontological collection contains remains of inhabitants of open steppe landscapes (horse), as well as mountain and foothill belts (Siberian mountain goat). Landscape was close to modern, possibly with a greater proportion of forest communities.

The last, Early Holocene, stage was characterized by a moderately warm and humid climate, with a transition from steppe and forest-steppe to savanna-type landscapes. The fauna includes steppe and forest-steppe species, as well as the mountain belt species.

In general, the data obtained through various methods correlate well both with each other and with the reconstructions of the Late Pleistocene environments proposed for other regions in the north of Central Asia.

## Conclusions

The research done has provided the first paleogeographic reconstructions for the southern part of East Kazakhstan. These show a gradual cooling and general aridization of the climate in this area during the period corresponding to MIS 3, especially at its terminal stages; more favorable conditions were determined during the last late-glacial interstadial and the transition to the Holocene. The faunal collection of the Shilikta Valley generally corresponds to the mammoth fauna of steppe and forest-steppe landscapes, and shows a stable composition of the main species during the second half of the Late Pleistocene. This indicates a high degree of sustainability and adaptability of various species of ungulates to a wide range of climate fluctuations and abrupt environmental changes. At the initial stages of the Upper Paleolithic (layers 7 and 6), hunted mainly large ungulates, such as bison/aurochs, horse, kulan, and camel; bones of these animals predominate in the sediments. The medium-sized ungulates (argali, mountain goats) were hunted too, but these remains are less abundant. Subsequently, medium-sized ungulates became the main hunting purpose, while the proportion of large prey decreased markedly. The site was intensely used in the early stages. This is reflected in the quantity and composition of stone industry, as well as in the amount and diversity of faunal materials. At this stage, the climatic and landscape conditions were optimal for ancient human habitation, including available sources of stone raw materials and stable animal hunting.

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# A New Type of IUP Settlement in the Selenga River Basin, Northern Mongolia: The Kharganyn Gol-13 Short-Term Occupation Site

*Here we outline the results of excavations at a recently discovered Initial Upper Paleolithic site, Kharganyn Gol-13, located on a tributary of the Selenga River in northern Mongolia. The Selenga valley and those of its tributaries were key routes along which humans dispersed during the Initial Upper Paleolithic. The concentration of sites of that period is highest here. Most are situated near outcrops of lithic raw material and are classified as relatively long-term quarry-workshops. Excavations at Kharganyn Gol-13 have revealed a single cultural layer in sediments damaged by bioturbation and slope processes. We describe the stratigraphy and spatial structure of the site and its lithic industry, which is shown to belong to the Initial Upper Paleolithic, being dominated by opposite platform bidirectional blade reduction. Analysis of the lithics reveals a lack of available raw materials nearby. Apparently, cores brought to the site were already prepared. All cores are heavily reduced and scarce, tools are frequent. The concentration of lithics is low. We conclude that the site, located at a distance from outcrops of suitable rocks on Selenga River tributaries, was a short-term camp associated with a specific activity.*

Keywords: *Northern Mongolia, Initial Upper Paleolithic, technology, typology, settlement systems.*

## Introduction

The earliest stage of the Upper Paleolithic in Northern Asia and Eastern Central Asia (50–42 ka BP) was associated with blade industries of the Initial Upper Paleolithic (hereafter, IUP) in those regions (Konstantinov, 1994; Derevianko, 2001; Tashak, 2011; Anoikin et al., 2019; Li et al., 2019; Zwyns et al., 2019).

The IUP of Southern Siberia and Central Asia can be identified by a stable set of reduction strategies and typological features. The manufacture of blades involved a technology based on sequential and alternating bidirectional subprismatic/asymmetric reduction of cores (Zwyns, 2021). IUP industries were distinguished by tool-markers with clear typological and morphological specificity (Rybin et al., 2022).

The diversity of natural environments revealing IUP manifestations suggests adaptive flexibility in the populations that possessed the behavioral pattern of this meta-culture. One of the most important dispersal routes for migrating populations was the transboundary valley of the Selenga River and its tributaries, connecting northern Mongolia with the western Transbaikal region. This is the area of the highest concentration of the IUP sites known so far (Ibid.). The appearance of assemblages of that period in the valleys of the adjacent right tributaries of the Middle Selenga River—Ikh-Tulburiyn Gol (Tolbor) and Kharganyn Gol (Tolbor Paleolithic district, Mongolia)—has been dated to ca 45 ka BP. The earliest manifestations of the IUP are known from industries at Tolbor-4 (horizon 6) and Tolbor-16 (horizon 6). The latest version of the IUP in that region is represented by the industry from Tolbor-21 (horizon 4), going back to ca 42–40 ka BP (Zwyns et al., 2019; Rybin et al., 2020).

These sites are usually located on piedmont alluvial fans of southern exposure, 500–1000 m from the modern riverbed, at relative heights of 25–40 m above the present level of the valley, and at absolute heights of 1000–1150 m above mean sea level. The vast majority of these sites are concentrated along a 10-kilometer stretch of these river valleys, which belongs to a latitudinally extending belt of metamorphosed Permian sedimentary rocks—silicites of the Tulbur suite, of various quality and suitable for the manufacture of stone tools. These sites are attributed to a single type of habitation associated with the use of lithic raw material outcrops located 100–200 m from them. The discovery of Kharganyn Gol-13, which differs markedly in a number of important aspects from the known IUP sites in that area, resulted from recent research work at these sites. This study analyzes technological features of the Kharganyn Gol-13 industry, reconstructs the degree of preservation of its sediments, establishes the stratigraphic sequence of cultural deposits, and identifies settlement types using the morphology of artifacts and the structure of lithic industries, comparing them with other IUP assemblages in the Tolbor district. This study also reconstructs one variant of the settlement systems among the population of the Middle Selenga River during the IUP.

## Location, stratigraphy, and spatial structure of the site

The Kharganyn Gol-13 site is located in the valley of the Kharganyn Gol River—a small right tributary of the Altaatyn Gol River, which flows into the Selenga 19 km from the site (Fig. 1, *a*). During surveys undertaken in 2012 and 2014, the Joint Russian-Mongolian-American Archaeological Expedition discovered several Paleolithic sites in the valley, including Kharganyn Gol-13, with a surface occurrence of artifacts (Gladyshev et al., 2012; Gillam et al., 2014). The site is located on a gently sloping low piedmont fan, cut by erosion into several small areas, which has a southwestern exposure and is bounded by rocky ridges (Fig. 1, *b*). Outcrops of stone raw material have not been found near the site. The distance to the river is about 200 m; the height above the valley's bed does not exceed 10 m; the absolute height of the site is 1184 m above mean sea level.

During a survey conducted by the Russian-Mongolian archaeological expedition in 2018, the site was explored by means of four 1 × 2 m test pits made at different heights on the slope; here, exposed artifacts had been discovered. The two pits containing cultural layers exhibited similar stratigraphy. The most numerous finds were made in test pit 2, with a depth up to 245 cm, reaching the level of the weathering crust. Six distinctive artifacts occurred there in a compact vertical distribution (Rybin et al., 2018).

In 2022, a 3 × 2 m excavation pit with its long axis oriented SW-NE across the slope, was attached to 2018 test pit 2. Together with the test pit, a small section of which was not invesitgated in 2018, the total area of the excavation was 8 $m^2$. Deposits were uncovered to a depth of up to 210 cm; the description of the deposits is based on the northern wall of the excavation, oriented along the dip of the slope (Fig. 1, *c*, *d*; 2).

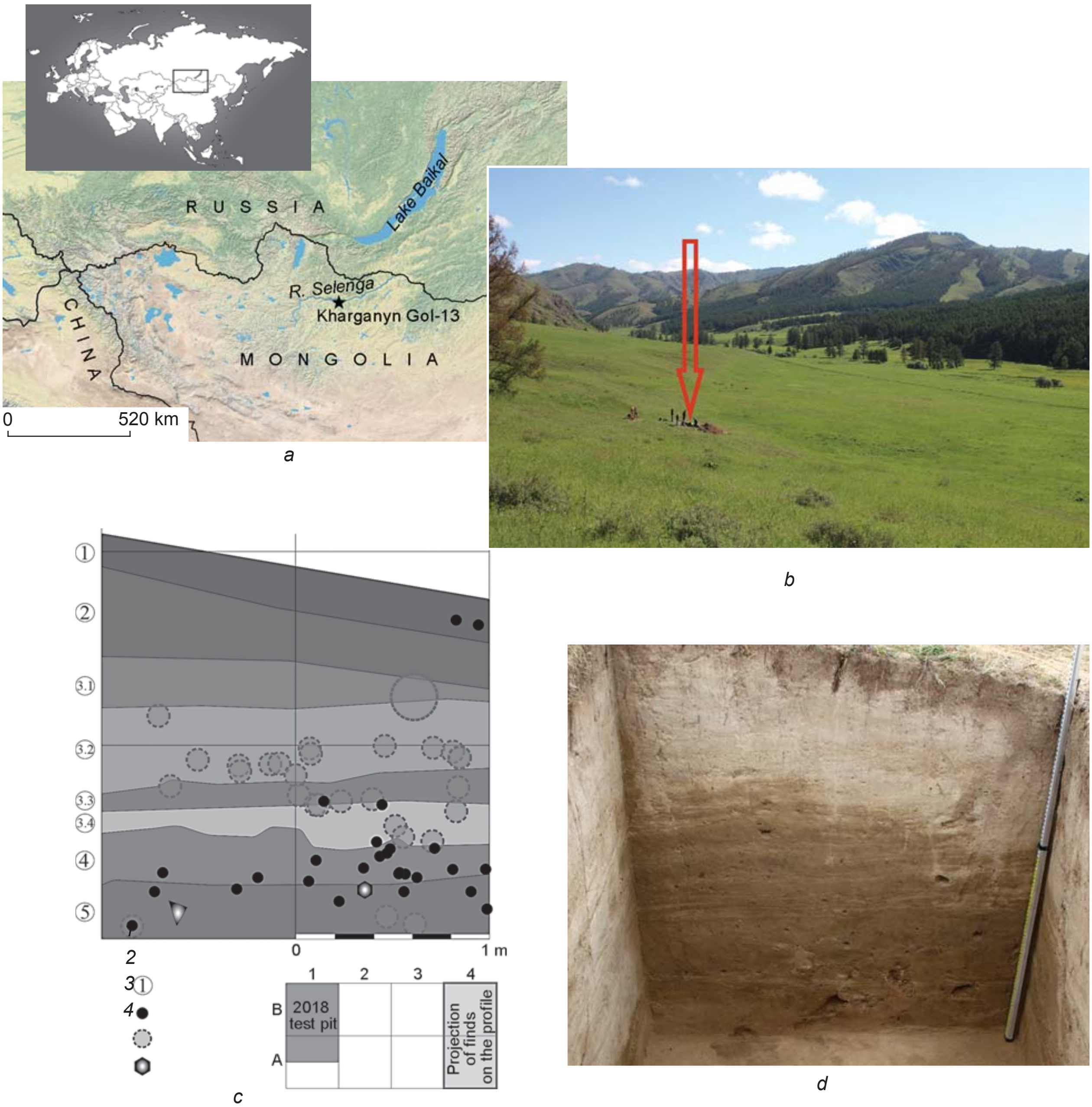


*Fig. 1*. Location of the Kharganyn Gol-13 site (*a*); general view of the site from the south (*b*); stratigraphic profile of lithological layers, northern wall of the excavation (*c*); photograph of the northern wall of the excavation (*d*).
*1* – lithological layer; *2* – lithic artifact; *3* – rodent burrow; *4* – stone.

Layer 1 is modern soil; thickness 10–15 cm.

Layer 2 is uniform whitish-gray dense loess-like powdery sandy loam, with inclusions of fine gravel and crushed stone; thickness 40–50 cm. This layer overlies laminated deposits.

Layer 3 consists of alternating sublayers of light gray, dark gray, and brownish loose loam and sandy loam, 2 to 5 cm thick; total thickness 70–80 cm. This layer includes four lithological horizons.

Layer 4, at depths from 140 to 170 cm, consists of dense light loam, permeated with fine gravel in the middle. Most artifacts were discovered in the upper part of the layer; however, isolated artifacts and bones occurred up to the top of layer 5 (Fig. 2, *a*). The underlying sediments of layer 5 (visible thickness 30 cm) consist of loose homogeneous yellowish loam, with inclusions of local rock cobbles.

Despite the higher (relative to other sites in the Tolbor district) disturbance of sediments resulting from bioturbation and low-energy movement of sediments (traced by inclusions of laminar sublayers and by uneven boundaries of layers), the deposits at Kharganyn Gol-13 reveal the main level of occurrence of archaeological and faunal evidence. This is confirmed by the quantitative distribution of artifacts and animal bones. In the stratigraphic sequence, artifacts form a visible concentrated horizon, which, during excavations was designated archaeological horizon 4, corresponding to lithological layer 4. Finds in the upper and lower layers are often associated with rodent burrows (at least one-third of artifacts) (Fig. 2, *b*); artifacts may have been moved along them from the cultural layer. Rodent burrows occur mainly in the middle of the sequence (lithological layer 3), and occasionally in lower lithological layer 5. The finds are unevenly distributed horizontally, forming elongated clusters (Fig. 2, *c*).

## Archaeological assemblage

As is the case with all archaeological complexes in the Tolbor district, the raw material for the manufacture of most artifacts was silicites—sedimentary silicified rocks. Among these, nine varieties can be distinguished, differing in their petrographic features (Rybin et al., 2022). High quality rocks, which are homogeneous and fine-grained, and at the same time rarer varieties of silicites, represent type 2 (microcrystalline silicite, with a grain size of 0.005–0.01 mm, silty, with a predominantly coarse texture and occasional horizontal layering), and type 5 (fine microcrystalline carbonaceous silicite, with a thinly laminated texture). Raw material of type 1 (silicite calcitized to varying degrees, leucoxenized, and sulfated, with a predominantly coarse texture, sometimes showing uneven recrystallization of the main mass) is a more coarse-grained and internally heterogeneous rock than those described above.

The assemblage collected during the 2022 excavations contains 339 lithic artifacts, including debitage (Table 1). Paleontological evidence is scarce (11 spec.). Lithological layer 4 yielded the remains of a red deer (*Cervus elaphus*) antler and Mongolian kulan (*Equus hemionus*) humerus; lithological layer 5, a tooth fragment of a large bovid.

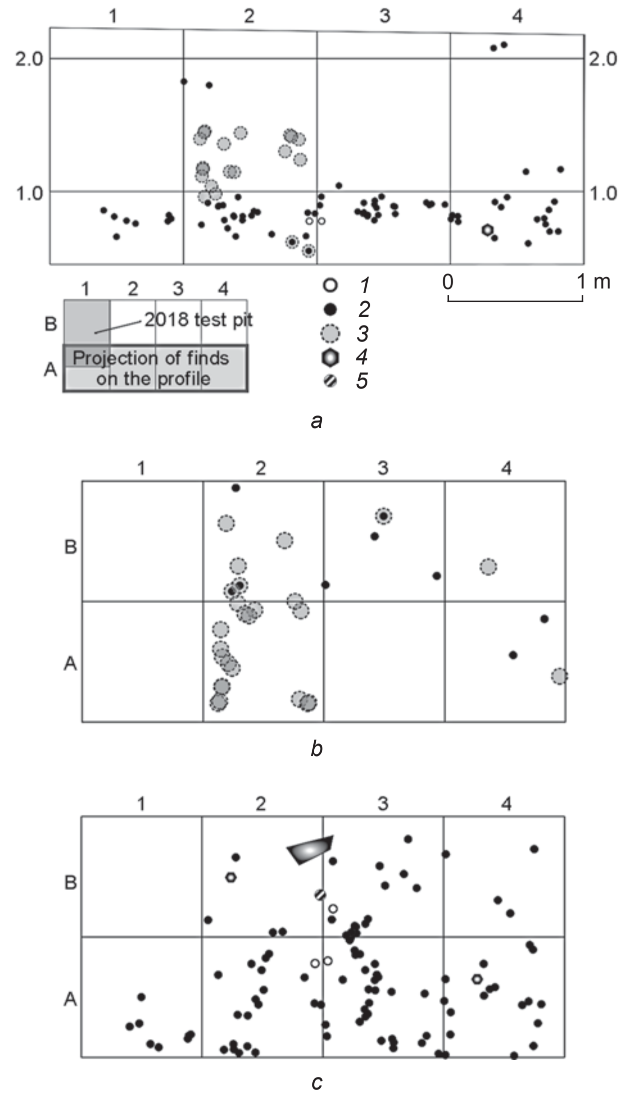


*Fig. 2*. Distribution of archaeological finds at Kharganyn Gol-13 in profile view along line A (*a*) and in plan view, in archaeological horizons 3 (*b*) and 4 (*c*).
*1* – bone; *2* – lithic artifact; *3* – rodent burrow; *4* – stone; *5* – charcoal.

Judging by finds designated on the plan during excavations, and by technologically significant artifacts selected during screening, the amount of archaeological evidence increases from top to bottom of the section, and reaches its maximum in the cultural horizon of layers 4 and 5 (Table 1). In layer 1, six artifacts were found; in layer 2, 12; in layer 3, 17; in layer 4, 89; and in layer 5, 12 artifacts. Some artifacts revealed traces of patination of various degrees of intensity, which may indicate exposure on the surface. In layers 4 and 5, 14.9 % of finds were weakly patinated

(Fig. 3, *15*); the rest of the finds were unpatinated. The analysis of the assemblage from layers 1–3 reveals a different situation: debitage with weak or strong patina constitutes 25.7 % each, while unpatinated items account for 48.6 %. Deposition of most of the artifacts outside layer 4, we assume, resulted from bioturbation and slope wash. We analyzed two assemblages of artifacts: one consisted of items from layers 1–3, and another, from layers 4 and 5. Such differentiation was due to the fact that artifacts from layers 4 and 5, in our opinion, were least affected by post-depositional movement, and formed a relatively compact cultural layer. Finds from layers 1–3 were artifacts redeposited for various reasons; it would be to combine them with those from layers 4 and 5.

The assemblage from layers 4 and 5 totals 224 artifacts, including 101 technologically significant artifacts (Table 1). 80.1 % of the artifacts were made of the most common raw material of type 1; 18.9 %, of higher quality types 2 and 4. A comparison of the types of raw materials has shown that blades and flakes were made on most common 1 and 2 types of silicites, which suggests reduction within a single production process, and all cores were made on a rarer high-quality silicite of type 5. All

*Table 1*. **Typological distribution of artifacts from the Kharganyn Gol-13 site**

| Type | Layers 1–3 | | | | Layers 4 and 5 | | | |
|---|---|---|---|---|---|---|---|---|
| | Total, spec. | Including | | %* | Total, spec. | Including | | %* |
| | | unretouched | tools | | | unretouched | tools | |
| Cores | 1 | 1 | – | 2.9 | 3 | 3 | – | 3.0 |
| Flakes | 14 | 10 | 4 | 40.0 | 40 | 33 | 7 | 39.6 |
| Blades | 9 | 5 | 4 | 25.7 | 27 | 16 | 11 | 26.7 |
| Bladelets | 7 | 7 | – | 20.0 | 7 | 6 | 1 | 6.9 |
| Cortical and semi-cortical blades | – | – | – | – | 3 | 1 | 2 | 3.0 |
| Crested and semi-crested blades | 1 | 1 | – | 2.9 | 7 | 5 | 2 | 6.9 |
| Side blades | – | – | – | – | 3 | 2 | 1 | 3.0 |
| Side flakes | – | – | – | – | 4 | 4 | – | 4.0 |
| Laminar flakes | 2 | 2 | – | 5.7 | 3 | 2 | 1 | 3.0 |
| Core trimming elements | 1 | 1 | – | 2.9 | 4 | 3 | 1 | 4.0 |
| including those resulting from: | | | | | | | | |
| removal of core flaking-surface | 1 | 1 | – | – | 1 | 1 | – | 1.0 |
| rejuvenation of the platform | – | – | – | – | 2 | 1 | 1 | 2.0 |
| removal of core ridge | – | – | – | – | 1 | 1 | – | 1.0 |
| *Subtotal* | 35 | 27 | 8 | 100.0 | 101 | 75 | 26 | 100.0 |
| Flakes < 3 cm | 43 | 43 | – | – | 83 | 83 | – | – |
| Chips | 22 | 22 | – | – | 23 | 23 | – | – |
| Chunks and shatters | 15 | 15 | – | – | 17 | 17 | – | – |
| *In total* | 115 | 107 | 8 | – | 224 | 198 | 26 | – |

*Relative to technologically significant artifacts.

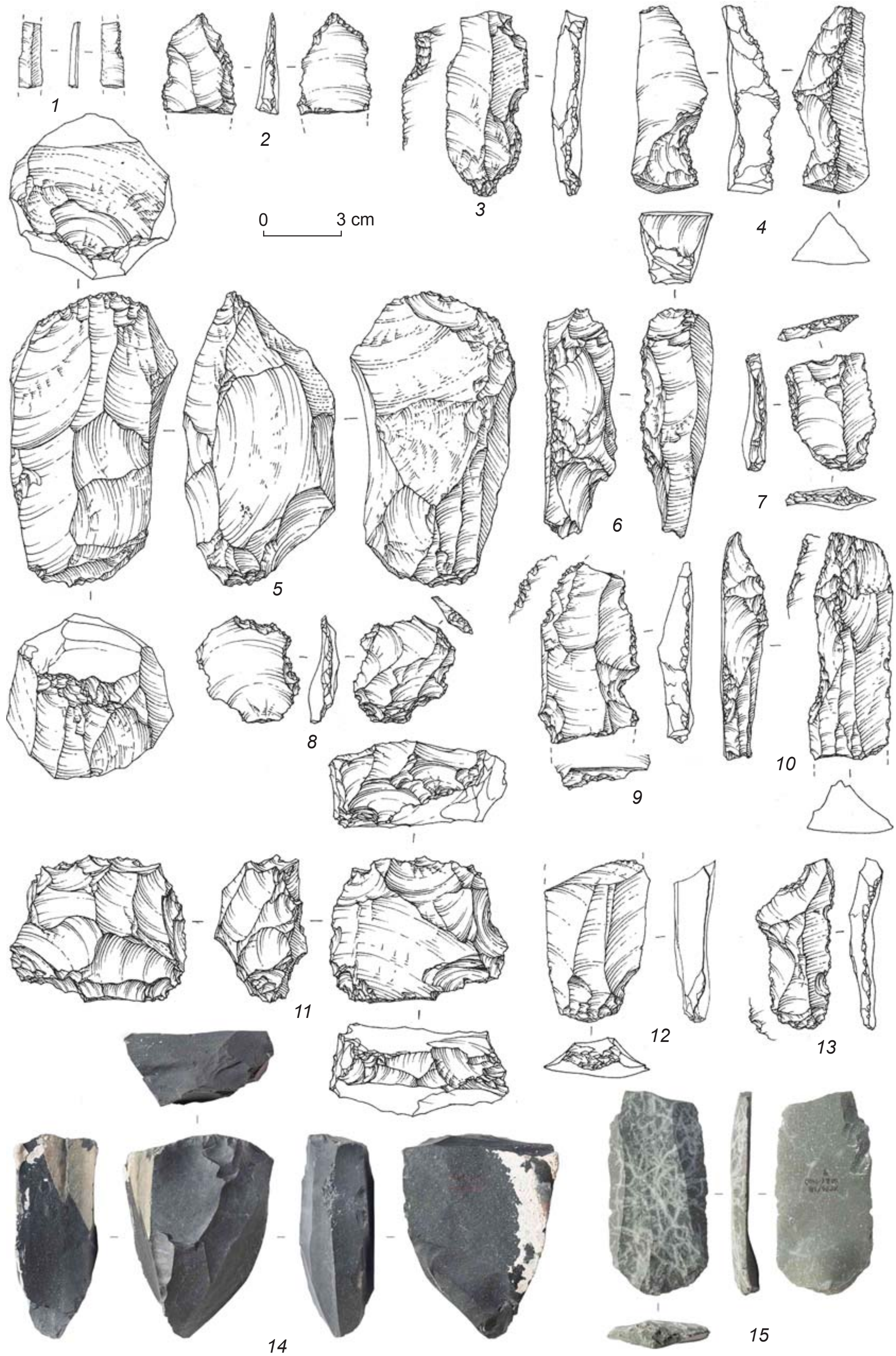


*Fig. 3*. Lithic artifacts from Kharganyn Gol-13. *Drawings by A.V. Abdulmanova; photographs by S.A. Kogai*.

the cores correspond to the final stage of flaking, since natural crust is absent from their working surfaces. In addition to a flat orthogonal core (Fig. 3, *11*), the assemblage includes a subprismatic nucleus with traces of bidirectional blade removals (Fig. 3, *5*). There is also an asymmetric core with two adjacent flaking-surfaces (Fig. 3, *14*), from layer 4 in test pit 2 excavated in 2018. A narrow-faced core on a marginal flake, bearing negative scars of unidirectional removals made after the detachment of a blank from the core, was similar in morphology to atypical core-burins (Fig. 3, *6*). Laminar pieces constituted a high share of all flakes: 46.5 % (Table 1; Fig. 3, *12*); flakes with remains of cortex on dorsal surfaces amounted to 45.5 %. The convex flaking-surfaces of cores were maintained by removing débordant flakes and blades and crested blades (Fig. 3, *4*, *10*). Different types of dorsal patterns of blades are dominated by parallel unidirectional scars (65 %); flakes with parallel bidirectional dorsal surfaces account for 25 %. Differentiation of laminar products by width revealed a series of small blades (≤12 mm; 23.4 %) (Fig. 3, *1*). The industry is dominated by medium-sized blades (20–40 mm; 51.1 % of all blades), while large blades (>40 mm) are rare (4.3 %). In terms of average metric parameters, relatively small blades (51 mm long, 25 mm wide, and 7 mm thick) dominate this assemblage. Natural and plain residual striking platforms of blanks prevail (71.7 %); the percentage of prepared striking-platforms (mainly dihedral) is 18.9 %. The technique of preparing the edge of the striking-platform by pecking, specific to the IUP, was recorded (Fig. 3, *12*, *15*).

The toolkit consists of 26 items, or one-fourth of all technologically significant artifacts (Table 1). Most of the tools (17 spec.) were made on laminar blanks. Retouched blades (5 spec.) and retouched flakes (6 spec.) are relatively numerous. Perforators/spur-like tools (6 spec.) form a significant series. There is a symmetrical point on a distal fragment of blade (Fig. 3, *2*). The industry shows the use of the intentional tool-fragmentation technique, manifested by the availability of one truncated (Fig. 3, *7*) and three multifunctional (Fig. 3, *9*) tools. There are five notched-denticulate pieces (Fig. 3, *8*, *13*); the same processing appears on a retouched bladelet (Fig. 3, *1*). One of the notched tools shows traces of another typical IUP method, namely, ventral trimming of the bulb of percussion (Fig. 3, *4*). Tools specific to the IUP (Rybin et al., 2022) include a multifunctional stemmed blade (Fig. 3, *3*); its proximal part on both longitudinal edges had been treated with intense abrupt scalar-stepped retouch. The toolkit of this industry exhibits a large proportion of fragmented items. Among 17 blades (tool blanks), only one is complete. The majority of tools exhibit traces of secondary trimming on one-quarter of their perimeter. The percentage of items with working edges subjected to strong or medium modification is high (15 % and 50 %, respectively). 7.7 % of tools have three or more morphologically different elements of secondary processing; 30.8 % of tools, two elements.

Artifacts from layers 1–3 were made of the same varieties of silicites as those from layers 4 and 5. Blanks from layers 1–3 and their preparation are similar to those from layers 4–5 at the site. The toolkit, consisting of eight items, includes non-serial varieties of simple implements, such as a single longitudinal side-scraper, an end-scraper, a spur-like tool, a retouched flake, three retouched blades (one with ventrally trimmed bulb of percussion), and a fragmented tool.

## Discussion

The lithic industry rom layers 4 and 5 is characterized predominantly by specific bidirectional volumetric technology aimed at the production of mainly medium-sized and small blades based on the sub-prismatic/asymmetric volumetric reduction concept. Flaking surfaces were formed by preparation of plain, less often rejuvenated, striking-platforms with the use of overhang removal, reverse reduction, and pecking. The toolkit is sparse, and contains typical IUP varieties of tools.

These data indicate the absence of any significant qualitative and quantitative differences between the industries from layers 1–3, as well as 4 and 5. The upper layers of the site have not revealed any manifestations of a tradition different from that appearing in the main cultural layer. The sediments of the site contain only one cultural layer, with its matrix located in lithological layer 4. All artifacts contained in the over- and underlying sediments found their way to this layer as a result of post-depositional factors, such as bioturbation, slope movement of soil, etc. Thus, Kharganyn Gol-13 is an exceptionally rare single-layer archaeological site of the IUP for the Tolbor district.

A very limited range of lithic raw materials was used at the site, which is extremely unusual for archaeological sites in the region. IUP assemblages of the Tolbor group usually testify to the use of all available varieties of silicites and other, rarer rocks (there are 13 main varieties). Since there are no primary outcrops of lithic raw material in the immediate vicinity of Kharganyn Gol-13 (which is also unusual for settlement systems in the Tolbor district), it can be assumed that all artifacts were brought to the site from distant locations. As mentioned above, all cores found in the excavation area reveal the final stage of reduction, and the percentage of items with cortex is quite large. Consequently, a small number of cores with initial preparation were brought to the site as raw materials, and their further reduction occurred in situ. The industry is distinguished by relatively small (in comparison with other IUP complexes in the region) cores and blanks, and by the high degree of fragmentation of the artifacts. This suggests intense and probably short-term use of tools designed to perform specific operations. Description of this complex can be supplemented by indicators revealing some aspects of the residential activities in the area of the site under study. The density of distribution of finds (including debitage; the 2022 excavation area alone was 6 m$^2$) is 37 lithic artifacts per m$^2$. This is one of the lowest values for IUP sites in the Tolbor district. The percentages of the main categories of lithic artifacts make it possible to classify the IUP industries of the Tolbor district as typical of sites located near rock outcrops (Table 2) (Rybin et al., 2022). According to the ratio of the number of technologically significant artifacts per core, a low intensity of reduction (from 15 to 25 blanks) can be reconstructed for such sites. Notably, the only sites with higher values of this indicator are both localities in the Kharganyn Gol valley, which is located on the periphery of the lithic raw material belt. Evidence from Kharganyn Gol-13 testifies to the intense production and use of tools (the number of unretouched blanks per tool), since every second or third flake was subjected to secondary trimming. These values are half as much at other sites, except for Tolbor-16. As to the efficiency of activities associated with tool manufacturing, it was low in almost all sites in the Tolbor district (2–5 tools per core), with the exception of sites in the Kharganyn Gol valley (6–8 tools per core), and approaches values recorded

*Table 2.* **Ratios of main categories of artifacts from the IUP assemblages of the Tolbor district**

| Site | Archaeological units | Cores : tools* | Tools : unretouched blanks* | Cores : blanks + tools* | Cores : tools** | Tools : unretouched blanks** | Cores: blanks + tools** | Cores, % of the assemblage*** | Blanks, % of the assemblage*** | Tools, % of the entire assemblage | Debitage, % of the entire assemblage | Source |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Tolbor-16 | Horizon 6 | 1:5.7 | 1:2.1 | 1:15 | – | – | 1:5 | 6.2 | 64.1 | 29.7 | 62.9 | Zwyns et al., 2019 |
| Tolbor-21 | Excavation pit 2, Horizon 4 | 1:3 | 1:6 | 1:22 | 1:1.8 | 1:6 | 1:13 | 4.2 | 82.8 | 13 | 32 | Rybin et al., 2020 |
| Tolbor-4 | Horizon 5a | 1:2.3 | 1:6 | 1:15 | 1:1.7 | 1:7.2 | 1:9.5 | 6.4 | 76.6 | 17 | 46.6 | This study |
| | Horizon 6 (2006) | 1:4.2 | 1:5 | 1:25 | 1:2.6 | 1:5 | 1:16 | 3.8 | 80 | 16.2 | 47.7 | Rybin et al., 2022 |
| Kharganyn Gol-5 | Horizon 5 | 1:6.1 | 1:7.8 | 1:44,5 | 1:3.9 | 1:8.2 | 1:36 | 1.8 | 86.9 | 11.3 | 41.4 | Khatsenovich et al., 2017 |
| Kharganyn Gol-13 | Layers 4–5 | 1:8.6 | 1:2.7 | 1:32,6 | 1:4.6 | 1:2.9 | 1:18 | 3 | 71.2 | 25.7 | 60.2 | This study |

*Including fragmented artifacts.
**Only complete blanks and proximal fragments.
***Excluding debitage.

at IUP sites in the Transbaikal region, where raw materials were probably transported in from other places (Lbova, 2000).

## Conclusions

The features revealed at the single-component Kharganyn Gol-13 site make it possible to attribute its lithic industry to the Selenga variant of the IUP. Several factors may have affected its structure. The main factor was the lack of outcrops of suitable lithic raw material in the vicinity of the site, which forced its inhabitants to bring already prepared cores there. Short-term, but intense human activities in this locality were associated with the manufacture, processing, and use of tools. The site was situated in the extension of a river valley, not far from rock outcrops that formed a relatively narrow space; it was a convenient place for hunting animals. IUP humans in northern Mongolia hunted large mammals (equids and bovids), which required constant movement. Another factor that determined the choice of site location was the availability of nearby lithic raw materials suitable for tool manufacturing. Until recently, quarry-workshop sites located near raw material outcrops were considered to be the only type of IUP settlement in the Tolbor district. During our study of Kharganyn Gol-13, we reconstructed the features of this short-term hunting camp, the inhabitants of which may have been engaged in the pursuit and utilization of game animals. This conclusion is indirectly confirmed by a few bones found at the site, which reflect the nutritionally valuable parts of animal carcasses. Kharganyn Gol-13 differs from other settlements in the absence of sources of lithic raw materials nearby. This feature suggests a more diverse settlement system than was previously assumed. Such complexes include small IUP sites (Rybin et al., 2016) characterized by small numbers or a complete absence of cores, a high percentage of tools, and a low density of distribution of artifacts and bones. These are known from the "dead-end" right tributaries of the Selenga River, outside the most actively populated valley of the Ikh-Tulburiyn Gol with its rich outcrops of stone raw materials, which was a "transitional route" for IUP populations. Thus, the IUP mobility system in northern Mongolia entailed the establishment of camps designated for different settlement activities.

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# Morpho-Stratigraphy, Sedimentology, and Radiocarbon Chronology of Suyanggae Sites, Focusing on Loc. VI, South Korea

*We reconstruct the processes of sedimentation at the Suyanggae Paleolithic sites, geomorphologically characterized by fluvial terraces in the Namhan River, the base level of which is higher than the present river bottom. The fluvial sedimentary deposits, slope deposits, and paleosols are the main units of surficial deposits, constituting the site materials of Suyanggae Loc. VI. According to the representative profiles of the site, the deposits comprise sands and gravel at the bottom part, while sands and flooding muds with occasional intercalations of reddish-brown slope muds, as well as rounded or subangular cobbles or boulders, dominate the middle to upper part. Regarding the terrace's morpho-stratigraphy, Suyanggae Loc. VI is located above the low (second) fluvial terrace. Considering the chronology of site material formations, Suyanggae Loc. VI was formed in the last glacial period. On the basis of radiocarbon dates obtained for the charcoals from Suyanggae Loc. VI, the age of cultural layers is determined. Cultural layer 2 was formed in the late Upper Paleolithic, and CL 3 and CL 4 are associated with the early Upper Paleolithic. The archaeological assemblage of Suyanggae Loc. VI is described: lithic*

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*artifacts of CL 2 are characterized by abundant microblades (ca 20 ka BP, Last Glacial Maximum), while those of CL 3 and CL 4 are associated with tanged points and blades (36–42 ka BP, middle of the last glacial period). Especially noted are a line-engraved cobble stone excavated from the sedimentary matrix of fluvial origin, and a face-engraved pebble stone found in flooding muds. The finds are interpreted as manifestation of symbolic human behavior.*

Keywords: *Suyanggae Loc. VI, site formation process, paleosols, microblades, tanged points, Upper Paleolithic.*

## Introduction

Suyanggae Paleolithic sites (Cultural Heritage Site No. 398) are located near the settlements of Aegog-ri (Suyanggae Loc. I and Loc. III) and Hajin-ri (Loc. VI), in Danyang County in Chungbuk Province (Fig. 1), central part of the Republic of Korea. Three excavation localities include Loc. I, Loc. III, and Loc. VI (Lee Y.J., 1989, 2000a, b; 2007; Lee Y.J., Yoon, 1992, 1993; Lee Y.J., Kong, 2004; Lee Y.J., Woo, Kong, 1999; Lee Y.J. et al., 2013a, b; 2018; Kim J.Y., Lee Y.J., 2005, 2006; Kim J.Y. et al., 2017, 2020; Kim K.J. et al., 2021; Oh, Kim, 2018). Suyanggae sites are geomorphologically associated with the marginal part and flooding bank of the upstream Namhan River (Fig. 2). The fluvial terraces, the base level of which is higher than the present river bottom, are surrounded by relatively steep mountains and meandering cores along the upstream Namhan River. Deposits in localities I, III, and IV are overlain by sand and gravel derived from the old Namhan fluvial process. Among the three Suyanggae sites, the topographic setting of Loc. III is the uppermost part of the elevation (Fig. 2). Loc. I is situated on the lower terrace (second FT) at an elevation of about 125–127 m a.s.l. (115 m above the present river bottom). Loc. VI is composed of old riverbed sands dominating the level above


*Fig. 1.* Locations of Suyanggae sites, Loc. I–VI.

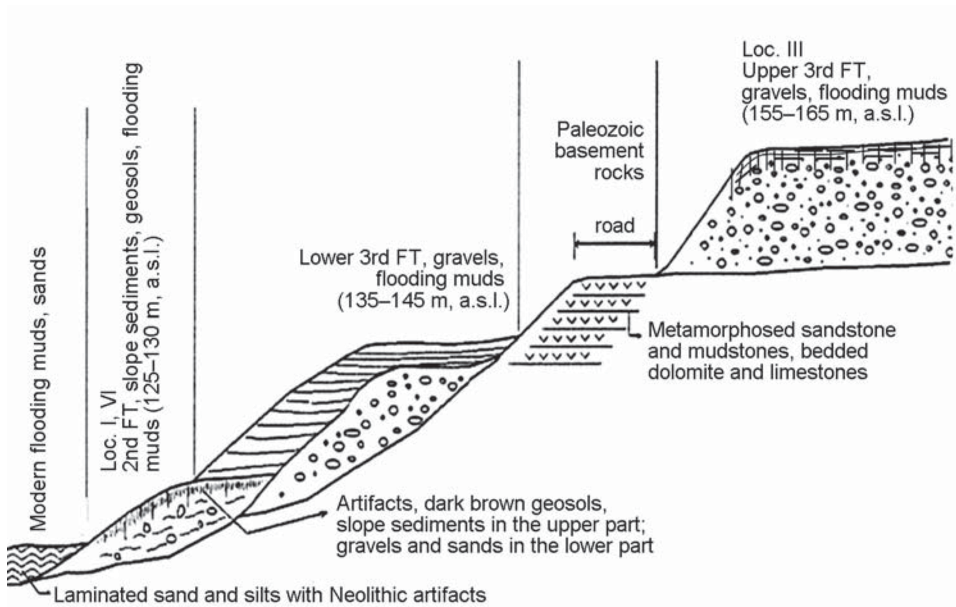


*Fig. 2.* Morpho-sedimentary implications of Suyanggae sites from the present riverbed to the third fluvial terrace, near the Danyang area.

121–126 m a.s.l. In all Suyanggae sites, either slope sediments or paleosols overlay fluvial deposits. The fluvial sediments underlie the paleosols, which are geosols associated with soil wedges and fragipans, formed during the freezing and thawing process of the Glacial Period. Paleosols are ubiquitously developed and observed in many Paleolithic sites in Korea (Kim J.Y. et al., 2016). Along the riverbank of Chungju Dam, both Suyanggae Loc. I and Loc. VI belong to the submerged parts of the hydropower dam. At several Suyanggae sites, cultural layers are associated mainly with paleosols and/or slope deposits. Some lithic artifacts are found in the lowermost part of reddish-brown paleosols; however, most often, finds (e.g., tanged points, blades, microblades, cores, end scrapers, and so forth, as illustrated in Suyanggae Loc. VI) are associated with yellowish-brown or dark-brown paleosols belonging to the Upper Paleolithic. The purpose of this study is to illuminate the site-formation process in the geoarchaeological background of Suyanggae Loc. VI.

## Morpho-stratigraphy and chronological background

Suyanggae Loc. VI (address: 302 Hajin-ri, Jeokseong-myeon, Danyang, Chungbuk Province) is adjacent to two distributary streams (Sangri-cheon from the north and Danyang-cheon from the south) of the Namhan River, where the incised meandering and longitudinal bars are observed in the riverbed. Suyanggae Loc. VI was excavated consecutively for three years (2013–2015) before the construction of the submerged embankment, up to about 132 m a.s.l. (Fig. 2). During the excavation survey, the water level of the dam was maintained at around 125 m a.s.l. The excavation site was situated approximately 125 m a.s.l. toward the Namhan River and 132 m a.s.l. toward the hillslope margin. Suyanggae Loc. VI is situated above the second fluvial terrace (Fig. 2). The representative lithologic profile is recorded in grid -5D toward the hillslope margin (Fig. 3), where fluvial deposits and mudflows intercalated with debris are conspicuous. Sandy muds are more abundant between 122 and 123.7 m a.s.l., perhaps due to flooding episodes in the paleo-Namhan River. C–M patterns of fine-grained sediments in the representative profile of Suyanggae Loc. VI indicate that these were derived from both the suspension process of the paleo-Namhan River and mudflows linked to the slope process (Kim J.Y. et al., 2020) (Fig. 4). Below 127.3 m a.s.l., suspension loads of flooding muds and fine sandy muds are dominant, while over 127.3 m a.s.l., mudflow is a conspicuous transporting process, mostly derived from the northwestern

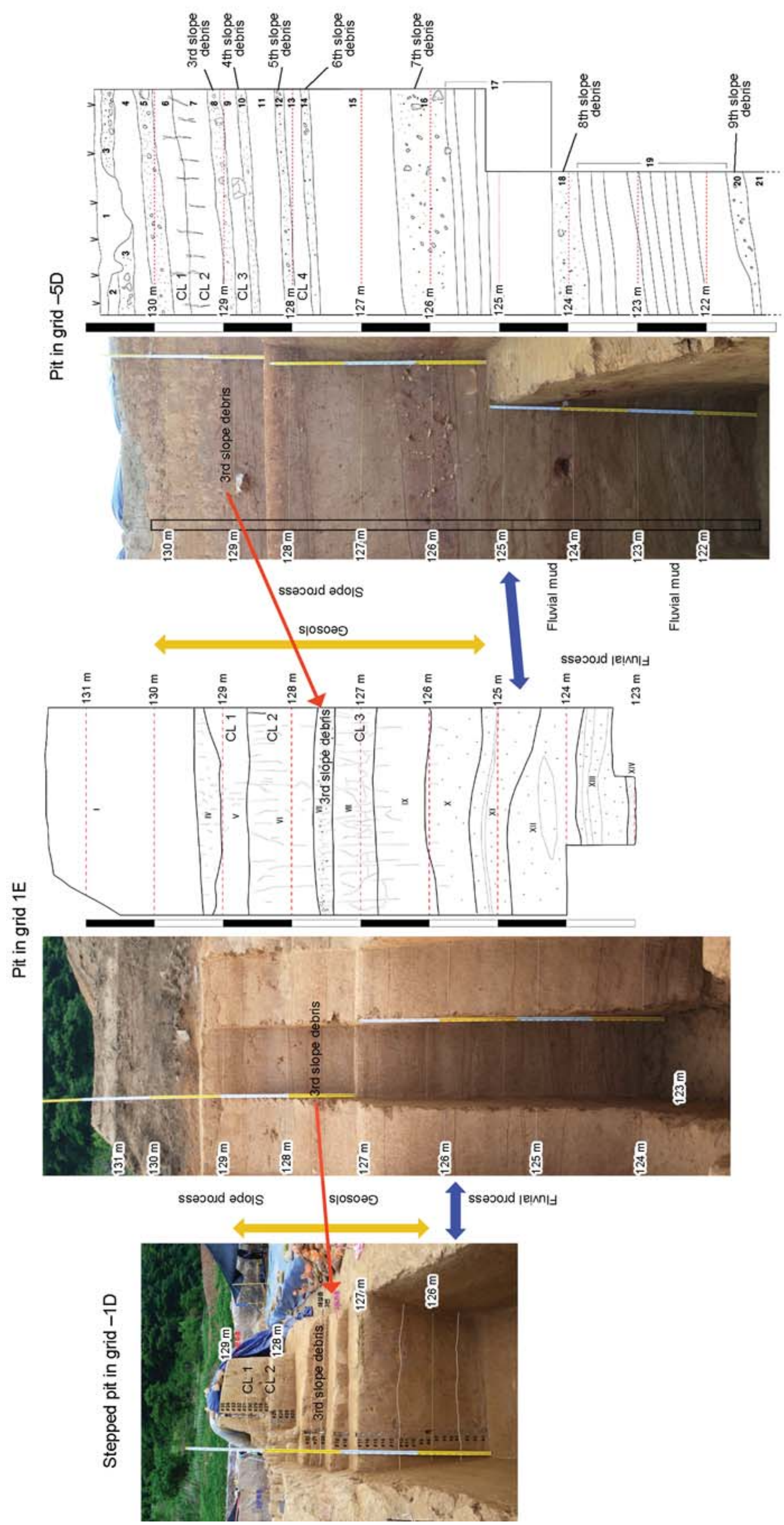


*Fig. 3.* Lithological profiles of three pits (grids -1D, 1E, and -5D) in the transverse direction of the Namhan River in Suyanggae Loc.VI.

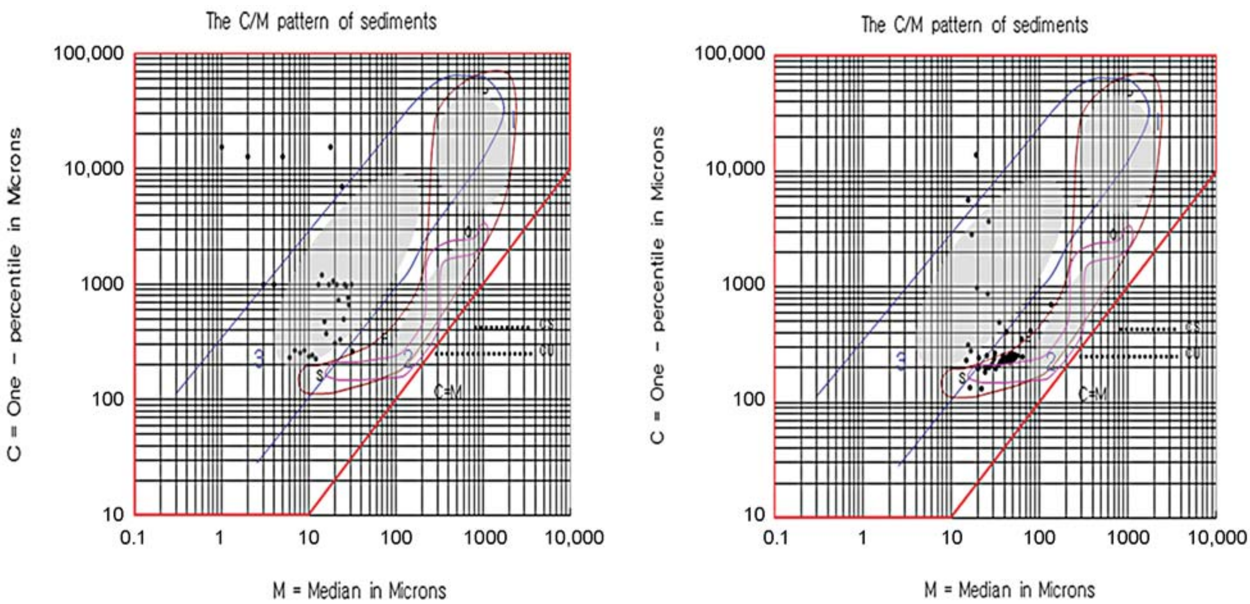


*Fig. 4.* C/M-patterns of both slope-derived deposits (SD) and fluvial sandy mud deposits (FD) of Suyanggae Loc. VI. SD is dominant above 127.3 m a.s.l., while both SD and FD are mixed between 127.3 and 123.7 m a.s.l.

hillslope margin. Sandy muddy loams, such as paleosols, are mainly distributed between 128 and 130 m a.s.l.; these were transported mainly by mudflows, which originated from the hillslope process rather than the fluvial process of the paleo-river.

Cultural layers (CL) 2 and 3 are linked to yellowish-brown paleosols, but CL 4 to reddish-brown paleosols (see Fig. 3). According to the projection diagram of artifact production vs. the elevation perpendicular to the NNW–SSE grids of Suyanggae Loc. VI (Lee Y.J. et al., 2018), CL 4 is mostly separated from CL 3 toward the hillslope over about 128 m a.s.l. (grids 4C–6A), but mixed with CL 3 between 126 and 128 m a.s.l. (grids 3A–1C) (Fig. 5). About 126 m a.s.l. (grids 1B–3G), many artifacts are predominantly produced with CL 3; artifacts from CL 4 become less diversified, except the tanged points. The radiocarbon age of CL 2 in the matrix of yellowish-brown muddy paleosols ranges between 17,550 ± 80 BP and 20,470 ± ± 70 BP (average age: 18,410 ± 70 BP, or 22,467–22,023 cal BP). This corresponds to the initial cold and dry period of the last glacial maximum (LGM) (see *Table*). The radiocarbon age of CL 3, composed of the yellowish-brown muddy paleosols, ranges widely between 30,360 ± 350 BP and 44,100 ± ± 1900 BP (average age: 35,180 ± 450 BP, or 40,172–39,321 cal BP). The radiocarbon age of CL 4, which comprises reddish-brown muddy paleosols, ranges between 34,620 ± 190 BP and 46,360 ± ± 510 BP (average age: 36,980 ± 350 BP, or 41,874–41,254 cal BP). Taking the average radiocarbon age into account, CL 4 is approximately 2000 years older than CL 3 (Lee Y.J. et al., 2018). At Suyanggae Loc. VI, in CL 2, the artifacts, such as microblade cores, scrapers, and blades, were found (Fig. 6). Blades and tanged points were discovered in CL 3 and 4 (Fig. 7, 8). Line-engraved cobble stones (LECS) were deposited in CL 3, where flooding muds predominated at about 126 m a.s.l. (grid 5C). Charcoals obtained from the same horizon of grid 5C (126.057 m a.s.l.) produced two radiocarbon ages: 34,020 ± 400 BP (OTg141001, KIGAM-2014) and 36,600 ± 1100 BP (AA105103, UA-2014). The average calibrated (2σ) age is 38,046–35,681 cal BP and 40,536–37,281 cal BP (Kim K.J. et al., 2021). The discovery of LECS in CL 3 (Fig. 9) suggests that modern humans who lived during the Early Upper Paleolithic might have had some metrological cognition to reproduce blade tools and LECS (Fig. 10). In addition, it can be inferred that CL 2 was formed in the Late Upper Paleolithic under severe paleoclimate conditions (events 2.2–2.21, after (Pisias et al., 1984)), while CL 3 and 4 in the Early Upper Paleolithic under relatively mild interstadial paleoclimate conditions (event 3.1, after (Ibid.)).

## Discussion

### *Morpho-stratigraphical and sedimentary environments*

The Namhan River Valley in Danyang County was excessively denudated. Correspondingly, the base level of old riverbeds might have been conspicuously lowered, at least to 115 m a.s.l. The average altitude difference between the gravel beds of the third FT and the present riverbeds in Suyanggae Loc. III is about 45 m. Accordingly, the geomorphic formation age of the middle fluvial terrace can be calculated to as old as ca 300 thousand years, if we apply a general uplift rate amounting to ca 0.14–0.15 m/thous. years; this rate is one of the lowest in the Korean Peninsula (Kim J.Y. et al., 2008). Morpho-stratigraphically, Suyanggae Loc. VI was developed above the second FT, but Suyanggae Loc. III is situated above the third FT, at least 25 m higher than the second FT (see Fig. 2). The second fluvial terrace, as shown in Suyanggae Loc. I and VI, is much younger than the third fluvial

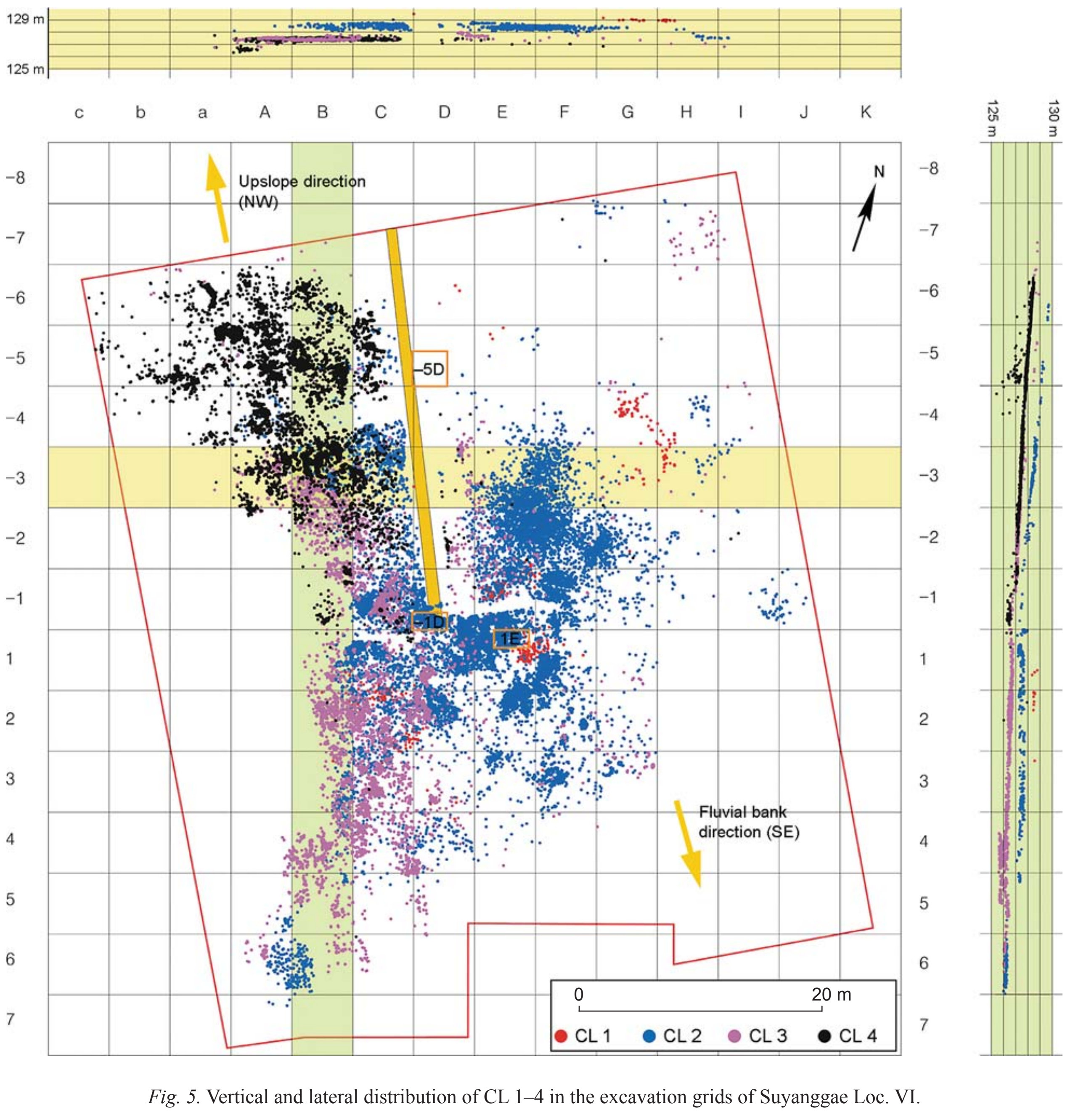


*Fig. 5.* Vertical and lateral distribution of CL 1–4 in the excavation grids of Suyanggae Loc. VI.

**Radiocarbon dates obtained from charcoals from CL 2–4 in Suyanggae Loc. VI**

| Cultural layer | Sample | Grid | $^{14}$C-age, BP | Calibrated age, ± 2σ (95.4 %) | AMS facility |
|---|---|---|---|---|---|
| 2 | SYG-2-1 | 3F | 18,400 ± 60 | 22,454 ~ 22,028 | IAAA |
| | SYG-2-2 | 1Tr | 17,779 ± 85 | 21,826 ~ 21,242 | NSF |
| | | | 17,660 ± 90 | 21,677 ~ 21,034 | CAL |
| | SYG-2-3 | 1C | 20,470 ± 70 | 24,962 ~ 24,344 | IAAA |
| | SYG-2-4 | 2C | 18,770 ± 60 | 22,846 ~ 22,442 | IAAA |
| | | | 18,690 ± 60 | 22,732 ~ 22.391 | IAAA |
| | | | 17,850 ± 60 | 21,850 ~ 21,411 | IAAA |
| | | | 17,550 ± 80 | 21,493 ~ 20,927 | KIGAM |
| | | | 18,490 ± 80 | 22,557 ~ 22,141 | KIGAM |
| 3 | SYG-3-1 | -3C | 34,880 ± 190 | 39,916 ~ 38,875 | IAAA |
| | SYG-3-2 | -1E | 32,450 ± 160 | 36,773 ~35,952 | IAAA |
| | SYG-3-3 | -1B | 36,280 ± 200 | 41,417 ~ 40,418 | IAAA |
| | SYG-3-4 | 1D | 34,690 ± 180 | 39,696 ~ 38,721 | IAAA |
| | SYG-3-5 | 2E | 38,180 ± 230 | 42,705 ~ 41,996 | IAAA |
| | | | 39,680 ± 390 | 44,163 ~ 42,755 | CAL |
| | SYG-3-6 | 3C | 30,360 ± 350 | 34,976 ~ 33,804 | NSF |
| | SYG-3-7 | 3C | 35,280 ± 470 | 40,965 ~ 38,821 | CAL |
| | SYG-3-8 | 5C | 36,000 ± 1,100 | 42,549 ~ 38,571 | NSF |
| | | | 34,020 ± 400 | 39,549 ~ 37,283 | CAL |
| 4 | SYG-4-1 | -3B | 36,580 ± 210 | 41,678 ~ 40,726 | IAAA |
| | SYG-4-2 | -3B | 34,620 ± 190 | 39,641 ~ 38,651 | IAAA |
| | SYG-4-3 | -3C | 42,000 ± 340 | 46,008 ~ 44,722 | IAAA |
| | SYG-4-4 | -6A | 36,600 ± 360 | 41,871 ~ 40,473 | CAL |
| | SYG-4-5 | -5B | 37,190 ± 320 | 42,201 ~ 41,186 | CAL |
| | SYG-4-6 | -4B | 34,870 ± 540 | 40,724 ~ 38,397 | CAL |

*Note*: AMS-dating was carried out in the Korea Institute of Geoscience and Mineral Resources (KIGAM), Carbon Analysis Laboratory, Korea (CAL), Institute of Accelerator Analysis, Japan (IAAA), and Arizona AMS Laboratory, USA (NSF).

terrace. The sedimentary deposits are typified by fluvial sand and gravel, slope deposits, such as mud and debris flow, and paleosols—the main lithological units constituting the site-formation materials of Suyanggae Loc. VI. On the basis of the representative profile of Suyanggae Loc. VI, dominant sedimentary deposits are composed of sands and gravel at the bottom, sands and flooding muds with occasional intercalations of reddish-brown slope mud flows, and debris flows comprising subrounded to subangular cobbles or boulders.

### *Paleosols as pedosedimentary units*

In the Korean Peninsula, paleosols formed during or after the last interglacial period (ca 130 ka BP) are widely observed in the eroded parts of slope margins or above fluvial terrace gravels (Lee D.Y., Kim, 1992; Kim J.Y., Lee, 2006; Kim J.Y., Lee, Choi, 1998; Kim J.Y., Yang, 2001, Kim J.Y. et al., 2016, 2017; Kim J.Y., 2001). Suyanggae sites are one of the most well-known fluvial open sites on the Peninsula. They are characterized by paleosols defined as pedo-


*Fig. 6.* Main artifacts from CL 2 in Suyanggae Loc. VI.
*1* – cores; *2* – blade cores; *3* – micro-blade cores; *4* – flakes; *5* – blades; *6* – spalls; *7* – hammer stones; *8* – side-scrapers; *9* – end-scrapers; *10* – burins and points; *11* – fragments of a stone-bowl.

sedimentary units. These overlie sand and gravel derived from the fluvial process of the paleo-Namhan River (see Fig. 3, 4). Lithic artifacts are not found directly on fluvial sand and gravel; they occur in typical paleosols. Correspondingly, artifact-bearing layers can be considered as soil sedimentary units. In Suyanggae Loc. VI, paleosols can be categorized into dark-brown (Pdb), brown (Pb), yellowish-brown (Pyb), and reddish-brown (Prb). Pb and Pdb are characterized by relatively rich goethite as iron hydroxides, generally showing polygonal patterns and low magnetic susceptibility. In Pb or Pdb, Upper Paleolithic flakes and (micro)blades were found. As observed in Suyanggae Loc. VI, which contains hematites, Prb shows a silt-dominant trend with increasing magnetic susceptibility. Hence, Prb is formed by oxidation during the surficial or overland flow process. Geomorphologically, Prb prevails in the slope margin, ranging from the slope summit through the backslope to the foot slope. Some large lithic artifacts are also associated with Prb in Suyanggae Loc. III. Prb and Pb above the second FT are regarded to have formed during the early to middle part of the last glacial period. The oldest Prb was formed between approximately 45 and 60 ka BP (Kim J.Y. et al., 2016; Kim J.Y., Lee, 2005, 2006). However, Pb was formed as late as about 30 ka BP. At Suyanggae Loc. I, the fluvial deposits at the foot slope were dated to the


*Fig. 7.* Main artifacts from CL 3 in Suyanggae Loc. VI.
*1* – cores; *2* – blade cores; *3* – blades; *4* – flakes; *5* – hammer stones; *6* – refitted artifacts; *7* – side-scrapers; *8* – tanged-points; *9* – line-engraved cobble stone.

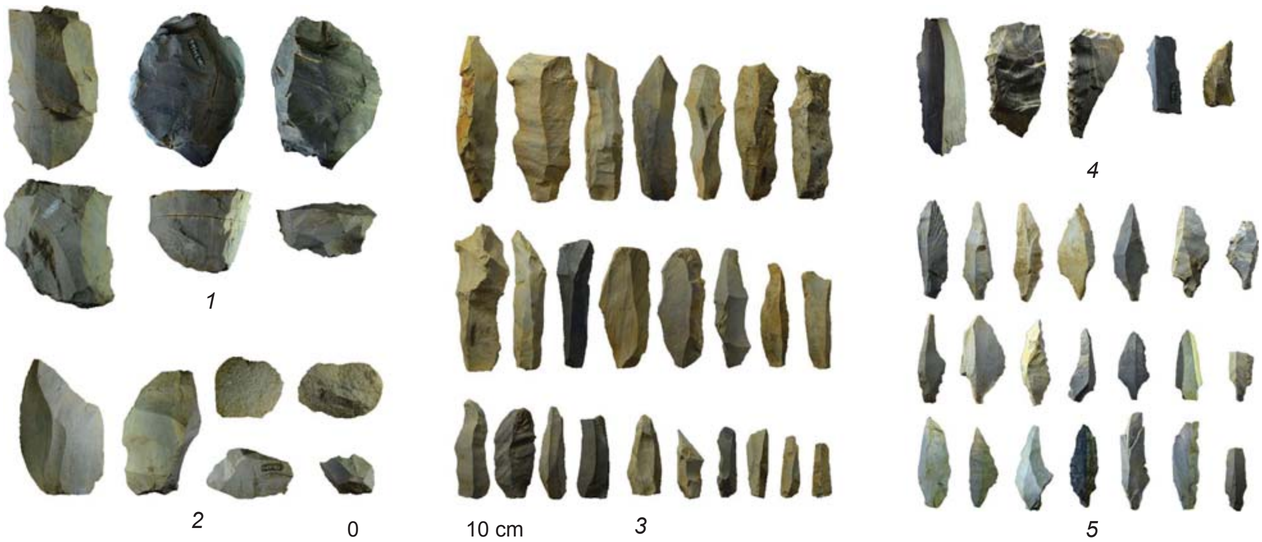


*Fig. 8.* Main artifacts from CL 4 in Suyanggae Loc. VI.
*1* – cores; *2* – flakes; *3* – blades; *4* – side-scrapers; *5* – tanged-points.

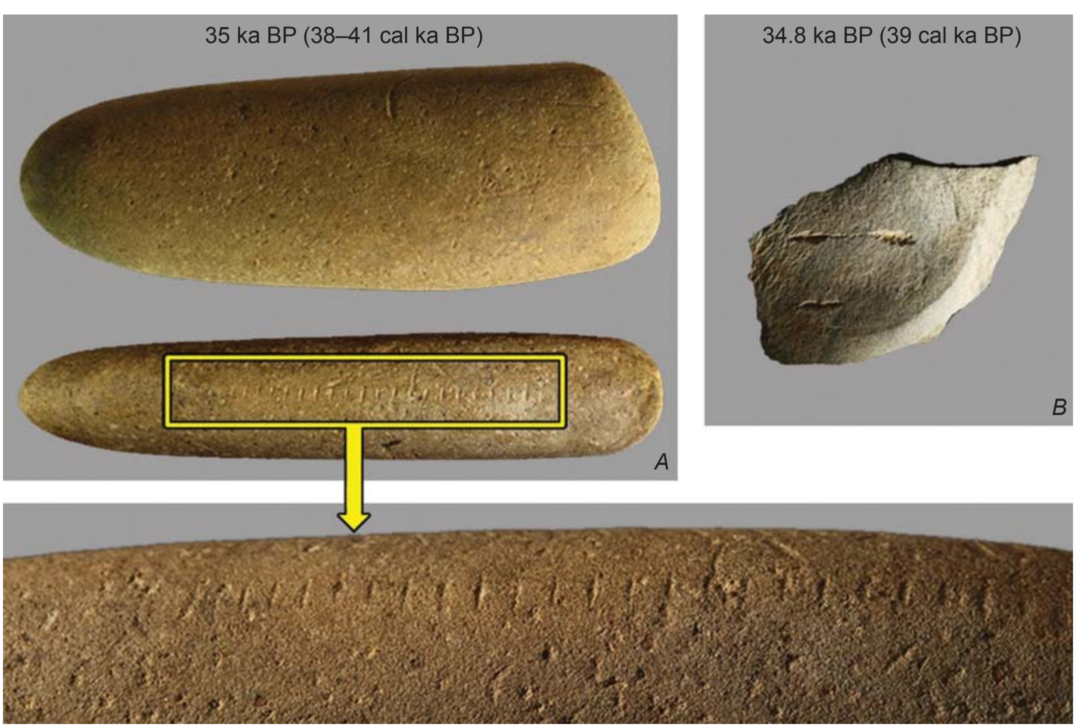


*Fig. 9.* Line-engraved cobble stone (*A*) and face-engraved pebble stone (*B*) from Suyanggae Loc. VI.

range from 28,630 ± 190 BP to approximately 31,140 ± ± 280 BP, so the cultural layer in the Pb matrix over the second FT may be regarded as the late middle last glacial period. Finally, the age of the Pdb in Suyanggae Loc. I is about 18 ka; this may be interpreted as the typical paleosol of the LGM (see Fig. 10).

### *Artifact assemblage*

Lithic artifacts discovered during successive excavation surveys in Suyanggae Loc. VI, included flakes, blades, and tanged points. Many small flakes, cores, blades, scrapers, and points were deposited in

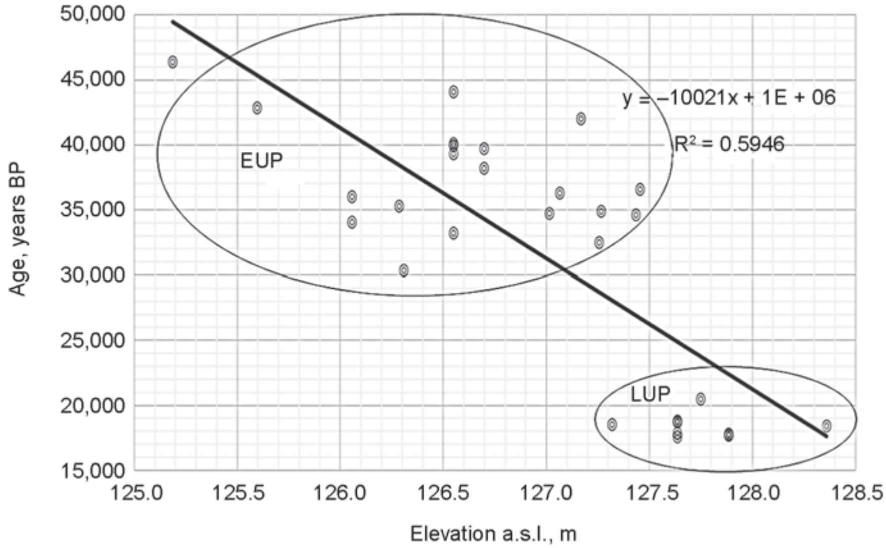


*Fig. 10.* Chronology of cultural layers showing the Late Upper Paleolithic (CL 2) and the Early Upper Paleolithic (CL 3 and 4) at Suyanggae Loc. VI.

Pdb, Pb, Pyb, and Prb. Artifacts are made from raw materials such as quartzite, quartz dykes, sandstones, rhyolites, hornblende, and so forth. At Suyanggae Loc. VI, most of artifacts (blades, scrapers, tanged points, microliths, and face-engraved pebble stones (FEPS)) (see Fig. 6, 7), as well as tool-making debitage, were found in CL 2 and 3. The lithic assemblage of Suyanggae Loc. VI CL 2 contains abundant microblades (see Fig. 6), while those of CL 3 and 4 tanged points and blades (see. Fig. 7, 8). Furthermore, in CL 3, in the sediments of flooding mud on the second FT of the paleo-Namhan River, below 127 m a.s.l., a line-engraved cobble stone was found (see Fig. 9). At Suyanggae Loc. VI, the chronology of CL 3, associated with tanged points and blades, ranges between 36 and 42 ka BP, and the age of lithic artifacts of CL 2, characterized by abundant microblades, converges to ca 20 ka BP (LGM) (see *Table*). Therefore, it makes sense that CL 2–4 at Suyanggae Loc. VI belong to the Early to Late Upper Paleolithic, with a predominance of blades and tanged points (see Fig. 6–8, 10).

## Conclusions

The site of Suyanggae Loc. VI is situated above the second fluvial terrace, which is below the middle fluvial terrace (third FT). The second FT generally prevails at the topographical level of the fluvial sand and gravel lower than about 130 m a.s.l., along the slope margins of the Namhan River valley. The main components of surficial deposits of Suyanggae Loc. VI are pedosedimentary units of fluvial deposits, slope deposits, and paleosols. The surficial deposits comprise sands and gravel at the bottom, sands and flooding muds with occasional intercalations of reddish brown slope muds, and rounded or subangular cobbles or boulders between the middle and upper parts of the representative profiles of Suyanggae Loc. VI. According to the results of the analysis of sedimentary site-formation processes and the chronological data, Suyanggae Loc. VI was formed after the middle last glacial period (ca 45 ka BP (Martinson et al., 1987)). Myriad radiocarbon datings for the charcoals collected from the excavations in Suyanggae Loc. VI suggest that CL 2 was formed in the Late Upper Paleolithic and CL 3 in the Early Upper Paleolithic. This is also supported by the dates of CL 2 of Loc. VI, which can be correlated with those of CL 1 of Loc. I, converging with the Late Upper Paleolithic culture, approximated to the LGM. The Late Upper Paleolithic culture is stratigraphically better established in Loc. VI than in Loc. III or I. The lithic artifact assemblage of Loc. VI CL 2 is characterized by abundant microblades (18–19 ka BP, post-LGM), while those of CL 3 and 4 by blades and tanged points, respectively, dating to ca 36–42 ka BP, before the LGM (see *Table*; Fig. 10).

Importantly, in the lower limit of the sedimentary matrix of fluvial origin, a line-engraved cobble stone (LECS) was found, and in the upper part of flooding muds, where the slope mudflow was gradually influenced by the sedimentary matrix, a face-engraved pebble stone (FEPS) was discovered. The radiocarbon ages of the LECS averaged 39,500 cal BP, ranging between 38,000 and 41,000 cal BP. On the basis of these estimates, it can be suggested that at Suyanggae Loc. VI, the earliest evidence of metric knowledge and symbolic behavior of the Early Upper Paleolithic humans in the territory of Korea were discovered. Finally, the 395 tiny holes distributed at the surface of LECS may be associated with observations of stars.

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# Khengerekte-Sukhotino— An Upper Paleolithic Culture in Transbaikalia

*During the studies at the Barun-Alan-1 stratified site in Western Transbaikalia, a lithic industry was described, providing a basis for a new archaeological culture, termed Khengerekte. Similar materials were excavated from nearby sites such as Sloistaya Skala and Khenger-Tyn-3 Svyatilishche. A comparative analysis of the Khengerekte industry of Barun-Alan-1 and that from the Sukhotino-4 in southern Chita, Eastern Tranbaikalia, reveals that most of their typological groups are quite similar. On that basis, the culture's distribution area was extended, and the culture itself was renamed Khengerekte-Sukhotino, spanning ~400 km from Barun-Alan-1 in the west to Unenker in the east. The calendar age of excavated layers of key Khengerekte-Sukhotino sites, Barun-Alan-1 and Sukhotino-4, was estimated at 12–33 ka BP. Their lithic industry, based mainly on microblades, is described. Bifaces, unifaces, and high side-scrapers are common. The origin of the Khengerekte-Sukhotino culture is an open question.*

Keywords: *Upper Palaeolithic, archaeological culture, Western Transbaikalia, Eastern Transbaikalia, Barun-Alan-1, Sukhotino-4.*

## Introduction

The Khengerekte-Sukhotino archaeological culture was identified based on similar and in many cases identical evidence at the Barun-Alan-1 and Sukhotino-4 sites (Tashak, 2020). At the initial stages of research, only the lithic industry of Khengerekte was distinguished during the works at the stratified site of Barun-Alan-1 in 2004–2015 (Tashak, 2010). It is represented in the materials of the lower layer of lithological horizon 6 and in all layers (7a–c) of lithological horizon 7 (Fig. 1)*. In 2015, artifacts of the Khengerekte culture were found at the Sloistaya Skala archaeological site, located 450 m north of Barun-Alan-1 and separated from it by a rocky ridge (Tashak, 2019). The additional technical and typological analysis of evidence from lithological layers 2–6 of the Khenger-Tyn-3 Svyatilishche archaeological site, located 1600 m southeast of Barun-Alan-1 (Tashak, 2005b), revealed that they belonged to that same culture. All these sites are located close to each other (2100 m between the extreme objects) on the southwestern spurs of Mount Khengerekte, in the estuary part of the Alan River valley. However, the issues of territorial distribution of the culture and its possible links with archaeological cultures of the adjacent areas remained unresolved.

In 2019, the evidence from the Sukhotino-4 stratified site (Eastern Transbaikalia), where field works had been carried out for many years since 1972, was used for the comparative analysis. Unfortunately, this evidence

*Layer 7d is an independent lithological unit.

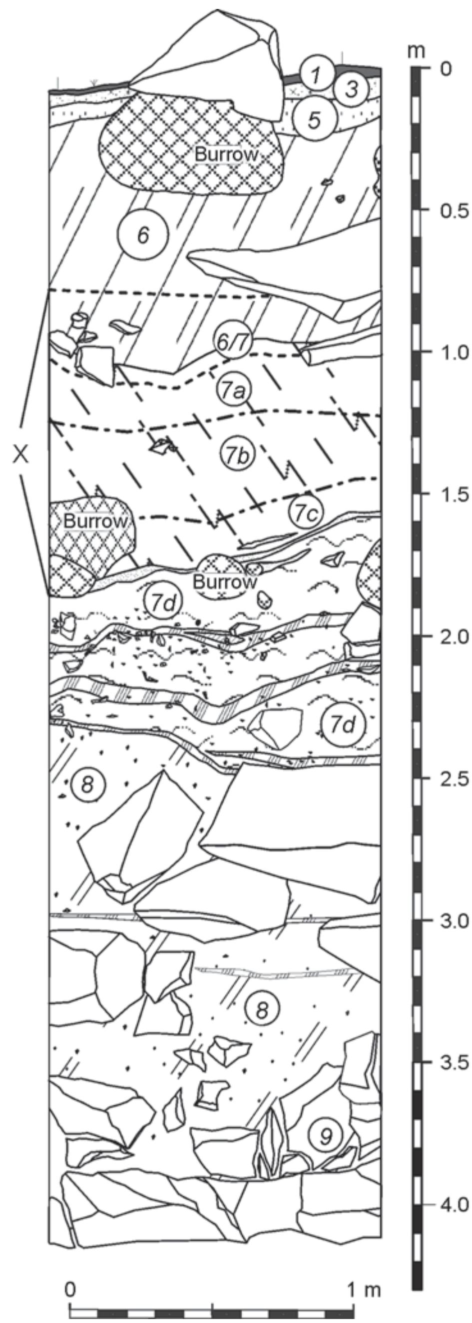


*Fig. 1*. Stratigraphic sequence of the southern wall of the excavation at Barun-Alan-1 (X – layers of deposition of archaeological evidence of the Khengerekte-Sukhotino culture).

was published extremely fragmentarily (Kirillov, 1973, 1980, 1986, 2003; Okladnikov, Kirillov, 1980: 41–51; Cherenshchikov, 1985), which hampered its comprehensive comparison with data from other Paleolithic sites. In the course of new research, it was established that some groups of Khengerekte artifacts were identical with those from Sukhotino-4 industry; the technique of lithic reduction and tool manufacture was also common. On the basis of these conclusions, it was proposed to name the culture "Khengerekte-Sukhotino". The ongoing works with materials from the Western and Eastern Transbaikalia have provided new information about the area of that culture, aspects of settling in habitation zones, and specific features of the lithic industry.

## Main features of the lithic industry

The sites of Barun-Alan-1 and Sukhotino-4 contain both macro- and microindustry. The former is dominated by the parallel reduction of flat-faced frontal single-platform cores (Fig. 2, *1*) aimed at the production of large laminar flakes. These flakes were detached from wide flat surfaces of cores, starting from the natural or specially prepared angle ridge. Multiplatform and cuboid cores executed in the orthogonal reduction technique are much less common. Large blades with even edges and parallel faceting (in Barun-Alan-1, about 1.1 %, including fragments), as well as subprismatic single-platform cores, are few. The majority of cores of all types bear flaking scars on the striking platforms in the areas of presumable flaking, while the entire surfaces were rarely processed. A part of striking platforms retain their natural crust. The most common type of large blades and laminar flakes is the oblong spall with dihedral and very asymmetric dorsal surface (Fig. 2, *2*). The abundance of such spalls suggests that the reduction from flat-faced frontal cores started from the angle ridge and gradually moved to the boad flaking surface, while permanently maintaining the ridge.

The microindustry at the sites under discussion aimed at obtaining small blades from edge-faceted cores, most of which were wedge-shaped (Fig. 2, *3–5*). The microblade industry was based on cores with flaking surfaces reaching 4 cm in height and 3 cm in depth. Items with low flaking surface and large distance from it to the back surface are rare. For example, there are only three cores from fractured biface tools. Their striking platforms were the surfaces of transverse break of a large biface (Tashak, Kovychev, 2020). Purposeful detachment of bladelets up to 10 mm wide (less often somewhat wider) was carried out from a few fan-shaped and large edge-faceted cores.

The industries of both sites contain a lot of side-scrapers (Fig. 2, *6–8*), including carinated items and scraper-knives. Carinated side-scrapers differ in the way they were shaped: some were fashioned as unifacial tools with complete or almost complete dorsal trimming, while in others, only the working edge was processed.

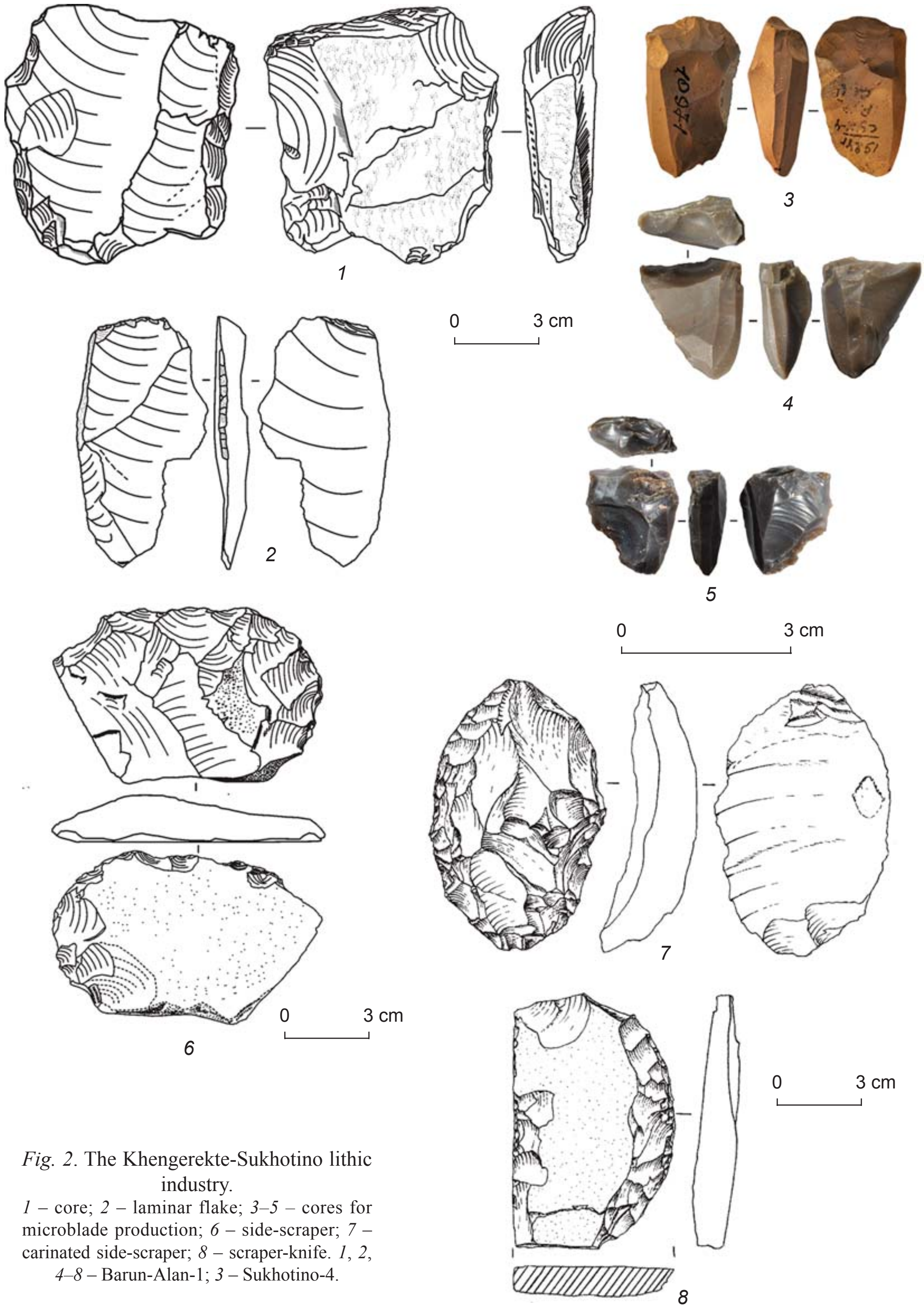


*Fig. 2*. The Khengerekte-Sukhotino lithic industry.
*1* – core; *2* – laminar flake; *3–5* – cores for microblade production; *6* – side-scraper; *7* – carinated side-scraper; *8* – scraper-knife. *1*, *2*, *4–8* – Barun-Alan-1; *3* – Sukhotino-4.

The most expressive are numerous bifaces and unifaces (Ibid.), which can be subdivided into tools and preforms of edge-faceted cores for the production of microblades. The majority of such tools are knives of various shapes (segment-shaped, ellipsoid, etc.) with natural or specially shaped backs (Fig. 3). The complete identity of tools from the sites of Barun-Alan-1 and Sukhotino-4 is observed precisely in this category of tools: similar are the shapes and methods of processing backs and edges, as well as methods of flattening the items (Ibid.). Side-scrapers are significantly less numerous among bifaces. Distinctive leaf-shaped

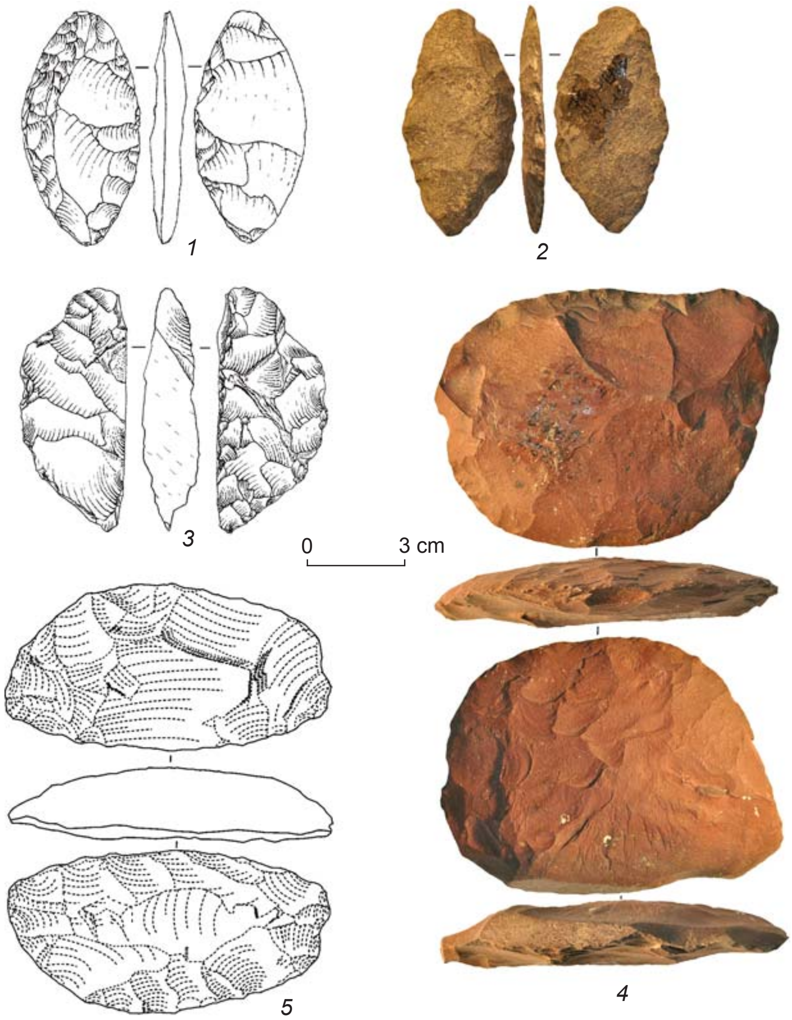


*Fig. 3*. Bifacial tools.
*1*, *2*, *5* – bifaces with retouched back (ellipsoid); *3* – segment-shaped biface (knife); *4* – large segment-shaped biface. *1*, *3*, *5* – Barun-Alan-1; *2*, *4* – Sukhotino-4.

pointed bifaces include strongly flattened items with the trimmed basal end, which makes it possible to consider them arrowheads.

The strategy of raw material use also shows some common features. At both localities, the macro-industry was based on the best available local raw materials, such as rhyolite-porphyry at Barun-Alan-1 (Tashak, 2020), and hornfels at Sukhotino-4 (Moroz, Yurgenson, 2018). Flints, jasperoids, and chalcedony were widely used in microindustry and in the manufacture of bifaces. The dimensions of lithics usually weren't a determining factor in choosing raw materials. However, for the production of microblades, knappers purposefully selected the blanks with metric parameters close to cores fully prepared for reduction.

## Area of the Khengerekte-Sukhotino culture

After ten years of systematic studies at Barun-Alan-1, the Khengerekte industry was found only at that site. Later, it was recorded at two more archaeological sites of Sloistaya Skala and Khenger-Tyn-3 Svyatilishche, located at the foot of Mount Khengerekte. The Khengerekte industry, which differs from other Upper Paleolithic industries in Western Transbaikalia, had remained geographically limited, calling identification of an independent culture into question. Establishing the similarity between this industry and the material evidence from Sukhotino-4, located in the vicinity of the city of Chita in the Eastern Transbaikal region, has led to identifying a vast area of distribution of sites of the same type. As a result, a more precise designation of the culture as "Khengerekte-Sukhotino" was proposed (Tashak, 2020).

Further studies of archaeological evidence from the collection of the Transbaikal State University have revealed common features in the industries of the Unenker site and the Khengerekte-Sukhotino culture (Tashak, Kovychev, 2021). That site, where surface finds were made, is located 130 km east of Sukhotino-4. This indicates the spread of the Khengerekte-Sukhotino culture to the east, deep into the Eastern Transbaikalia. The Unenker site, like Sukhotino-4, is located in the valley of the Ingoda River, 2 km from the right, southern bank. Paleolithic evidence was discovered in the area where the slopes of the Borshchovochny Ridge spurs meet the alluvial piedmont plain. This area rises 15–20 m above the river level. Taking into account the distance between the extreme archaeological sites (387 km) of the Khengerekte-Sukhotino culture, currently the area of this culture from west to east is believed to reach about 400 km (Fig. 4).

Notably, in the vicinity of Chita, horizons with the evidence of the Khengerekte-Sukhotino culture were excavated at another archaeological site of Dvortsy. The site is located 20 km northwest of Sukhtino-4, in the Ingoda River valley, on the opposite side of Sukhtino-4, in a wide gorge of the Yablonovy Ridge,

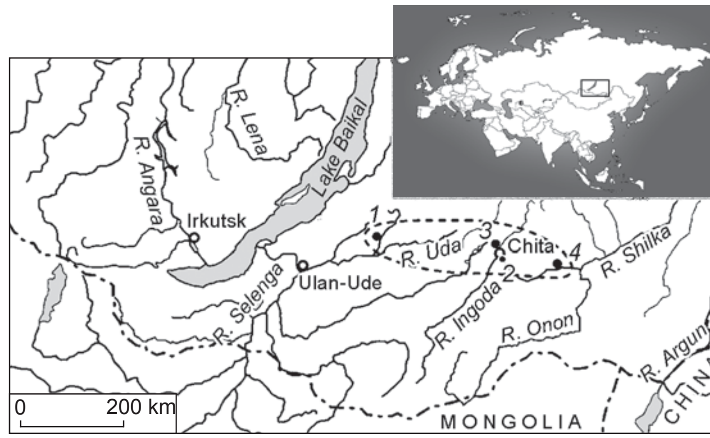


*Fig. 4*. Area of archaeological objects with the Khengerekte-Sukhotino evidence.
*1* – Barun-Alan-1, Sloistaya Skala, Khenger-Tyn-3 Svyatilishche; *2* – Sukhotino-4; *3* – Dvortsy; *4* – Unenker.

where the Kadalinka River flows. Although Paleolithic finds from that site have not been decribed in publications, their similarity with the evidence from Sukhotino-4 has been mentioned (Cherenshchikov, 2013: 31). Unlike Sukhotino-4 and Unenker, and similarly to Barun-Alan-1, the Dvortsy site is located far from a large watercourse. The presence of two similar sites on the sides of the wide Ingoda River valley suggests the active development of this location and adjacent areas by the Khengerekte-Sukhotino people.

## Chronology

Dating the sites of Barun-Alan-1 and Sukhotino-4 has shown that the period of the Khengerekte-Sukhotino culture coincided with that of the Sartan cooling. According to the data for Barun-Alan-1 layer 7, the culture appeared at the final stage of the Karga interstadial: layer 7c was dated to 26,911 ± 975 BP (NSKA-s571) or 32,140–30,035 cal BP, and layer 7b, 22,920 ± 140 BP (TKa-17114) or 27,325–27,155 cal BP (Tashak, 2020: 125, 126). The final stage of the Khengerekte-Sukhotino culture was associated with the end of the Sartan cooling, as indicated by the radiocarbon date of 11,900 ± 130 BP (SOAN-841) obtained for Sukhotino-4 layer 1 (Okladnikov, Kirillov, 1980: 51). Layers 6–8 of that site are dated to 15,820 ± ± 300 BP (LE-3652), 16,810 ± 390 (LE-3647), and 16,870 ± 700 BP (LE-3653), respectively (Lisitsyn, Svezhentsev, 1997), which coincides with most of the dates for Barun-Alan-1 layer 7a, while layers 10 and 11, which occur much deeper than layer 8, can be correlated with layer 7b. The above date for Barun-Alan-1 layer 7c is close to the earliest date of 26,110 ± 200 BP (SOAN-1138) for Sukhotino-4, which raises some doubts due to large difference with the date of layer 1. It has been mentioned that the samples came from different excavation areas, and so the layers of deposition could have been different (Okladnikov, Kirillov, 1980: 51). The coincidence of the earliest radiocarbon dates for Barun-Alan-1 and Sukhotino-4 testifies to the acceptability of the latter date and to contemporaneous existence of the two archaeological sites remote from each other. The initial stage of the Khengerekte-Sukhotino might have occurred in the late stage of the Early Upper Paleolithic, which is comparable with late dates of the Upper Paleolithic Tolbaga culture.

## Conclusions

At the current stage of research, the Khengerekte-Sukhotino archaeological culture in the Western Transbaikalia can be identified on the basis of the lower layer of horizon 6 and all layers of horizon 7 at Barun-Alan-1. Similar materials were discovered at the nearby archaeological sites of Sloistaya Skala and Khenger-Tyn-3 Svyatilishche. In the Eastern Transbaikalia, the basic site is the stratified site of Sukhotino-4; the Khengerekte-Sukhotino culture also occurs at the Dvortsy and Unenker localities. Unenker marks the eastern boundary of its area.

Lithic artifacts from Barun-Alan-1 and Sukhotino-4 are similar in many respects. For example, the same technique of primary reduction in macro- and micro-industry can be observed. Bifacially and unifacially processed tools, carinated side-scrapers, pointed items made of microblades, etc. are completely identical. All this makes it possible to speak about a cultural affinity of these industries, which leads to the establishment of a corresponding archaeological culture. The distance between the two basic sites (Barun-Alan-1 in the west and Sukhotino-4 in the east) is 250 km, which indicates a significant area of distribution of the Khengerekte-Sukhotino culture. This area was expanded at a new stage of research by adding the Paleolithic evidence of the Unenker site (about 400 km from west to east).

There are some differences between western and eastern sites. First, this is the location in the terrain: Barun-Alan-1 and the accompanying objects are confined to the slopes of a mountain with expressive rocky cliffs; Sukhotino-4 and Unenker are associated with terrace levels of a large watercourse of the Eastern Transbaikalia—the Ingoda River. The locality of Dvortsy indicates that the Khengerekte-Sukhotino people in the Eastern Transbaikal region also chose for their camps places on alluvial piedmonts in the valleys of small rivers. Futhermore, the remains of horizons with dwellings and hearths with stone linings were found at Sukhotino-4, but not at Barun-Alan-1, possibly because the latter is located under the rocks with abundant rubble at the foot, which precludes the identification of any stone structures.

Chronological studies carried out at the sites of Khenger-Tyn-3 Svyatilishche, Sukhotino-4, and Barun-Alan-1 have established the time frame for the Khengerekte-Sukhotino archaeological culture within the entire Sartan cooling period. The dating of Barun-Alan-1 layer 7c has revealed that its earliest stage coincided with the end of Karga interstadial, ca 30 ka BP. In the area of Titovskaya Sopka (the Sukhotino group of sites), the earliest manifestation of this culture are presumably the materials from the lower layers of Sukhotino-2. These were compared with the Tolbaga culture of the Western Transbaikalia and, accordingly, attributed to the Initial Upper Paleolithic (Cherenshchikov, 2013: 51). However, the relationship between these cultures has not been proven. The Tolbaga complexes completely lack bifacially processed tools and microblade industry, but show the mass production of tools on large blades. The lithics from Barun-Alan-1 layer 7d (not to be confused with the overlying layer 7) contain very few items connecting it with the Khengerekte industry; therefore, the continuity of industries from layer 7d to layer 7 remains in doubt. The materials from lithological layer 7d have more common features with the Tolbaga culture, but still reveal a lot of peculiarities. According to main components, such as bifaces and edge-faceted microblade cores, there is similarity between the Khengerekte-Sukhotino culture and Dyuktai Paleolithic culture of Northeast Asia, identified by Y.A. Mochanov (2007: 41). Since their earliest manifestations are comparable in terms of age (35–30 ka BP for the Dyuktai culture (Mochanov, 1977: 223) and 32–30 cal ka BP for Barun-Alan-1 layer 7c), the issue of possible influence of the Dyuktai on the origins of Khengerekte-Sukhotino should be left open.

It was suggested that the Khengerekte-Sukhotino had a wider area of distribution in the late Karga interstadial and the early Sartan cooling (Tashak, 2020). In particular, bifacial tools typical of the lower layers at Sukhotino-4 have been discovered on the banks of the Selenga River at Ust-Kyakhta-16, in a layer with a radiocarbon date of ca 27 ka BP (Tashak, 2005a: 77). Such tools have not been found among the evidence from the sites of the Final Paleolithic associated with the Selenga culture, which may testify to a decrease in the area of the Khengerekte-Sukhotino culture or a cultural entity with common features in lithic industry.

## Acknowledgment

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# Late Pleistocene to Early Holocene Paleoclimatic Boundaries and Human Settlement of the East Siberian Arctic

*This article examines archaeological records relating to the East Siberian Arctic in the Stone Age. It spans approximately 50,000 years, from the early stage of MIS 3 to the Early Holocene. Human settlement of the region can be divided into three main stages: early (~50,000–29,000 BP, MIS 3), middle (~29,000–11,700 BP, MIS 2), and late (11,700–8000 BP). The peopling of Arctic Eurasia and the cultural evolution in that part of the world were driven both by abiotic and biotic factors, as evidenced by the correspondance between archaeologically detectable changes and key paleoclimatic events. Early human settlement of that region is associated with a population marked by West Eurasian genetic ancestry, whose cultural elements are typical for Southern Siberia. The early settlers were replaced by people displaying East Asian ancestry, migrating northwards under the impact of climatic changes. It is concluded that the successful peopling of the Arctic was facilitated by the adoption of critically important innovations such as sewing with eyed bone needles, and manufacture of long shafts and pointed implements made of mammoth tusks. Lithic industries marking various stages are described. That of the early stage is characterized by flake technology; in the middle stage, wedge-shaped core technology appeared; and the principal feature of the late stage is microprismatic technology, indicating total population replacement. The onset of the Holocene coincides with a key innovation—land transportation by dogsled, resulting in much higher mobility.*

Keywords: *Stone Age, Upper Paleolithic, human settlement of the Arctic, environment and climate change, complex technologies.*

## Introduction

The paleogeographic situation in the part of the Eurasian Holarctic studied was determined in the Late Pleistocene by the absence of large glacial formations parallel to European and North American ice sheets. The dynamics of these ice sheets determined natural, climatic, and also cultural and historical development. In the northern regions of Eastern Siberia, these processes depended on changes in the "sea-land" balance, with an increased area of land in cold periods, aridization of the climate, and emergence of a distinctive habitat (mammoth steppe) as a part of the Eurasian belt of open landscapes in the Late Pleistocene. This regional feature amplified the impact of global climate trends. In Eastern Siberia, the tundra-steppe biome encompassed contemporary lowlands along the Arctic Ocean coast, as well as expansive arctic plains that occupied drained portions of the present-day shelf. A decrease in ocean levels in the Bering Strait area led to a land bridge connecting the Eurasian and North American continents. Known as the paleogeographic phenomenon of Beringia, this land connection exerted a profound influence on the region's natural development, ancient human migration, and cultural and historical processes.

## Peopling of the East Siberian Arctic

The available archaeological record of the Stone Age in the East Siberian Arctic covers approximately 50,000 years from the Late Pleistocene (early stage of MIS 3) to the Early Holocene (beginning of MIS 1). Although the data are scarce, three chronological groups can be identified: the early group covers ca 50,000–29,000 BP, MIS 3 (Fig. 1, *G–I*; 2, *A*, *B*); the middle group is from ca 29,000 to ca 11,700 BP, MIS 2 (see Fig. 1, *G–I*; 2, *C*, *D*); and the late group belongs to the Early Holocene, from 11,700 to ca 8000 BP (see Fig. 1, *G–I*; 2, E)*. Our overall knowledge of the East Siberian Arctic for the second half of the Holocene, based on the dated sites, is shown in Fig. 2, *F*. Since the time of the initial peopling, beginning after 50,000 BP, the Arctic region of Eastern Siberia has continuously been inhabited by people, including the least favorable climatic periods, during which the presence of people became fragile (see Fig. 2, *C*).

The overwhelming majority of archaeological evidence is associated with warm periods (see Fig. 1), which suggests a positive demographic trend in human populations. For example, the Yana complex of sites indicates stable prosperity in the local Upper Paleolithic culture, coinciding with the Greenland Interstadial (GI) 5 (see Fig. 1). Earlier sites also indicate a similar trend. The earliest evidence corresponds to the onset of GI 13, which experienced warmer and more humid conditions than the beginning of MIS 3. At that time, an ecosystem of open spaces, with an increasing role of grains favorable for the existence of megafauna, emerged in the western part of Arctic Beringia (see Fig. 1). The alternating patterns of relative warming and cooling within the MIS 3 interstadial, along with the cooling of the extreme continental climate in MIS 2, contributed to the wide spread of tundra-steppe landscapes. These landscapes varied based on their local setting, but maintained similar features over large territories, which played a crucial role in the initial peopling.

The early phase of the MIS 3 interstadial (see Fig. 1) yielded few archaeological materials, spread over ca 3000 km (see Fig. 2, *A*, *B*) and close in age (within 1000–3000 years). Consequently, peopling of the region was very rapid. This could only have been possible if humans appropriated an ecological niche that was free at the time of their arrival, and which had a familiar landscape, not requiring adaptation to a different environment. As a result, the region was rapidly populated with an extremely low demographic density (Sikora et al., 2019).

Radical changes in the material culture of the ancient population of the East Siberian Arctic were associated with natural and climate changes, and with the influx of migrants to the region. Anthropological remains of the Pleistocene are very rare in Siberia and are sporadic in the Arctic (see Fig. 1, *J*). During MIS 3 and 2, the inhabitants of the East Siberian Arctic most likely mainly consisted of Ancient North Siberians, including the inhabitants of the Yana site (Ibid.). The genetic features of the migrants who displaced or assimilated this population are documented by a significant fragment of a *Homo sapiens* skull found on the lower reaches of the Kolyma River, specifically on the Duvanny Yar outcrop. This discovery, dating back approximately 10,000 years, indicates the complete replacement of the previous inhabitants of the region by individuals carrying East Asian genomes (Ibid.).

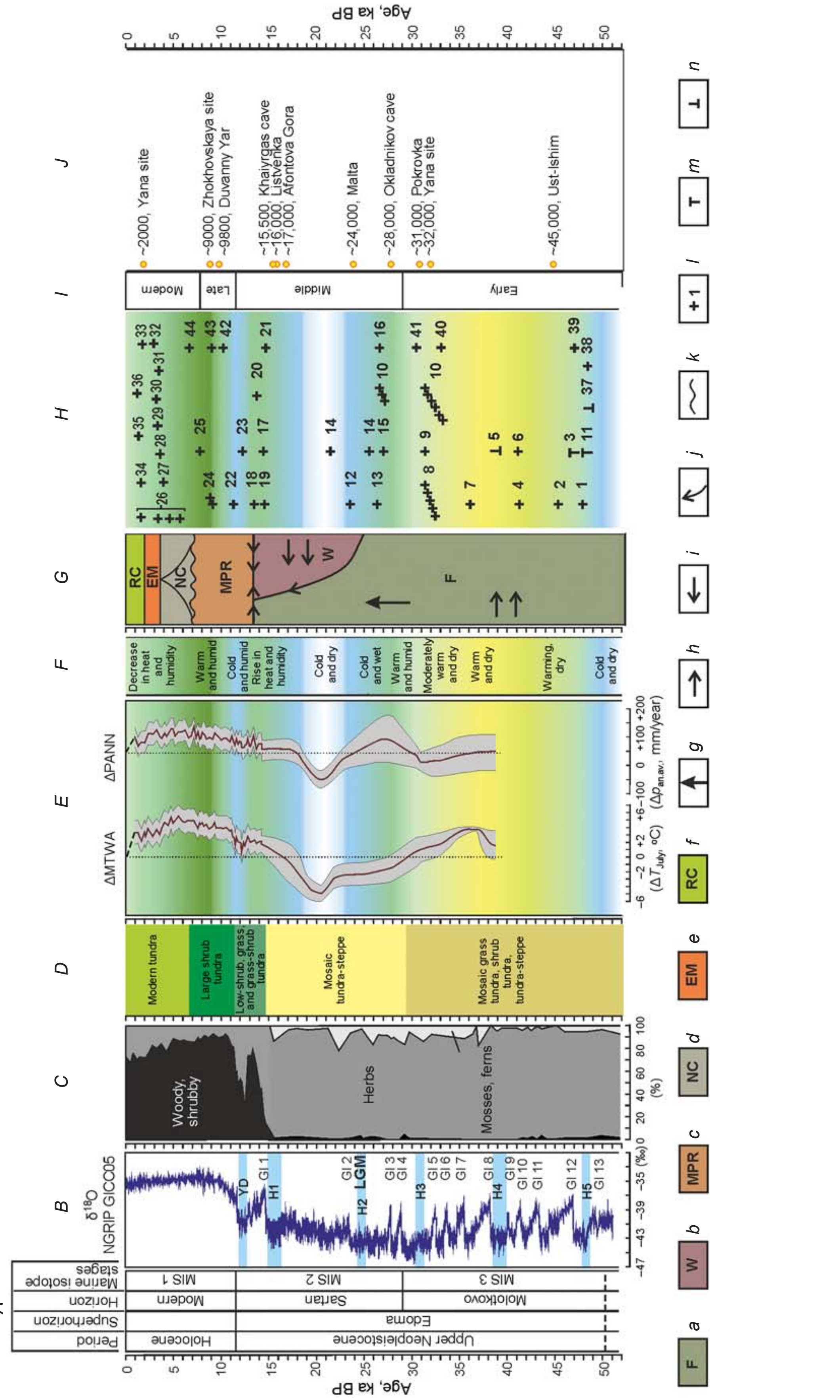
## Adaptation of the East Siberian Arctic population in the Stone Age

The difficulties of living in vast open spaces of the mammoth steppe were successfully overcome with a set of well-known Upper Paleolithic innovations. These reflect the technological development of the early human culture (Hoffecker J., Hoffecker I., 2018). The finds at the Yana site serve as ample evidence of such technologies (Pitulko, Pavlova, 2019; Pitulko, Pavlova, Nikolsky, 2015); their signs have also been recorded at other sites. Initially, the most important were three technologies: procuring food by hunting, making clothing, and building dwellings. At all chronological segments, animal procurement supplied raw materials for the manufacture of goods from hides, skins, and bones. The most significant bone items were hunting weapons and sewing tools.

Sewing was one of two technologies that played a vital role in the survival of humans in cold regions of the planet. The advancement of sewing was characterized by the introduction of eyed needles, with the earliest examples discovered in Siberia. Large-scale clothing production in the Upper Paleolithic is confirmed by the evidence from Yana (Pitulko, Pavlova, 2019). Availability of eyed needles made it possible to sew multi-layered clothes, adjust them to size, and create a whole range of sewn products, such as footwear, sleeping bags, soft containers and bags, as well as dwellings. Judging by the evidence from Yana, dwellings were light ground structures with hearths (Pitulko et al., 2013); bones of large animals, including mammoths, were used as fuel in the winter.

One of the most important cultural and economic features of that period were relationships in the "man-

*Hereafter, the calendar age is used.


A
B
C
D
E
F
G
H
I
J
Age, ka BP
Period
Superhorizon
Horizon
Marine isotope stages
Holocene
Upper Neopleistocene
Edoma
Modern
Sartan
Molotkovo
MIS 1
MIS 2
MIS 3
δ18O NGRIP GICC05
YD
H1
H2
LGM
H3
H4
H5
Woody, shrubby
Herbs
Mosses, ferns
(%)
Modern tundra
Large shrub tundra
Low-shrub, grass and grass-shrub tundra
Mosaic tundra-steppe
Mosaic grass tundra, shrub tundra, tundra-steppe
ΔMTWA
ΔPANN
Decrease in heat and humidity
Warm and humid
Cold and humid
Rise in heat and humidity
Cold and dry
Cold and wet
Warm and humid
Moderately warm and dry
Warm and dry
Warming, dry
Cold and dry
RC
EM
NC
MPR
W
F
Modern
Late
Middle
Early
~2000, Yana site
~9000, Zhokhovskaya site
~9800, Duvanny Yar
~15,500, Khaiyrgas cave
~16,000, Listvenka
~17,000, Afontova Gora
~24,000, Malta
~28,000, Okladnikov cave
~31,000, Pokrovka
~32,000, Yana site
~45,000, Ust-Ishim
a
b
c
d
e
f
g
h
i
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l
m
n

*Fig. 1*. Climatic, paleonatural, and archaeological record of the East Siberian Arctic.

*A* – regional stratigraphic map of the Yana-Kolyma Lowland and bordering mountains (Stratigraficheskiy kodeks, 2019: 58; Sher, 1984; Sher, Kaplina, Ovander, 1987); *B* – NorthGRIP $\delta^{18}$O scale, and the sequence of Greenland interstadials (GI 1–GI 13) (after (Svensson et al., 2008)); blue bands mark the approximate position of the Young Dryassic cooling (YD) and Heinrich events (H1–H5) (after (Tierney et al., 2008)); *C* – diagram of the general composition of pollen spectra: section of Quaternary deposits Mkh IC (after (Sher et al., 2005)) and sequence of bottom sediments from Lake Dolgoye (after (Pisaric et al., 2001; Klemm et al., 2013)); *D* – biomes; *E* – paleoclimatic reconstructions based on paleoflora analysis: ΔMTWA – deviation of air temperatures of the warmest month from modern values ($\Delta T_{July}$, °C), ΔPANN – deviation of average annual precipitation from modern values ($\Delta p_{average\ year}$, mm/year); *F* – total climate changes; *G* – archaeological chronicle of the East Siberian Arctic; *H* – dated archaeological sites shown according to their calendar age (after (Pavlova, Pitulko, 2020: Tab. 1, fig. 2), with additions after (Dikov, 1993: 36–56; Pavlov, Suzuki, 2020; Khlobystin, 1998: 38–40; Cheprasov, Obade, Grigoriev et al., 2015; Cheprasov, Chlachula, Obade et al., 2018; Chlachula et al., 2021; Gusev, 2002; Kirillova, Shidlovskiy, Titov, 2012; Pitulko, 2001; Pitulko, Pavlova, 2016: 110–125; Pitulko, Pavlova, Nikolskiy, 2017; Pitulko et al., 2016)): *1* – Bunge-Toll-1885 site, *2* – Kyuchus, *3* – Verkhniy locality, Yana complex of sites (YCS); *4* – Novaya Sibir/West, *5* – Novaya Sibir/East, *6* – AL044-2005 site, *7* – Omoloy, *8* – Severny and Yana V localities, Yana mammoth “cemetery”/YMAM (YCS), *9* – Buor-Khaya/Orto-Stan, *10* – Diring-Ayan, *11* – Bolshoy Anyui, *12* – Zyryanka-1, *13* – Lagerny locality (YCS), *14* – Yana A locality (YCS), *15* – Ilin-Syalakh 034; *16* – Wrangel Island, *17* – Ilin-Syalakh bone bed site, *18* – Lake Nikita, *19* – Urez-22, *20* – Berelekh geoarchaeological complex; *21* – Achchagyi-Allaikha, *22* – Tytylvaam IV; *23* – Cape Kamenny, *24* – Zhokhovskaya site, *25* – Tuguttakh, *26* – Siktyakh I, *27* – Rodinskoye burial, *28* – Chertov Ovrag, *29* – Burulgino, *30* – Rauchuagytgyn I, *31* – Pegtymel, *32* – Aachim-baza, *33* – Aachim-mayak, *34* – Cape Baranov, *35* – Pegtymel Cave, *36* – Shalaurova Izba, *37* – Zyryanka, *38* – Sopochnaya Karga mammoth, *39* – Irelyakh-Siene, *40* – Kastykhtakh mammoth, *41* – Tabayuryakh mammoth, *42* – Nayvan, *43* – Chelkun IV, *44* – Tagenar VI; *I* – stages of peopling; *K* – dated anthropological remains from various regions of Siberia. *G–F*, *I*, *K* – after (Pavlova, Pitulko, 2020).

*a* – flake-based industry; *b* – industry of wedge-shaped cores with microblades; *c* – microblade industries based on prismatic reduction; *d* – Neolithic cultures with degradation of microblade technology after 3000 BP; *e* – emergence of metals: cultures of the Bronze Age; *f* – late prehistoric/protohistoric cultures, including the Eskimos of the Arctic coast and the Bering Strait area; *g–j* – migrations: *g* – from south to north, *h* – from west to east, *i* – from east to west, *j* – to the northwest; *k* – replacement of the edge-faceted wedge-shaped reduction by microprismatic reduction; *l* – dated archaeological sites; *m* – open dating; *n* – possible dating based on the structure of the stratigraphic sequence.

mammoth” system. Many sites of the early and middle stages of the area’s settlement (at least 11) are associated with mass accumulations of mammoth bone remains of anthropogenic origin, resulting from human hunting, which led to emergence of “warehouses” (reserves of raw materials).

Mammoth hunting was an important activity aimed at obtaining raw materials for the manufacture of hunting equipment—long points and full-sized spears, which were needed because of the constant shortage of wood (Pitulko, Pavlova, Nikolsky, 2015). This was the second crucial technology of the Upper Paleolithic in the East Siberian Arctic. Mammoth meat was used for food, but did not play a substantial role in the diet of ancient hunters, who hunted bison, horses, and reindeer in large numbers (Pitulko et al., 2013). There is no evidence of large-scale one-time hunting of mammoths.

In terms of the development of the lithic industry, there are obvious fundamental differences between the sites remaining from different stages of the settlement of the region. For example, the early period was characterized by a flake industry of archaic appearance, which was based on splitting pebbles and retained some Middle Paleolithic features or rather the method of simplified splitting. These features are observed in the Yana industry at the final period of the early stage. However, there is no reason to believe that it was preceded by some advanced technology of blade production. Material evidence from the last glacial maximum show only traces of human presence, which was low at that time. The only site with stone items of this period suggests that an industry of small blades, produced using cores with circular reduction, was spreading in the East Siberian Arctic at that time. At the end of the early stage of human settlement in the region, a technology of edge-faceted wedge-shaped reduction appeared, manifested by evidence from rare sites in the west of Chukotka and possibly in the north of the Yana-Indigirka Lowland.

The spread of the microblade blank technology was most likely associated with migration of populations from inland areas, who encountered sharp cooling and aridization of the climate due to the global climate trend in the LGM period, desertification of the region, northward shift of vegetation zones, changes in landscapes, and spatial redistribution of faunal populations serving as a resource base for that population. In fact, the very emergence of the technology of small blade production by splitting wedge-shaped cores most likely resulted from environmental changes that caused the loss of the mammoth from the biome of the southern part of the tundra-steppe belt of Northern Eurasia. Mammoth tusks served as an important raw material for the production of hunting equipment, such as long points and/or full-sized spears. Spatial dynamics of the local population of mammoths (Pitulko, Nikolskiy, 2012) suggests that their

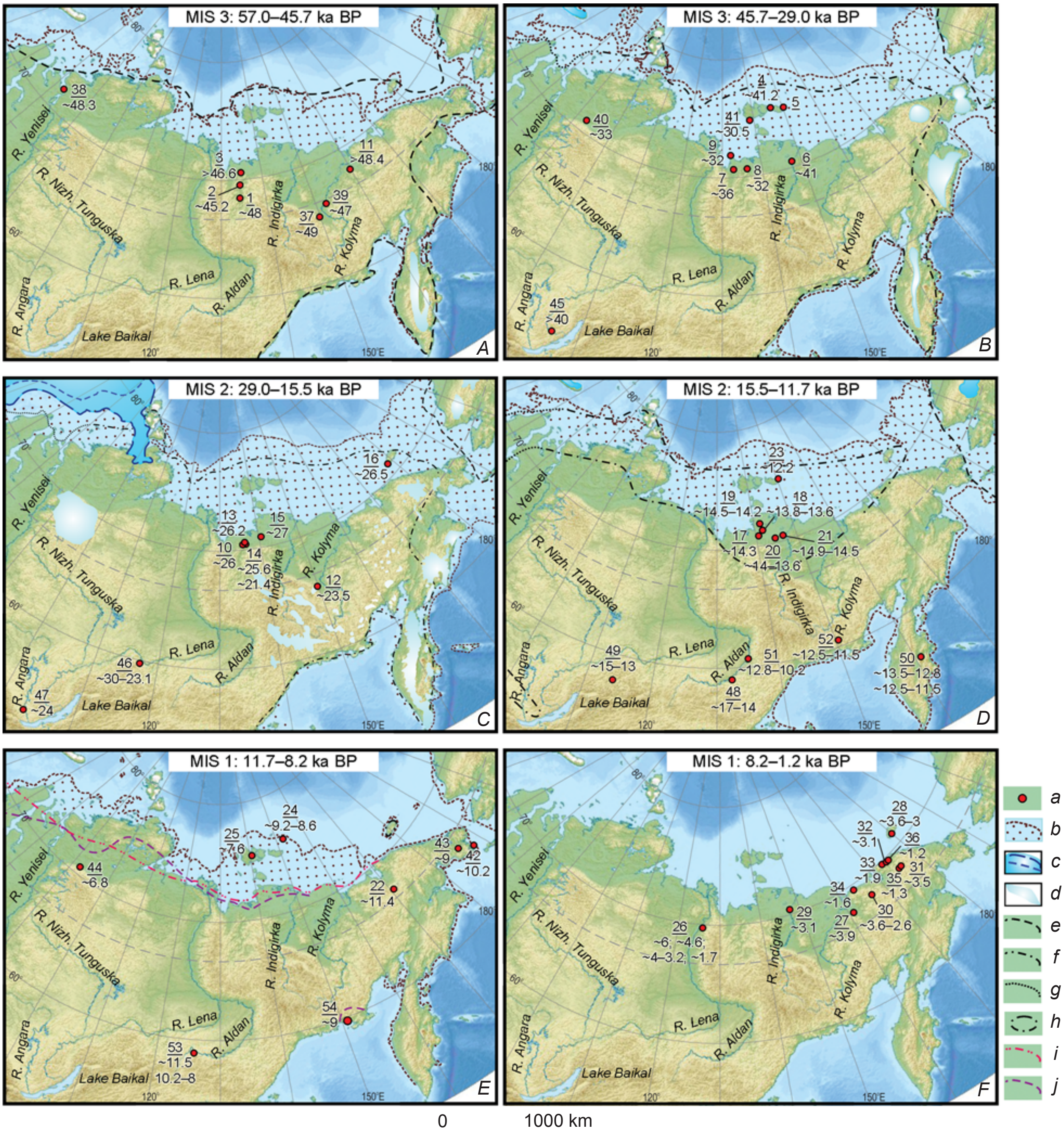


*Fig. 2*. Archaeological sites of the Late Pleistocene–Early Holocene in Eastern Siberia.

Reconstructions of the drained shelf area and the land-sea boundary made after (Pico, Creveling, Mitrovica, 2017), at a World Ocean level lower than modern levels: *A* – ca 40 ka, BP 40 m; *B* – ca 32–31 ka BP, 90 m; *C* – ca 27 ka BP, 120 m; *D* – ca 14 ka BP, 70 m; *E* – ca 9 ka BP, 30 m; *F* – ca 9 ka BP, 30 m. Numbering scheme used in the maps: the numerator designates the number of the archaeological site, and the denominator represents its age (×1000 years). *1–44* – see Fig. 1; *45* – Makarovo IV; *46* – Khaiyrgas Cave; *47* – Malta; *48* – Dyuktai Cave; *49* – Bolshoy Yakor; *50* – Ushki; *51* – Ezhantsy; *52* – Kheta; *53* – Ust-Timpton; *54* – Uptar I (after (Dikov, 1993: 35–56; Mochanov, 1977: 6–32, 49–58; Slobodin, 1999: 36–57, 59–73; The Paleolithic…, 1998; Kuzmin et al., 2017; Pitulko, Pavlova, 2016)).

*a* – archaeological sites; *b* – drained shelf area and land-sea boundary; *c* – complex of sheet glaciation (after (Dalton et al., 2020; Hughes et al., 2015)); *d* – mountain glaciation (after (Galanin, 2012; Barr, Clark, 2012; Glushkova, 2011)); *e–h* – areas of woolly mammoths: *e* – in Northeast Asia and Alaska (after (MacDonald et al., 2012)), *f* – in Northeast Asia (after (Pitulko, Nikolskiy, 2012)), *g* – in Western Siberia (after (Kahlke, 2014)), *h* – isolated population of mammoths on Wrangel Island (after (Vartanyan et al., 2008)); *i* – northern boundary of the woody *Betula* area ca 9000 BP, based on its dated macroremains (after (Kremenetski, Sulerzhitsky, Hantemirov, 1998; Binney, Willis, Edwards et al., 2009)); *j* – northern boundary of *Larix* ca 9000 BP, based on its dated macroremains (after (Kremenetski, Sulerzhitsky, Hantemirov, 1998; Binney, Willis, Edwards et al., 2009; Binney, Edwards, Macias-Fauria et al., 2017)).

distribution area steadily declined, moving in a northern direction. Notably, a new stone processing technology based on reduction of wedge-shaped cores spread in the same direction (to the north and east) from the regions of Northern China and Mongolia, adjacent to Western Beringia.

The traditions of flake-based industries remained intact in the region up to the transition to the Holocene. During the late Pleistocene, assemblages containing mainly teardrop-shaped, small incomplete bifaces (known as Chindadn points) emerged. However, with the onset of the Holocene, these artifacts vanished, and reduction techniques underwent another transformation. Across the entire region, spanning from Taimyr to Chukotka and extending from the southern regions to high latitudes, the widespread adoption of micro-prismatic reduction technology occurred rapidly (see Fig. 1, *G*; 2, *E*). This was associated with the arrival in Eastern Siberia of the carriers of the East Asian genetic lines (Sikora et al., 2019). These events might have been accelerated by the availability of land transport (dogsleds) among the Early Holocene population. Their appearance, associated with completion of the dog/wolf domestication process in the Terminal Pleistocene, was the most important innovation at the turn of the Holocene (Pitulko, Pavlova, 2020).

## Conclusions

The record of human settlement in the Arctic covers about 50,000 years. This evidence marks the final stage in the global dispersal of anatomically modern humans. The initial peopling of the East Siberian Arctic in the Late Pleistocene was associated with a population whose gene pool was dominated by the West Eurasian lineage.

The initial peopling of Arctic regions and the ability of people to thrive during the Late Pleistocene, despite the changing natural environment, can be attributed to the adoption of significant technological advancements, which consisted of complex technologies. Remarkable shifts in archaeological cultures correspond to the crucial paleoclimatic events that occurred during the Late Pleistocene and Early Holocene periods.

During the Late Pleistocene, the population inhabiting the East Siberian Arctic followed the economic model of continental hunters, using any available resources in the form of local populations of Pleistocene fauna. At the onset of the Holocene, species diversity decreased to a state close to the one we have now; in the Arctic zone, the main source of livelihood for the population became reindeer.

Technologies for the production of hunting equipment (long points and full-sized spears) from mammoth tusk, together with sewing technologies, played a crucial role in the Late Pleistocene adaptations. The most important innovation at the onset of the Holocene was the creation of land transport (dogsleds). This accomplishment ensured the mobility of the population and facilitated the rapid dissemination of cultural knowledge, gene exchange, and the development of large social and cultural systems.

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# Late Upper Paleolithic of the South Minusinsk Basin and its Mountain Surroundings: Research Results and Problems

*This paper briefly reviews the main Late Upper Paleolithic sites of the Upper Yenisei—in the South Minusinsk Basin and in the adjacent highlands of the West Sayan. Known sites mostly date to the Late Sartan period. They concentrate on the Upper Abakan River, in the Yenisei valley between Maina and Sayanogorsk, and on the Upper Tuba River. Information is provided on the composition of fauna and on pollen data, indicating the predominance of mosaic landscapes with alternating forested and open steppe spaces. Climate fluctuations of the Final Pleistocene were reflected in the alternation of phases of herbaceous and forest vegetation. The association of most sites with deposits of the second and third terraces has been established. Certain sites, however, are associated with cover deposits at high elevations, on the one hand, and with the first terrace lowered to the level of the high floodplain, on the other. In recent years, the Late Paleolithic of the Upper Yenisei has been considered in the context of the original version of catastrophic floods, which presumably occurred repeatedly in the Late Pleistocene. The nature of the stratigraphic sections of the multilayered sites of the Maina group on the Yenisei, however, disagrees with this hypothesis, and indicates continuous alluvial sedimentation in the Sartan Age. A conclusion is made about the predominance of remains of seasonal hunter-gatherer habitation sites on the riverbanks. But there are also traces of a lithic workshop near the quartzite outcrops (Kuibyshevo II). Unfortunately, no sites earlier than the Late Upper Paleolithic are known in the region, and Mesolithic ones are extremely rare.*

*Keywords: Yenisei, Abakan, Minusinsk Basin, Sartan Age, Late Upper Paleolithic, site location.*

## Introduction

The vast area of the South Minusinsk Basin and the surrounding mountainous areas is one of the main centers of Late Upper Paleolithic sites in Siberia. Over the past decades, the known Paleolithic sites in the Yenisei and Abakan valleys (Paleolit…, 1991) have been supplemented with information on previously unexplored areas—the basins of the Upper Abakan (Zubkov et al., 2019), and the lower (Kharevich et al., 2018; Akimova, Kharevich, Stasyuk, 2020) and upper (Vasiliev et al., 2019) reaches of the Tuba River (Fig. 1). The purpose of this publication is to discuss briefly some controversial issues of the paleogeographic situation in the region in the Late Pleistocene in connection with the prehistoric human development.

## Paleolithic humans and the natural environment

The South Minusinsk (or Abakan-Minusinsk) Basin is enclosed by the ridges of the Kuznetsky Alatau in the

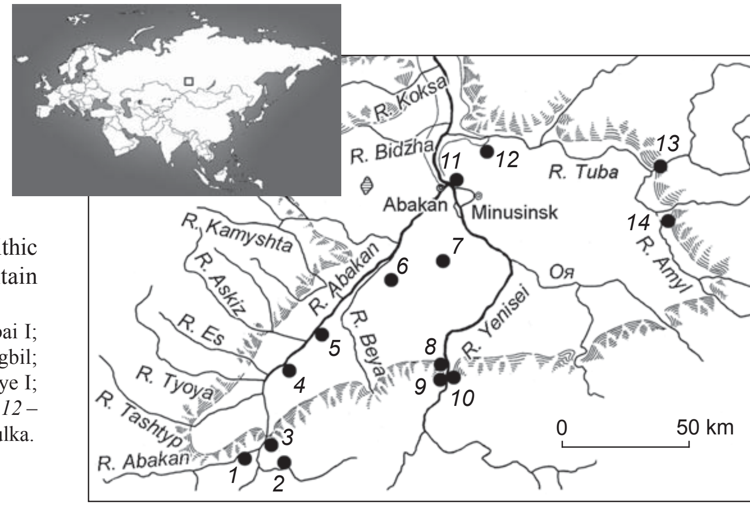


*Fig. 1.* Location of the mentioned Late Upper Paleolithic sites of the South Minusinsk Basin and its mountain surroundings.
*1* – Mozharov Uval I; *2* – Kuibyshevo II, Krivoi Chistobai I; *3* – Bolshiye Arbaty I, Matros I; *4* – Kongure; *5* – Ulugbil; *6* – Sosnovoye Ozero I; *7* – Smirnovka; *8* – Oznachennoye I; *9* – Maina, Uy I, II; *10* – Golubaya I–IV; *11* – Bystraya II; *12* – Pritubinsk I; *13* – Irba II, Gora Veselovskaya; *14* – Kachulka.

west, the West Sayan in the south, and the East Sayan in the east. In the north, it is separated from the Sydo-Erba Basin by the spurs of the Batenevsky Ridge. The central part of the basin (the interfluve of the Yenisei and Abakan) is the expanse of the Koibal steppe, with sandy blowouts and numerous lakes. The foothill Uibat steppe stretches along the Abakan valley. The main groups of Late Paleolithic sites are concentrated near the junctions of the mountain-taiga and steppe zones where the Abakan and Yenisei flow into the Minusinsk Basin, and in the upper reaches of the Tuba River.

The time of the last (Sartan) glaciation is characterized by the development of glacial activity in the mountain systems surrounding the Basin. In the mountains of the Kuznetsky Alatau, this activity had a local character. As for the West Sayan, here the last (Karakhol) glaciation covered the central part of the Sayan and Shapshal ranges, the sources of the Alash, Khemchik, and Kantegir rivers, and led to the formation of cirque and mountain-valley glaciers, reaching up to 15–20 km in the maximum length phase (Efimtsev, 1961: 139–142). In the mountains of the East Sayan, the Sartan (Azas) glaciation was of a mountain-valley character; its traces are recorded in the upper reaches of the Kazyr and Kizir rivers, as well as in the Todzha Basin (Matsera, 1993).

South Minusinsk Basin can hardly be classified as a "mammoth steppe" or "tundra steppe". No mammoth remains have been found at any locality in the region. Data on the paleogeography of the sites of the Maina group indicate the mosaic nature of landscapes of the Sartan glaciation, with alternation of steppes with forests along the river valleys. Cooling periods are reflected in the predominance of herbaceous vegetation in the palynological spectra and the increase in the proportion of bison remains in faunal materials. In interstadial conditions, on the contrary, flora was dominated by forest vegetation (mainly pine-birch forests including fir, spruce, larch, and Siberian pine), and fauna by red deer. The combination of open-space animals (bison, horse) and forest dwellers (red deer, and in the Final Pleistocene also elk and roe deer) suggests the mosaic nature of the landscape. The remains of reindeer are found at the sites in the lowland and foothill parts of the region. The extreme southern point of distribution of this species is the site of Oznachennoye I, located directly at the junction of the West Sayan mountains and Koibal steppe. No remains of reindeer have been found at any of the numerous sites located near the Maina to the south, in the northern part of the Sayan canyon of the Yenisei (Vasiliev, 1996: 15; Vasiliev et al., 2005).

The geological and geomorphological settings of the Late Paleolithic sites make it possible to describe the living conditions of prehistoric humans. Cultural layers of the majority of the sites are confined to thin-layered strata of sandy loamy-sandy alluvium of low above-floodplain terraces. Judging by the data on terrestrial mollusks, prehistoric habitations were located in places near water with high herbage and shrubs. The alternating locations of habitations at levels of various heights (the second and third terraces), known from the materials of Maina, can be explained by the peculiar hydrological regime of the rivers of the periglacial zone, with frequent and prolonged high floods (Yamskikh, 1991).

Most of the Paleolithic sites in the Abakan valley (Mozharov Uval I, Matros I, Bolshiye Arbaty I, etc.), on the Yenisei (Maina, Uy I, II, etc.), and on the Tuba (Gora Veselovskaya) are associated with deposits of the second and third terraces (Fig. 2, *2*). New research problems arose with the discovery of Paleolithic sites on the Upper Yenisei, located in unusual geological and geomorphological settings as compared to traditional ideas about the altitudinal location of sites. On the one hand, sites associated with cover deposits of high

*Fig. 2*. Late Upper Paleolithic sites located at different hypsometric levels in the Upper Yenisei basin.
*1* – section at Golubaya I; *2* – site on the second above-floodplain terrace (Gora Veselovskaya at the Tuba River); *3* – site at high elevations (Kuibyshevo II on the Dzhebash River); *4* – site on the first above-floodplain terrace, lowered to the level of the high floodplain (Irba II at the Tuba River).

hypsometric levels have been recorded. An example of this is the large workshop-site of Kuibyshevo II in the Upper Abakan basin. The cultural remains were deposited in thin bed of upper loams overlying the weathering crust at a level of 70–75 m (there are finds confined to the elevations of 60–65 and 90 m; Fig. 2, *3*). At Krivoi Chistobai I, a Paleolithic cultural layer was found on a 35–40 m terrace in stratigraphic conditions similar to those of Kuibyshevo II (Zubkov et al., 2019). On the other hand, Paleolithic sites have been discovered at unexpectedly low hypsometric marks corresponding to the level of a high floodplain. Such is the site of Irba II, where Paleolithic remains occurred in the sediments of the first terrace lowered to a level of 3.5–4.0 m (Fig. 2, *4*) (Vasiliev et al., 2019).

## Sartan Age in the Basin: were there any catastrophes?

Recently, discussions about the nature of the Late Upper Paleolithic on the Upper Yenisei have taken an unexpected turn: there emerged an original version of the repeated flooding of the South Minusinsk Basin in the Late Pleistocene because of catastrophic outbursts of the waters of the Darkhat and Todzha paleolakes, reconstructed in the area of the headwaters of Big Yenisei (Biy-Khem) in Tuva and Mongolia (Arzhannikova et al., 2014; Komatsu et al., 2009). The remnants of the ancient riverbed of the Yenisei are considered as runoff valleys in the South Minusinsk Basin. Since the time of D.A. Klemenets, it has been known that in the Middle

Pleistocene, the Yenisei, after leaving the mountain gorges of the West Sayan, flowed in a northwestern direction to the modern stream of the Abakan River, and the lake depressions in the Koibal steppe are traces of the gradual displacement of the Yenisei to the east (Zyatkova, 1973: 48).

Krasnoyarsk archaeologists (Akimova, Kharevich, Stasyuk, 2020) attribute the absence of Paleolithic traces in a number of the South Minusinsk Basin valleys to hypothetical flooding. Even though I am not a specialist in Quaternary geology and paleogeography, I will consider some contradictory points of this hypothesis.

First of all, catastrophic descents of a large mass of water should have led to the erosion of low terraces, especially in mountainous conditions. However, no traces of such phenomena were found in the Sayan canyon of the Yenisei. Notably, all low terraces and floodplains here are composed of loose sandy/sandy loam deposits, and are easily eroded. As an example, I will give the results of the survey of the Maina hydroelectric power station reservoir, undertaken by V.S. Zubkov in 2013 in an assignment for the Lenhydroproekt Institute. Owing to the changes in the level of the reservoir's surface, we were instructed to examine the Neolithic to Bronze Age sites discovered here earlier by S.N. Astakhov (1989). Unfortunately, not even traces of the sites could be found; all low levels had been swept away by the river. The reason is clear: the accident that occurred in 2009 at the dam of the Sayano-Shushenskaya hydroelectric power station and the subsequent release of a huge mass of water. It was a kind of human-made analog of the hypothetical natural disasters of the Pleistocene.

As a proof of the water flow into the valleys of the Yenisei tributaries during a catastrophic breakthrough, the authors repeatedly reproduced photographs of the stratigraphic section at the Golubaya River (Arzhannikova et al., 2014: Fig. 5; Komatsu et al., 2009: Fig. 9). In reality, this was the outcrop of the back-slope part of the second terrace, which included Golubaya I studied by Astakhov in 1972 (1986: Fig. 23) (Fig. 2, 1). At present, this part of the terrace is destroyed by erosion. In an unexplainable way, in the thickness of deposits, which presumably were formed as a result of "catastrophic flood", the remains of the Late Paleolithic habitation unit, with a hearth in the center, were perfectly preserved, without any traces of disturbance of the cultural layer. The age of this stratum can hardly be correlated with the hypothetical water breakthrough 17 ka BP, since for the main third cultural layer of Golubaya I, a series of radiocarbon dates was obtained in the range of 13–12 ka BP.

In general, the stratigraphic sections of the multilayered sites of the Maina region show uninterrupted cultural development in the period from 19–18 to 10 ka BP. They lack traces of erosion, abrupt breaks in sedimentation, intrusion of lenses or layers of coarser material (Vasiliev, 1996: 18–23, 107–112, 145–149; Vasiliev et al., 2005).

The idea that the entire lowland of the South Minusinsk Basin is a "blank spot" on the map of the Late Upper Paleolithic sites (Akimova, Kharevich, Stasyuk, 2020: 4) is not quite correct. First of all, in the valley of the middle and lower reaches of the Abakan, which, according to researchers (Arzhannikova et al., 2014: Fig. 4), was sometimes covered with water, stratified sites are known—Kongure, Ulugbil, and Sosnovoye Ozero I (Abramova, 1975; Lisitsyn, Hudiakov, 1997: 9–11, 14–16, 24–26; Lisitsyn, 2000: 94–101). In the central part of the Koibal steppe, at the Smirnovka locality, the remains of a cultural layer were found; and near Minusinsk, a stratified Paleolithic site of Bystraya II was discovered (Paleolit…, 1991: 61, 64).

According to the researchers, flooding of the Minusinsk Basin explains the absence of traces of the Paleolithic in the Oya River valley, the right tributary of the Yenisei (Akimova, Kharevich, Stasyuk, 2020: 5). This fact has been known since the time of I.T. Savenkov (1887). It should be noted that the distribution of Late Paleolithic sites in the region is clearly asymmetric. On the right bank of the Yenisei, there are much fewer of them. Many years of exploration show that here, traces of Paleolithic humans are sometimes absent even in well-developed river valleys, with a complex of Late Quaternary low terraces. An example would be the valleys of the middle reaches of the Us River (within the Us intermountain basin) and its left tributary, the Idzhim River. In the Amyl River valley, during explorations along the route of the future Kyzyl-Kuragino railway, for more than 70 km, only one destroyed Paleolithic site (Kachulka) was found; moreover, it was located in the lowest section of the river, near the formation of the Tuba River at the confluence of the Amyl and Kazyr (Vasiliev, 2020). Notably, this area contains abundant remains of Late Quaternary fauna. Examination of finds stored in the local history, factory, and school museums of the towns of Kuragino, Karatuzskoye, Berezovskoye, Bolshaya Irba, and Verkhniy Kuzhebar showed the complete absence of traces of prehistoric human impact. Probably this territory was uninhabited by humans in the Sartan Age, which may be because of the proximity to the areas of glaciation in the East Sayan.

## Conclusions

To date, during many years of excavations, primarily at the sites of the Maina group, materials have been accumulated that make it possible to describe prehistoric habitation sites and to reconstruct the lifestyle of Paleolithic hunter-gatherers. Most of the sites show traces of seasonal camps near open water, with hearths and accumulations of chipped stone scattered over the area, sometimes with the remains of light aboveground dwellings. Nearby pebble gravels served as the main source of raw material, although cases of the long-distance transportation of products made from high-quality rocks have been recorded. The exception is the workshop-site of Kuibyshevo II, confined to the outcrops of veined quartzite.

As for the cultural affiliation of the sites, the vast majority of the Late Paleolithic assemblages of the region belong to the Afontova culture. Furthermore, the latest discoveries significantly expand the area of the Kokorevo culture in the southwestern (Krivoi Chistobai I) and southeastern (Pritubinsk I) directions. The blade industry of the third cultural layer of Golubaya I stands apart. The number of variants of the Late Upper Paleolithic culture of the Yenisei is increasing, as evidenced by the discovery of a peculiar industry with foliated bifaces, represented by the materials from Kuibyshevo II (Vasiliev, Zubkov, 2021).

Despite the more than a century-long study of the Old Stone Age of the region, the Upper Yenisei basin has been studied extremely unevenly. Almost all the known sites belong to the Late Glacial, Sartan period. The collections from some sites (Oznachennoye I, Irba II) contain rare corroded artifacts, suggesting the presence of older (probably pre-Upper Paleolithic) assemblages in the region; but the sources of collection of such items by the Late Paleolithic inhabitants of the sites are unknown.

The fate of the Late Paleolithic population of the Upper Yenisei in the Holocene also remains unclear. The main unresolved problems of the archaeology of the Minusinsk Basin include the extreme rarity of Mesolithic finds, although palaeoenvironmental data do not indicate catastrophic changes in the natural environment at the turn of the Pleistocene and Holocene.

## Acknowledgment

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# Điem Cave: A Stratified Late Pleistocene and Early Holocene Site in Northern Vietnam

*This study presents the findings of excavations at Điem Cave, a Late Paleolithic site in Vietnam. Several lithological units and cultural layers are identified. Archaeological materials, including stone and bone artifacts, are described in detail. Findings from the three lower layers include sumatraliths, axes, bone tools, and ornaments. All of these, as well as features of the funerary rite, are typical of the Hoabinhian period. Human bones in the earliest burial were found in anatomical order, whereas those in other burials were crushed and charred. The authors demonstrate that the three lower layers date to the Pleistocene and belong to the Hoabinhian stage, whereas the upper layer dates to the Holocene and belongs to the Đa Bút culture. Micromorphological and stratigraphic observations suggest that the sedimentation of two of the Hoabinhian layers occurred under a humid climate, whereas one Hoabinhian layer attests to a more arid environment. Judging by the absolute dates, the Hoabinhian period appeared in Northern Vietnam before 23 ka BP. During certain stages of the Pleistocene, human populations in the region were rather numerous.*

Keywords: *North Vietnam, Điem Cave, Hoabinhian lithic industry, sumatraliths, human burials, paleoecology.*

## Introduction

Paleolithic evidence appears at a large number of Pleistocene sites in Vietnam. However, given the absence of reliable geochronology, it is very difficult to reconstruct the dynamics of prehistoric human populations with the use of only traditional methods, such as analysis of artifact typology, as well as fauna and flora species composition analysis. These difficulties are due to the specific aspects of the natural environment and sedimentation in the region. Application of modern geoarchaeological methods allows for a qualitatively new level of study of the important issues relating to the activities of Pleistocene hominines in North Vietnam.

Cave sites with evidence of the Hoabinhian culture have been studied in the karst regions of Vietnam. The term "Hoabinhian" also means "Mesolithic culture" (see, e.g., (Matthews, 1966)); "technocomplex" (Gorman, 1970; Ha Van Tan, 1997; Forestier et al., 2015), reflecting an adaptation to environmental conditions; or "stone industry" (Shoocongdej, 2000). Some scholars consider the Hoabinhian to be a transition point for the cultures whose carriers participated in the Late Glacial settlement in tropical regions of Southeast Asia (Ji et al., 2016). The discovery of a unique archaeological complex in North Vietnam by the French scholar M. Colani in 1926–1931 (Colani, 1927, 1929) initiated discussion on the essence of this phenomenon, its periodization, as well as its geographical and chronological boundaries, which has continued until this day (Gorman, 1971; Reynolds, 1989; Shoocongdej, 2000; Ha Van Tan, 1997; Marwick, 2013; Sophady et al., 2016).

About 150 open and cave sites with Hoabinhian evidence are known in Vietnam, mainly in the karst areas of North Vietnam in Thanh Hoa and Hoa Binh Provinces (Nguyễn Khắc Sử, 1984). Unfortunately, most of these sites do not have $^{14}$C dates; they were attributed to the Hoabinhian period on the basis of typological analysis of finds (Hoang Xuan Chinh, 1989). Lithic artifacts were often described briefly, only indicating tool components specific to the Hoabinhian (sumatraliths, short axes, and side-scrapers of various kinds) (Nguyễn Viet, 2000). Some studies contain information on paleobotany (Nguyễn Viet, 2004, 2006, 2008). There are problems in establishing technical and typological differences, as well as a chronological boundary between the Hoabinhian and the preceding Son Vi culture (Nguyễn Khắc Sử, 1992). The interpretation of lithic industries of Southeast Asia is complicated by the fact that the changes in reduction technique and toolkit were insignificant; this was fostered by relatively stable natural and climatic conditions over a long period of time, and by availability of alternative raw materials, primarily bamboo (Derevianko, 2018). This article introduces new findings in the study of Điem Cave, including data on technical and typological analysis of artifacts, paleontological, anthropological, micromorphological, and stratigraphic analyses, as well as estimates obtained by absolute dating. Such large-scale research has been carried out at ten archaeological sites in North Vietnam (such as Con Moong Cave (McAdams et al., 2019) and Boi Cave (Rabett et al., 2011)).

## Material evidence

Điem Cave (20°12′43.8″ N, 105°55′56.6″ E) is located in the northern foothills of the Truong Son Bak Mountains (northern part of the Annam Highlands), in Ban San village, Thái Nguyên Commune in Thạch Thành District of Thanh Hóa Province, on the territory of the Cuc Phuong National Park (Fig. 1). The cave was discovered in 2012 by the Russian-Vietnamese expedition (Derevianko et al., 2013). Trial trenching showed the presence of rich Paleolithic archaeological evidence in the sediments. After the works in 2013–2014, the trench was expanded into an excavation pit; the total area of research was 9 m$^2$ (Derevianko et al., 2014, 2015; Kandyba, 2015; Le Hai Dang et al., 2015). In 2018, an additional study of the cave clarified the stratigraphy and established the absolute chronology and micromorphology of loose deposits (Derevianko, Kandyba, Chekha, 2018; McAdams et al., 2022). For determining the absolute age of two samples from layers 2 and 3, the OSL method was used. One sample from layer 3 was subjected to radiocarbon dating (Fig. 2).

The cave, which is a part of a limestone massif, is a system of karst cavities with a total area of 500 m$^2$, with large calcined concretions, stalactites, and stalagmites, containing a large number of shells of forest aquatic mollusks on the walls. The entrance, facing northeast, is located at a height of 25 m from the valley surface and at a height of 100 m above sea level. Loose deposits have been found only at the entrance part, which has a tubular shape 30 m long and 5–10 m wide.

Field research has revealed seven lithological units and four cultural layers. The upper layer consists of a mechanically mixed and rewashed loose dark brown dusty silt, 0.05–0.2 m thick, saturated with well-preserved mollusk shells, which remained intact within the deposit. The layer contains archaeological and paleontological evidence spanning various periods (from the Holocene to the present). This lithological subdivision could have been associated with water erosion of the cave, potentially occurring in relatively recent times.

The first lithological unit (cultural layer 1) is made up of a very loose ash-gray dusty silt, saturated with clastic material and intact snail shells, with inclusions of calcite sinter-drop formations 0.1–0.4 m thick.

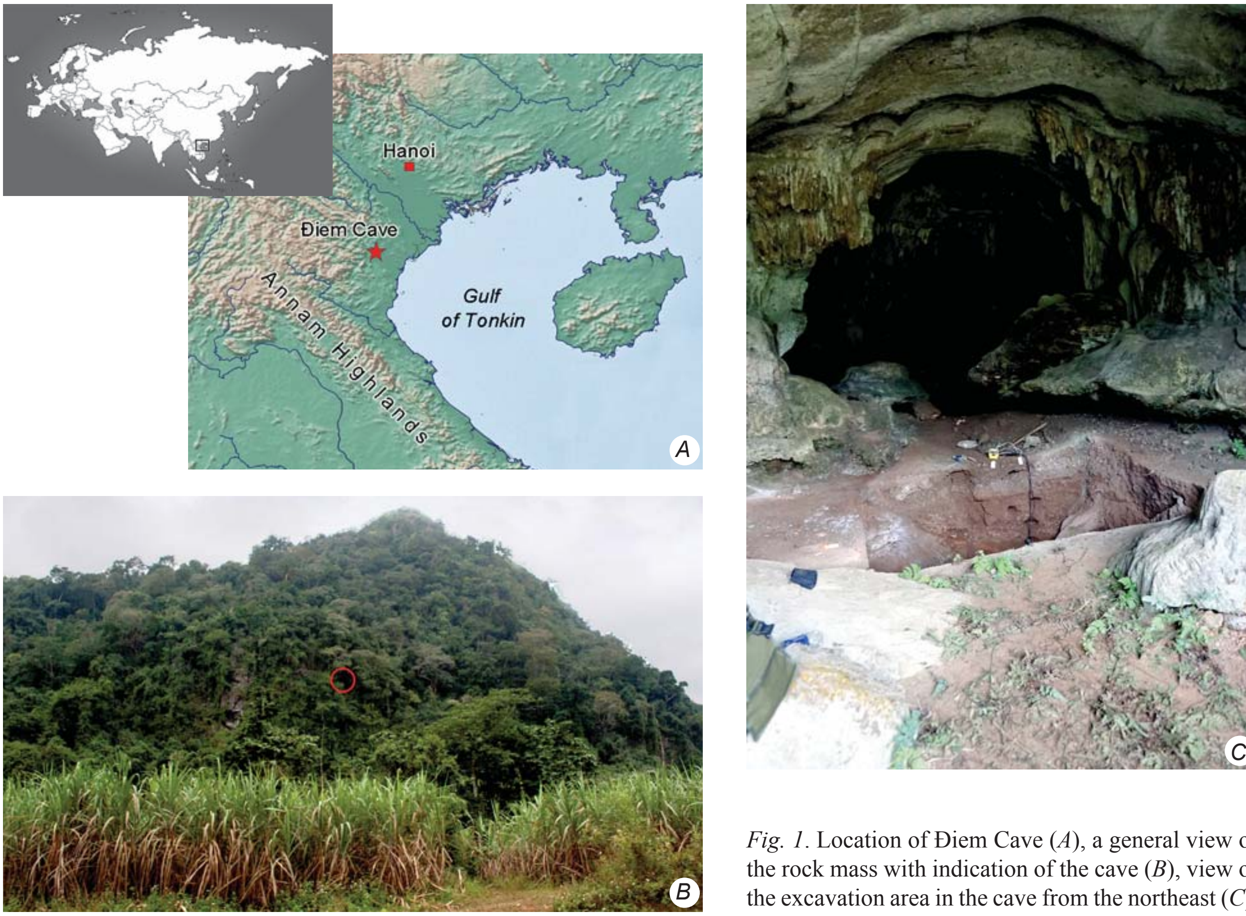


*Fig. 1*. Location of Điem Cave (*A*), a general view of the rock mass with indication of the cave (*B*), view of the excavation area in the cave from the northeast (*C*).

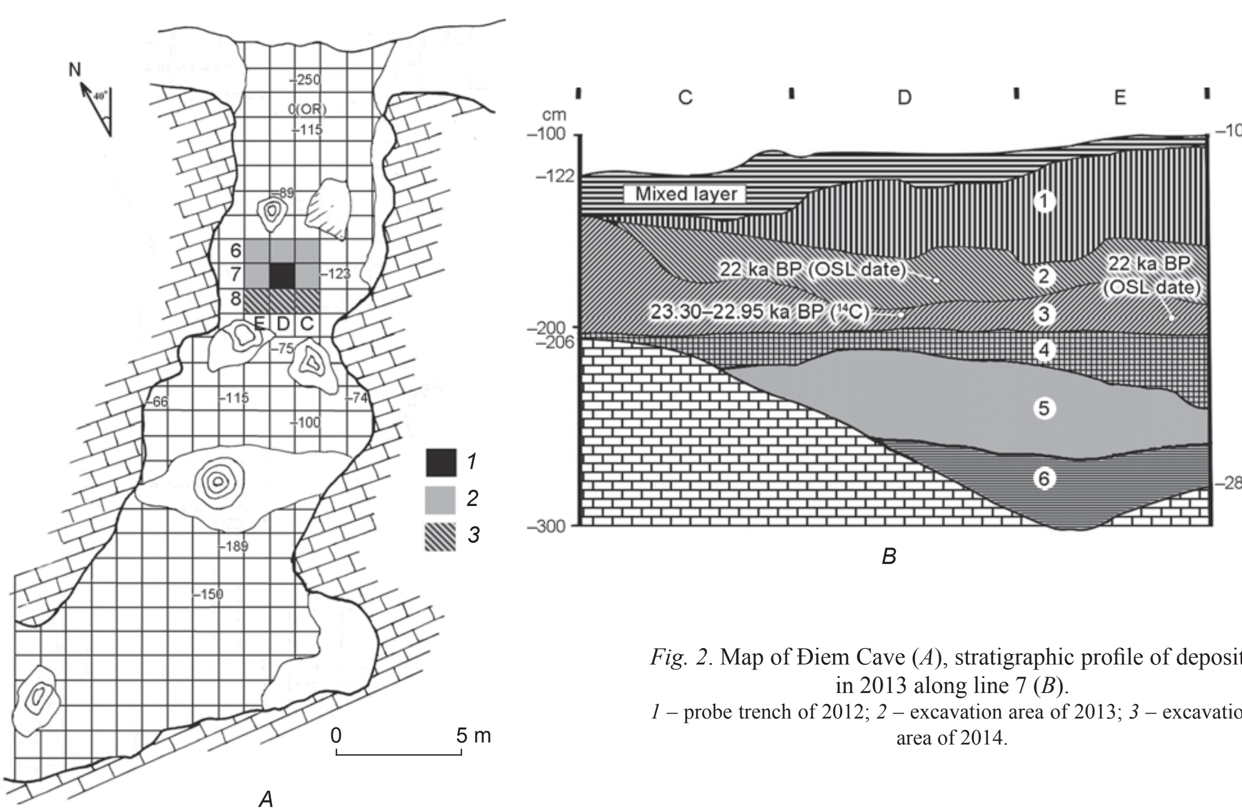


*Fig. 2*. Map of Điem Cave (*A*), stratigraphic profile of deposits in 2013 along line 7 (*B*).
*1* – probe trench of 2012; *2* – excavation area of 2013; *3* – excavation area of 2014.

The archaeological evidence consists of 429 artifacts, including 15 large pebbles (with long axis over 5 cm). Primary reduction is manifested by seven large chipped pebbles and two large core-shaped fragments. The category of spalls includes 365 items. There are 16 primary (removal of natural crust) spalls, mostly small (1–3 cm) and short (with ratio of length and width 1:1), and 39 secondary spalls (with the dorsal surface partly covered with natural crust), usually medium-sized (2–5 cm) and short. Residual striking platforms are natural in 90 % of cases. There are 251 flakes; 95 % are small and short specimens, bearing parallel unidirectional dorsal faceting. Residual striking platforms (natural, plain, and unidentified) occur in equal shares. The assemblage contains 39 fragments, 7 debitage items, and 13 chips.

The toolkit consists of only two items: a fragmented almond-shaped axe made from a limestone pebble, with its working edge created by continuous scaly retouch (Fig. 3, *1*), and an axe fragment, with traces of unifacial processing. The working edge of the latter tool was originally formed by trimming and was rejuvenated in the same way as the first tool. The assemblage also contains 39 pottery fragments, decorated by zigzag discontinuous comb dragging.

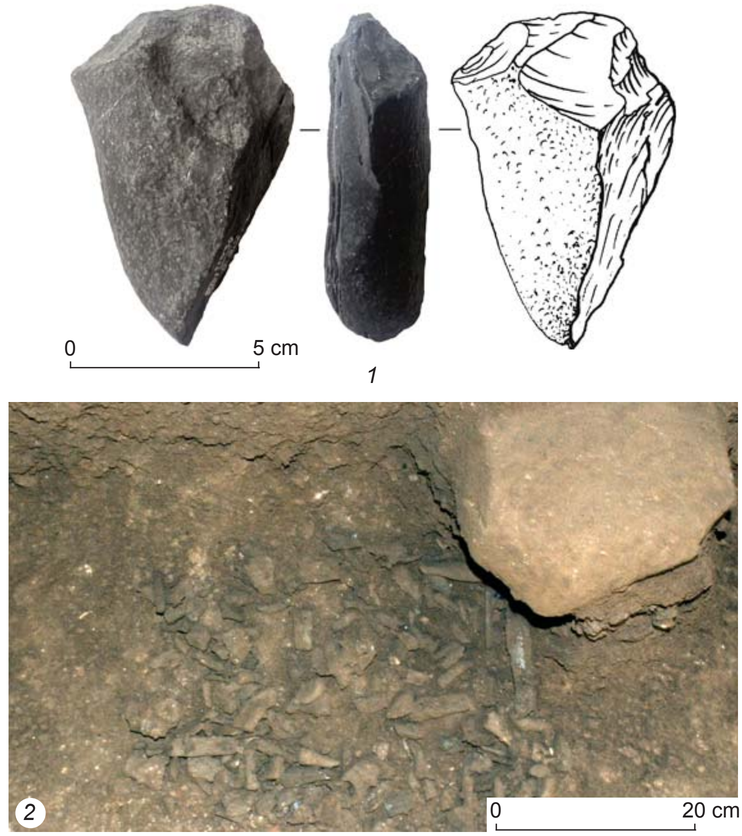


*Fig. 3*. Axe (*1*), accumulation of human bones (*2*). Điem Cave layer 1.

The anthropological evidence consists of an accumulation of bones, probably of a single individual, heavily charred and crushed, which precludes its more detailed description (Fig. 3, *2*).

The second lithological unit (cultural layer 2) has loose reddish-brown silt with fragments of mollusk shells; 0.25–0.3 m thick. The archaeological evidence consists of 551 specimens, including two large pebbles. Primary reduction is manifested by five large items: two split pebbles, two core-shaped fragments, and a double-platform bifacial transverse core (Fig. 4, *1*). The spall industry amounts to 537 items. There are 402 flakes, dominated by small and short or medium-sized and short specimens, with traces of parallel dorsal faceting. There are also 20 primary spalls, which can be divided into two equal parts: small and short, or medium-sized and short. Secondary spalls (31 spec.) are mostly medium-sized and short, or small and short. Identifiable residual striking platforms (90 % of all the spalls) are natural. The industry includes 15 fragments, 16 debitage items, and 53 chips.

The toolkit consists of eight artifacts. Intact tools include two convex side-scrapers, with their working edges created by continuous scaly retouch, and two flakes: one with ventral faceting, the other retouched. The toolkit also includes two fragmented disc-shaped side-scrapers (sumatraliths), and an axe fragment. Unusual elements in this assemblage are an awl-type bone tool (Fig. 4, *2*) shaped by planing, and a trapezoidal hematite pendant with a hole, which was first cut and then drilled (Fig. 4, *3*). Small pieces of ocher were also found in the layer.

The anthropological evidence consists of an accumulation of highly fragmented human bones, presumably of two individuals (Fig. 4, *4*).

The third lithological unit (cultural layer 3) consists of loose reddish-brown silt of grayish hue, with numerous inclusions of mollusk shell fragments; 0.25–0.6 m thick. Archaeological evidence is made up of 477 items, including 2 large pebbles. Five large split pebbles are associated with primary reduction. The assemblage includes 459 spalls and 300 flakes. The overwhelming majority of flakes are small and short, or medium-sized and short with parallel dorsal faceting. There are also 19 primary small and short,

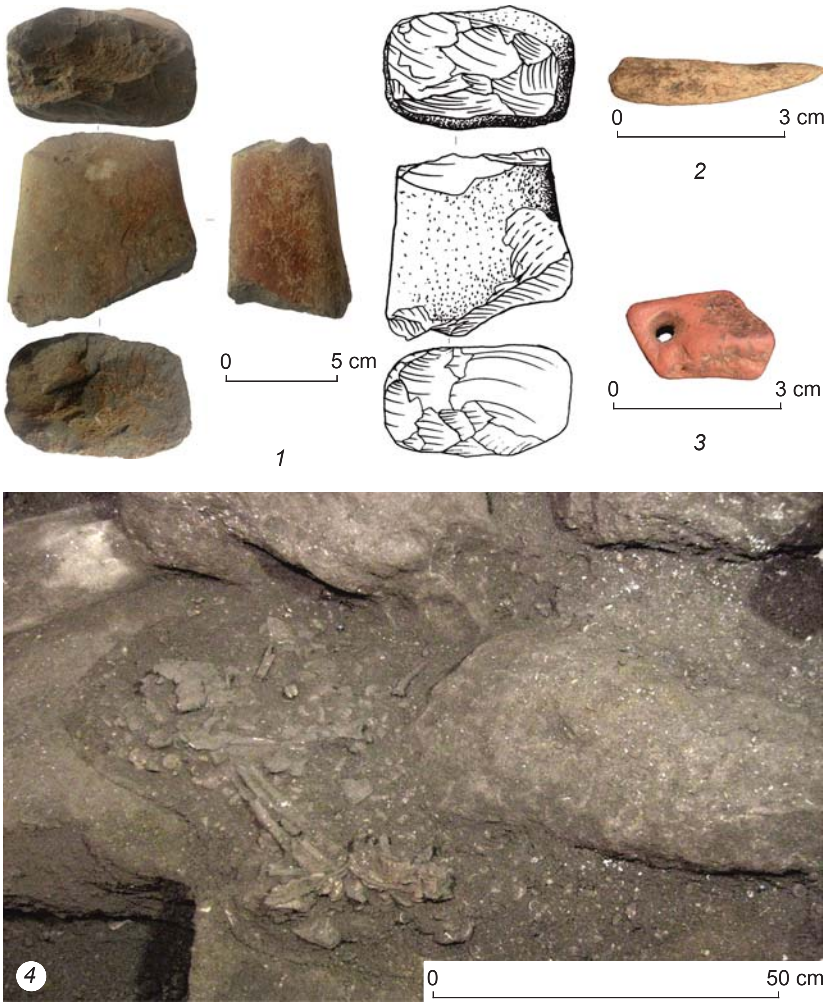


*Fig. 4*. Double-platform bifacial core (*1*), awl-type bone tool (*2*), pendant (*3*), accumulation of human bones (*4*). Điem Cave layer 2.

Archaeological evidence, confined to the top of the layer, consists of 757 specimens, including 23 intact large pebbles. Primary reduction is manifested by 25 large items: 10 chipped pebbles, 12 core-shaped fragments, an intact core, and two core fragments. A single-platform unifacial core demonstrating traces of transverse reduction was made on a large pebble; it was reduced without preliminary preparation (Fig. 6, *1*). Two core fragments show traces of a radial flaking system.

The spall industry includes 709 specimens: 416 flakes, 28 primary spalls, 32 secondary spalls, 157 fragments, 25 chatters, 49 chips, and 2 technical spalls. As in the previous cultural layers, the industry from this layer is dominated by small and short, or medium-sized and short flakes with parallel dorsal faceting. Identifiable

or medium-sized and short spalls (almost in equal amounts); 40 secondary spalls, mostly medium-sized and short, or small and short; 22 fragments; 22 debitage items; and 55 chips. Features of the spall industry from this layer completely coincide with those of the previous unit. One item is a technical spall, which is a removed flaking-surface or a flattening spall of a sumatralith. The toolkit from layer 3 is the same as in layer 2. It consists of 11 large items, including four convex side-scrapers, two of which are intact and two fragmented (Fig. 5, *1*, *2*), two fragmented disk-shaped (sumatraliths) side-scrapers, a retouched flake, and an axe fragment. In this layer, for the first time, two choppers were found (Fig. 5, *3*) made on rounded pebbles, initially by trimming and later with continuous scaly steep retouch, as well as an adze fragment.

The fourth lithological unit (cultural layer 4) has loose red-brown silt of yellowish hue, with small fragments of shells and inclusions of veined quartz, strongly travertinized in some places; 0.15–0.3 m thick.

residual striking platforms are mostly natural, with a few plain platforms. Primary spalls (small and short, or medium-sized and short) occur in equal amounts. Secondary spalls (95 %) are small and short, or medium-sized and short. Residual striking platforms in spalls of both categories are natural. There are two technical spalls in the assemblage: removed flaking-surfaces or flattening spalls of sumatraliths.

The toolkit consists of ten large items. An end-scraper was made on a flake by marginal scaly retouch (Fig. 6, *2*). A side-scraper with working edge along 3/4 of the perimeter and natural butt was made on a rounded piece of limestone by trimming and continuous stepped retouch (Fig. 6, *3*). A heavily fragmented side-scraper was shaped in a similar way (Fig. 6, *4*). A spurred tool was made on a quartz fragment of trapezoidal shape; its working part was shaped using the natural contour of the blank. The spur-like protrusion was fashioned by continuous steep, scaly retouch. A piercing tool was made on a small, short flake. Its working edge was shaped in the medial part by continuous scaly retouch. An awl-type bone tool has been identified, which was made from a piece of rib by planing. The assemblage contains two flakes with sporadic ventral retouch, and two fragments of retouched pebbles.

The upper part of this layer yielded a female burial (Fig. 7). The bones were found in anatomical order. The woman was buried on her side, with bent knees and head oriented toward the cave. There were no grave goods except for a few scattered small flakes. Notably, the burial was located basically on the rocky base of the cave, which rose in the southeast direction, and was partially covered with travertine deposits.

The dense travertine sequence of red-black-yellow-brown (layer 5) and white-yellow (layer 6) silts, with numerous rounded quartzite fragments and small quartzite pebbles, was archaeologically sterile.

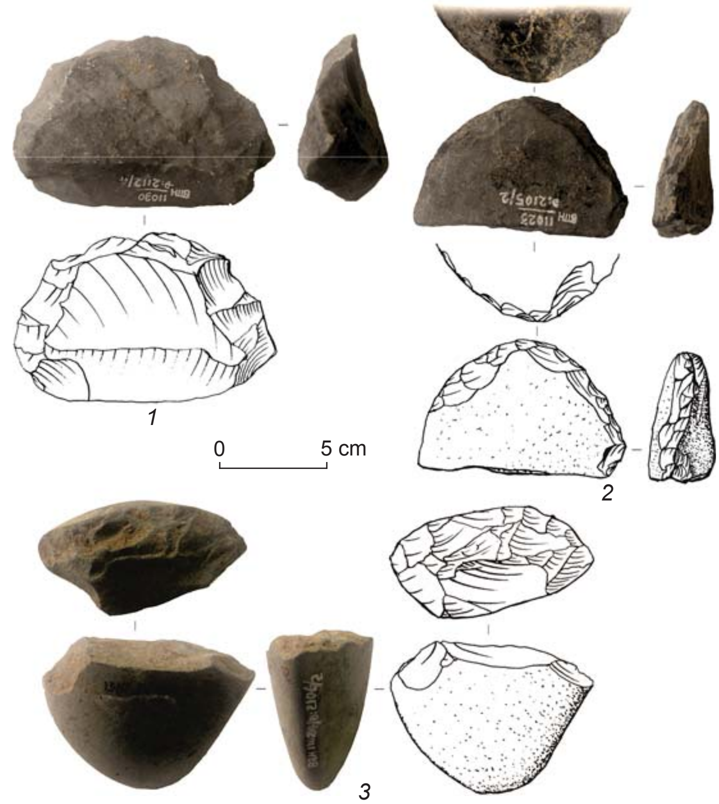


*Fig. 5*. Convex side-scrapers (*1*, *2*), chopper (*3*). Điem Cave layer 3.

## Discussion

Field and laboratory research in 2012–2014 and 2018 made it possible to establish features of early human habitation in Điem

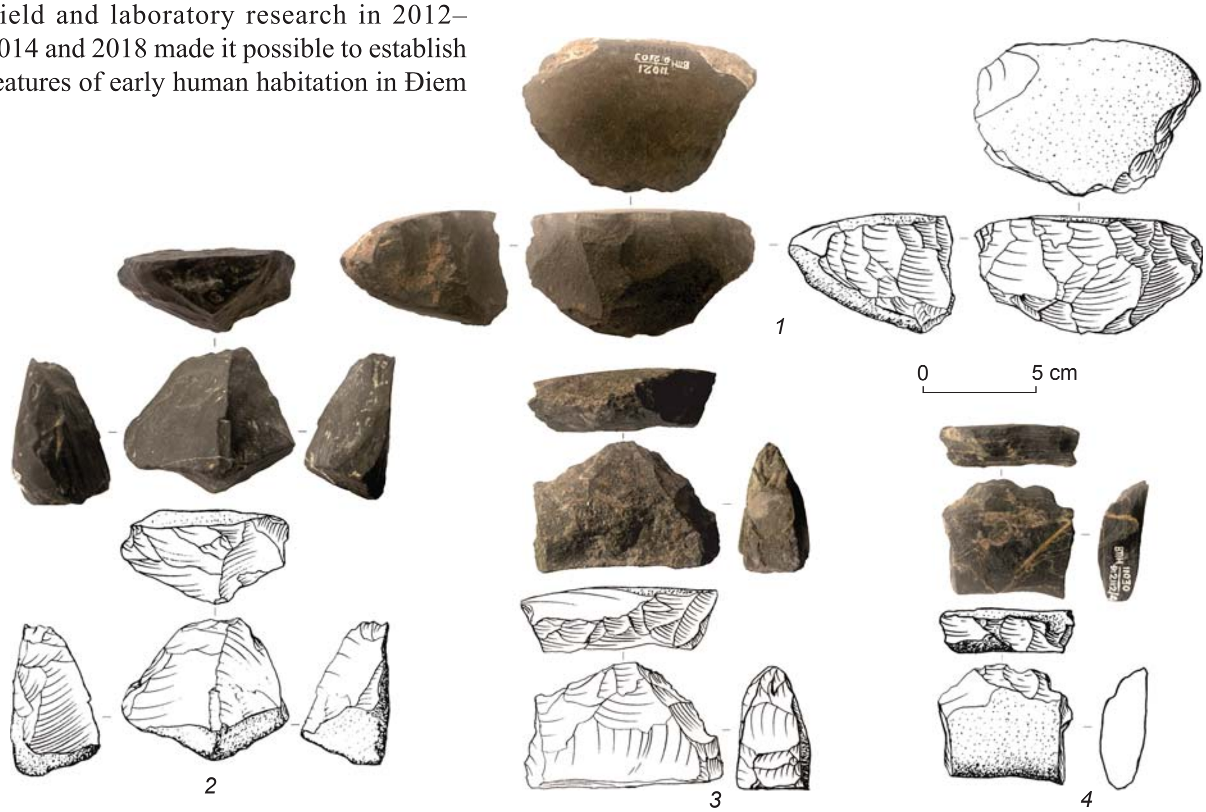


*Fig. 6*. Single-platform unifacial core (*1*), end-scraper (*2*), side-scrapers with working edge along 3/4 of the perimeter (*3*, *4*). Điem Cave layer 4.


*Fig. 7*. Female burial. Điem Cave layer 4.

Cave. Layers 5 and 6, which correspond to the initial stage of sedimentation, yielded no traces of prehistoric humans. According to micromorphological studies, during that period, the cave had an active watercourse and humid climate (McAdams et al., 2022).

The lithic industry from layer 4 is difficult to classify, because it is dominated by spalls. Primary reduction was based on the system of parallel flaking. The toolkit is poor and consists of items typical of the Late Paleolithic of Vietnam. Dates for the overlying lithological layers indicate that the age of this cultural and chronological unit is over 23 ka BP. Sedimentation occurred in the conditions of a humid climate (Ibid.). The inhumation burial found in the layer is similar to the Hoabinhian burial in Con Moong Cave located 3 km west of Điem Cave (Kandyba et al., 2020; Nguyễn Khắc Sử, 2009).

The lithic industry of layer 3 includes the same components of primary reduction as the previous assemblage, but the toolkit shows typical Hoabinhian artifacts, such as disk-shaped side-scrapers (sumatraliths), as well as fragments of axes and adzes. The age of this cultural and chronological unit is 22–23 ka BP; it was accumulated in a dry climate. According to microstratigraphic studies, at that time, humans already actively used Điem Cave (McAdams et al., 2022).

The lithic industry of layer 2, in its technical and typological features, is a typical Hoabinhian complex, as represented in the two previous lithological units. However, layer 2 contains ornaments and traces of using ocher. The age of the second cultural and chronological unit is 22 ka BP; sedimentation occurred in a humid climate, with occasional human habitation in the cave (Ibid.).

The material evidence from all three cultural layers is Hoabinhian in terms of typology; during the formation of these layers, Điem Cave was actively used by prehistoric humans. Significant production waste (flakes, fragments, etc.) associated with the final stage of stone processing testify to the manufacture of tools. Habitation in the cave is evidenced by the burial practice, as well as by over one thousand bone fragments of reptiles, birds, and mammals, which were collected within the three cultural and lithological units (layers 2–4). Among them, 286 bones and teeth were identified, in some cases on the level of species, and most on the level of order (by A.N. Tikhonov). Over 50 % of the identifiable bones and teeth belong to medium-sized deer (*Cervus nippon* – sika deer, *Cervus porcinus* – hog deer). A large portion consists of the remains of wild pig (*Sus scrofa*). As herd animals, pigs could have been hunted more effectively than solitary species. Bone remains of large mammals—a tiger (*Panthera tigris corbetti*), large bull (possibly a new species), and probably a rhinoceros (*Rhinoceros sondaicus annamiticus*)—were found. A mandible fragment, with unusually large premolars, might have belonged to a stump-tailed macaque (*Macaca arctoides*). Turtle remains were discovered in almost all the layers; birds were represented by two bones. Three human bones (one of them burnt) were discovered apart from the burials. The humerus of a sambar deer

(*Cervus unicolor*) showed a predator bite; judging by the width of the traces, most likely from a dog. All the layers contained shells of terrestrial mollusks (*Bradybaena jourdyi* and *Cyclophorous sp*).

Archaeological and paleontological evidence from the Hoabinhian layers of Điem Cave correlate well with the finds from similar layers of the nearby Con Moong Cave. Moreover, the remains of the same animals were also typical of the Son Vi culture, which leads to the conclusion that species composition of faunal complexes in North Vietnam was relatively stable in the Final Pleistocene (Derevianko, Kandyba, Chekha, 2019). Despite periodic aridity associated with the last glacial maximum in 26–19 ka BP (Clark et al., 2009), flora and fauna did not undergo significant changes in the mountains of the tropical regions of Southeast Asia (Visser, Thunell, Stott, 2003; Shintani, Yamamoto, Chen, 2011). This is confirmed by the studies of the Late Pleistocene and Early Holocene complexes of Trang An, especially Chong Cave (Rabett et al., 2017). Karst areas like Cuc Phuong and Trang An were inhabited for thousands of years by prehistoric populations due to guaranteed access to natural resources. According to the evidence from Điem Cave, this also occurred in the Holocene. The last cultural unit (layer 1) contained scarce stone implements belonging mainly to the spall industry, but the cultural affiliation of the pottery suggests the time when that layer was accumulated and correlates it with the Neolithic Đa Bút culture (7000–4000 BP). The data obtained indicate that the cultural phenomenon of the Hoabinhian appeared before 22 ka BP.

## Conclusions

In addition to North Vietnam, Hoabinhian sites widely occur on the Indochina Peninsula, Sumatra Island, and South China. The artifacts found at these sites were made of river pebbles by trimming. Scholars regard sumatraliths as the most common tools, acting as a kind of cultural marker. Some experts differentiate the items of this category by their morphology (Zeitoun et al., 2019) and purpose (Kandyba et al., 2021). There are numerous short and rounded oval and oval-pointed axes, and side-scrapers of various kinds. Interestingly, the Hoabinhian complexes retained features inherent to the Son Vi industry (traces of "citron" cleavage, presence of various choppers), while the Son Vi industries began to show some Hoabinhian elements, such as isolated sumatraliths, axes and adzes, including polished ones. The analysis of archaeological evidence relating to the industry of Paleolithic humans in Southeast Asia, including North Vietnam, has revealed that a techno-typological industry fundamentally different from that of the rest of Eurasia evolved in this region in the Final Pleistocene. The results of the interdisciplinary research of cave complexes in North Vietnam of the last decade give grounds to consider the Hoabinhian culture as a unique example of relatively stable human adaptation to tropical latitudes in the Final Pleistocene and Early Holocene.

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# A Case of Systemic Connective Tissue Disorder in a Pazyryk Male from the Altai Mountains

*We present the results of an anthropological and paleopathological study of a male skeleton from a Pazyryk kurgan 1 burial 1 at Ak-Alakha-1, the Altai Mountains. The archaeological context testifies to a rather high social status of this person. His appearance was modeled using a modern facial reconstruction method. The combination of craniometric and anthropometric traits indicates a brachycranic Caucasoid type, which predominated in the male population of the Volga-Ural region and Western Kazakhstan in 600–200 BC. The individual suffered from a systemic disorder of the connective tissue affecting virtually all parts of the skeleton. The case is unique, and the condition is diagnosed as DISH—diffuse idiopathic skeletal hyperostosis, possibly caused by grave metabolic and endocrine disorders. Judging by his physical type, the male was not native to the Altai Mountains and belonged to a population that was not genetically adapted to that region. This may account for the severity of the rheumatoid disorder, which was aggravated by 4th degree osteoporosis of lumbar vertebrae and pelvic bones and by traumatic lesions of the shoulder girdle.*

Keywords: *Pazyryk culture, Altai Mountains, anthropological reconstruction, rheumatoid diseases, diffuse idiopathic skeletal hyperostosis (DISH).*

## Introduction

Manifestations of musculoskeletal connective tissue diseases (i.e. those of the muscular tendons, synovial joint membranes, ligaments, cartilage and bone tissues) are the most commonly observed markers in a paleopathological study of ancient skeletons. In modern medicine, such diseases are classified as rheumatic. Their common and the most typical manifestations are inflammatory lesions of the joints of both axial and appendicular skeletons. The number of various nosological forms and syndromes is extremely high—from 150 (Adzhigaytkanova, 2013: 5) to 200 (Turdialieva et al., 2015). There are no specific locations mainly affected by the systemic connective tissue diseases: the lesions can be detected in any part of the skeleton.

In the case presented in this study, the whole skeleton was affected by a disease. As such a unique combination of manifestations of connective tissue destruction can be of interest for both medicine and anthropology, we provide a thorough description of the individual.

Importantly, in modern clinical practice, a patient cannot be subjected to whole-body imaging, as in this case permissible exposure limits will be exceeded. Thus, the information regarding the scale and distribution of skeletal lesions not included in classic lists of the main diagnostic criteria of inflammatory rheumatic diseases is of a particular practical value. In the anthropological context, the same information can be employed for reconstructing the aspects of ancient social life that were protecting and supporting physically impaired members of the Pazyryk society. In this line, we set out to integrate the data on the burial rite and morphology of the studied skeleton in order to evaluate the social specific of the individual in the context of the ethno-cultural and geographic diversity of the Pazyryk population.

## Material and methods

The male skeleton from the Al-Alakha 1 kurgan burial, located at the basin of the Al-Alakha River, at the Ukok Plateau, was the focus of a complex anthropological and paleopathological study. This site of the Pazyryk archaeological culture was excavated by N.V. Polosmak in 1990 (Polosmak, 1994: 16–60; Naseleniye…, 2003: 17–21). Remains of two individuals were excavated from two burials of the kurgan, one of which—a 45–50-year-old male (burial 1)—is the subject of the present study*.

A complex construction and ritual elements of the burial suggest a high social status of both individuals from the kurgan. The larch log coffins, in which the buried had been placed, were as large as those from the "royal" 1st Pazyryk mound (Rudenko, 1953: 44). These were enclosed by two logworks—internal with five layers of logs and external with seven layers. In a special compartment of the latter, an accompanying burial of nine horses was found. Both coffins contained sets of weaponry, including iron pick-axes with wooden handles, iron daggers in wooden scabbards, gorytos-quivers with arrows, and bows. This kurgan was the first unplundered "frozen" burial of noble warriors-horsemen in the history of research of the Pazyryk culture, with fully preserved burial goods and fragments of outfit (Polosmak, 1994: 16–60; 2001: 45–59).

The male skeleton from burial 1 was almost completely preserved, with only minor post-mortem damage to the anterior wall of the right maxilla and the floor of the right orbit. Several teeth were lost post-mortem as well. A craniometric study of the individual (Naseleniye…, 2003: 216–220), as well as a brief general description of the skeleton (Ibid.: 259–261), were published earlier. A facial reconstruction based on the skull of the individual was created employing the methods developed by leading Russian specialists (Gerasimov, 1949, 1955; Lebedinskaya, 1998; Balueva, Veselovskaya, 2004; Veselovskaya, 2015; Nikitin, 2009) to visualize the appearance of the male. The pathological lesions of the skeleton were assessed visually and using computed tomography (CT) imaging.

## Anthropological type of the individual

Craniometric data describe the individual as a representative of a brachycranic Caucasoid type with a tall and wide face. Such a combination is found in the craniologically polymorphic Saka population of Western Kazakhstan (Kitov, Mamedov, 2014: 300–349). An analysis of the correlations between craniometric variables in the 6th–4th and 4th–3rd centuries BC samples carried out by Kitov and Mamedov shows that this morphological combination is the basal component of the male population of the Volga-Urals and Western Kazakhstan in the 6th–3rd centuries BC (Ibid.: 177).

The sculptural portrait of the individual (Fig. 1) visualizes the craniometric features mentioned above, as well as his reconstructed somatological traits. The final reconstruction employs the age and pathological lesions of the individual and is supplemented with elements of clothing and jewelry. This reflects the most typical appearance of a representative of the Pazyryk culture.

## Pathological status of the individual

### *Axial skeleton*

**Cervical spine (*pars Cervicalis*).** All the seven cervical vertebrae have survived. Of these, six (except for C2) display large marginal outgrowths, up to 12 mm. In the left occipital condyle, the osteophytes form an almost continuous band 3 to 7 mm wide (Fig. 2, *1*). In the right condyle, one of the lesions forms a false joint with the anterior arch of the atlas (C1), while another appears as a flat and wide vertical plate (12 × 4 mm). Those osteophytes could severely limit side head tilt. A bone spine at the upper surface of the anterior arch of the atlas and an osteophyte of the right condyle make another false joint. The joint surfaces of the C1 lateral

*The second individual (burial 2) was determined as a 16–17-year-old male. A molecular genetic analysis of the two specimens (Pilipenko, Trapezov, Polosmak, 2015) has shown both maternal and paternal genetic relatedness between the two men.

*Fig. 1.* Facial reconstruction of the male from Ak-Alakha-1 kurgan 1 burial 1.

masses also display substantial marginal outgrowths of the same morphology as the occipital osteophytes (Fig. 2, *2*). The right mass is affected by osteoporosis, while the left mass is of a decreased size due to the "advent" of the marginal outgrowths.

The axis (C2) displays the least number of lesions among the cervical vertebrae. The superior articular facets was only slightly affected, while the inferior articular processes are porous and lack the cortical bone layer. C2 is fused neither with C1 nor with C3. Thus, manifestations of spondyloarthritis are observed in the lateral atlantoaxial joints, while the medial joint is less affected; the ligament at the apex of the dens is partially ossified (Fig. 3, *1*).

The 3rd to 5th (Fig. 3, *2*) and 6th to 7th vertebrates are partially fused in the area of the arcuate connections of their bodies. The joints between C5 and C6 are pathologically changed, but preserved. The articular processes of these vertebrae are enlarged to 2–3 cm and display prominent "cauliflower" marginal outgrowths. The joint spaces are present. The fusion of the articular processes has likely occurred due to the growth of the marginal osteophytes towards each other and the ossification of the joint capsule: these turned the posterior parts of the vertebrae into an immobile conglomerate of fused bone structures (Fig. 3, *2*, *a*). Neoartrhroses and uncovertebral fusions between the posterior aspects of C3, C4, and C5 are clearly visible (Fig. 3, *2*, *b*). New joints between the anterior elevated parts (hamuli) of the C4–C5 bodies and the lower convex surfaces of the upper vertebrae were formed as a result of the thinning and destruction of the intervertebral disc (Zharkov, 1994: 26). The vertebral bodies in some places are connected with vertical or horizontal bone "bridges" (Fig. 3, *2*, *c*), located between their margins or even inside the intervertebral space. This indirectly suggests that the new joints were formed in the absence of the intervertebral disc. The intervertebral spaces are substantially narrowed (almost absent). The cervical

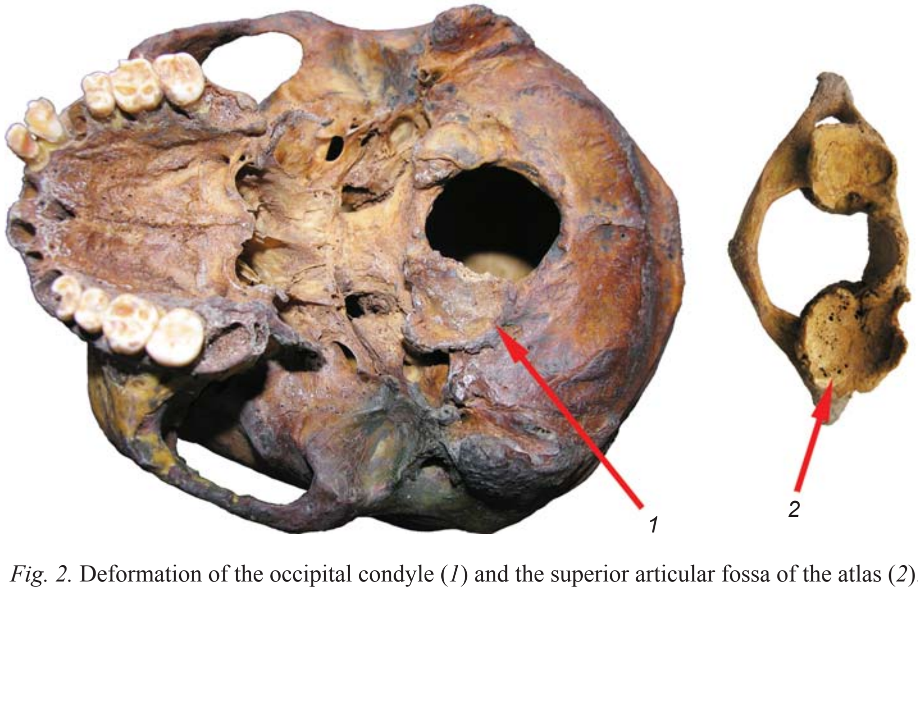


*Fig. 2.* Deformation of the occipital condyle (*1*) and the superior articular fossa of the atlas (*2*).

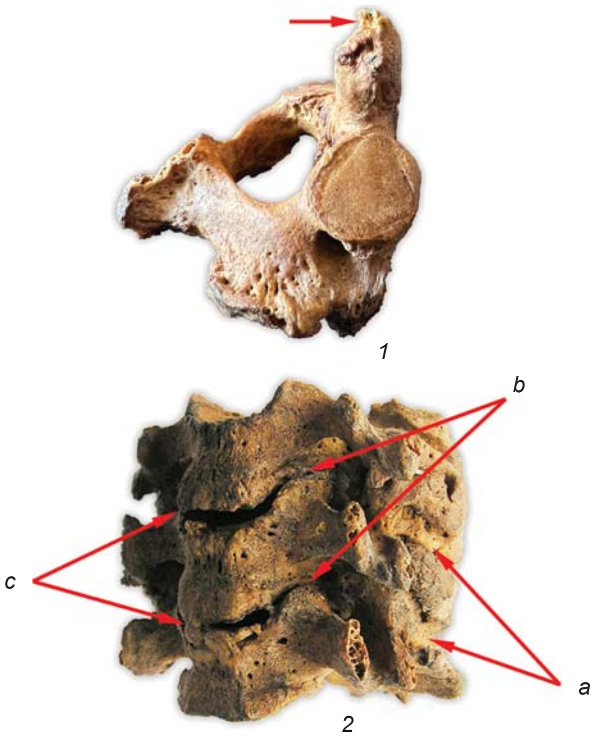


*Fig. 3.* The axis displaying ossification of the ligament of the dens apex (*1*); vertebrae 3rd to 5th fused into a bone conglomerate (*2*).
*a* – ossification of the articular capsules; *b* – uncovertebral fusions; *c* – bone "bridges" in the intervertebral spaces.

part of the vertebral column is thus severely compressed vertically.

The sequence of the pathological changes in the cervical vertebrae can be tentatively reconstructed as follows. First, the structure of the intervertebral disc was altered, likely due to a chondrosis triggered by extreme physical loadings at a young age. Later, a number of pathological processes began: subligamentous bone formation (osteochondrosis), decrease of the intervertebral spaces, formation and fusion of uncovertebral neoarthrosis, increase of the load on the posterior vertebral parts, spondyloarthrosis, ossification of the connective tissue structures in the area of the intervertebral joints and their complete fusion. These led to a significant limitation of functions and shortening of the neck. A patient with such changes in the cervical spine involuntary displays a "proud" posture, conspicuous to those around him, who might have an impression that the patient is flaunting self-confidence and arrogance (Rokhlin, 1965: 264–267). This severe pathology of the cervical spine makes it really difficult to turn one's head towards his interlocutor.

**Thoracic spine (*pars Thoracales*).** Seven thoracic vertebrae are present, all displaying some pathological changes in the bodies, but not in the articular processes. The articular surfaces of the latter preserve the cortical layer, and some of the surfaces exhibit stand-alone osteophytes up to 7 mm long. Bone outgrowths up to 3 mm long were detected on the margins of the costal facets of the transverse processes (Fig. 4, *1*), which were likely an outcome of osteoarthrosis of the costal transverse joints. The costal facets of the vertebral bodies do not display marked pathological manifestations. The spinous processes exhibit bone outgrowths at the supraspinous ligament attachment site (Fig. 4, *2*).

The bodies of all of the thoracic vertebrae (right and anterior surfaces) clearly display bony subligamentous layers forming a flat band interrupted in the intervertebral spaces. The band, 3 to 3.5 cm wide, is of a lighter color than the surfaces of the vertebral bodies. The margins and surface of the lesion in the intervertebral space display a typical "candle-wax" appearance (Fig. 4, *3*). This bone formation represents a cast of a fragment of the soft tissue spine, and based on its morphology, it can be hypothesized

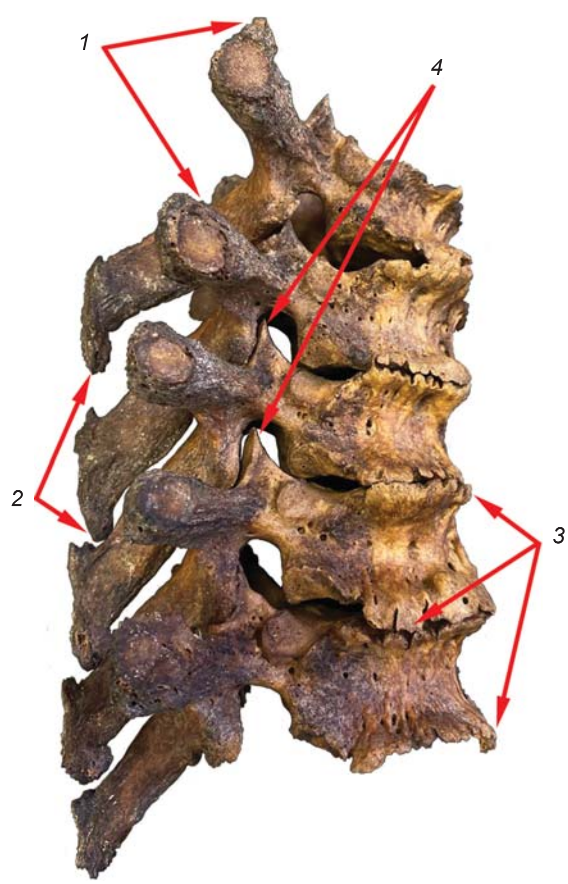


*Fig. 4.* Thoracic spine.
*1* – osteophytes at the margins of the articular facets of the transverse processes; *2* – ossification of the supraspinous ligament; *3* – subligamentous bone deposits, right and anterior; *4* – unaffected intervertebral joints.

with a high probability that the intervertebral discs of the thoracic spine were lowered and bulged aside the margins of the vertebral bodies.

It is well known that such manifestations are typical for the spine pathology entitled "spine idiopathic fixing hyperostosis", or the "Forestier disease" (Zharkov, 1994: 78; Starkova, Erdes, 2016: 80). The modern clinical literature describes this pathology as a form of non-inflammatory spine lesions (Starkova, Erdes, 2016: 80) similar, according to many formal criteria, to spondylosis (Ivashkin, Sultanov, 2005: 497–501). It must be differentiated from the Bekhterev's disease (Starkova, Erdes, 2016: 81; Skryabina, Magdeev, Korneeva, 2020: 68–69), for which severe lesions of the intervertebral joints and their fusion (ankylosis) are typical (Ivashkin, Sultanov, 2005: 497). But in the skeleton under study the articular processes are the least affected structures (Fig. 4, *4*). In addition, the Bekhterev's disease is always accompanied by ankylosis of the synovial part of the sacroiliac joins. Morphology of the pelvic bones and their joints is considered below, but it is of note that this part of the skeleton was not affected and the sacroiliac joint space is clearly visible throughout.

The Forestier's disease affects the thoracic spine first, while the lumbar or cervical vertebrae get affected later. As is detailed below, the right surfaces of the bodies of the lumbar vertebrae also display subligamentous bone formation. The disease is characterized by generalized ectopic ossification of tendons and ligaments not only of the spine, but of the appendicular skeleton as well (Ibid.: 496). In our study case, numerous loci of ossifying entesopathy (i.e. pathologic bone formation at the attachment sites of connective tissue structures—ligaments and capsules of joints, muscle tendons) and hyperostosis were detected. A description of those lesions follows.

**Lumbar spine (*pars Lumbales*).** Four lumbar vertebrae (L2–L5) are present. These are extremely light and display marked pathological changes in both bodies and arches. The height of the L5 body is reduced by a third. At the lateral surfaces of the vertebral bodies, a subligamentous bone formation bulging at the intervertebral spaces is clearly visible (Fig. 5, *1*),

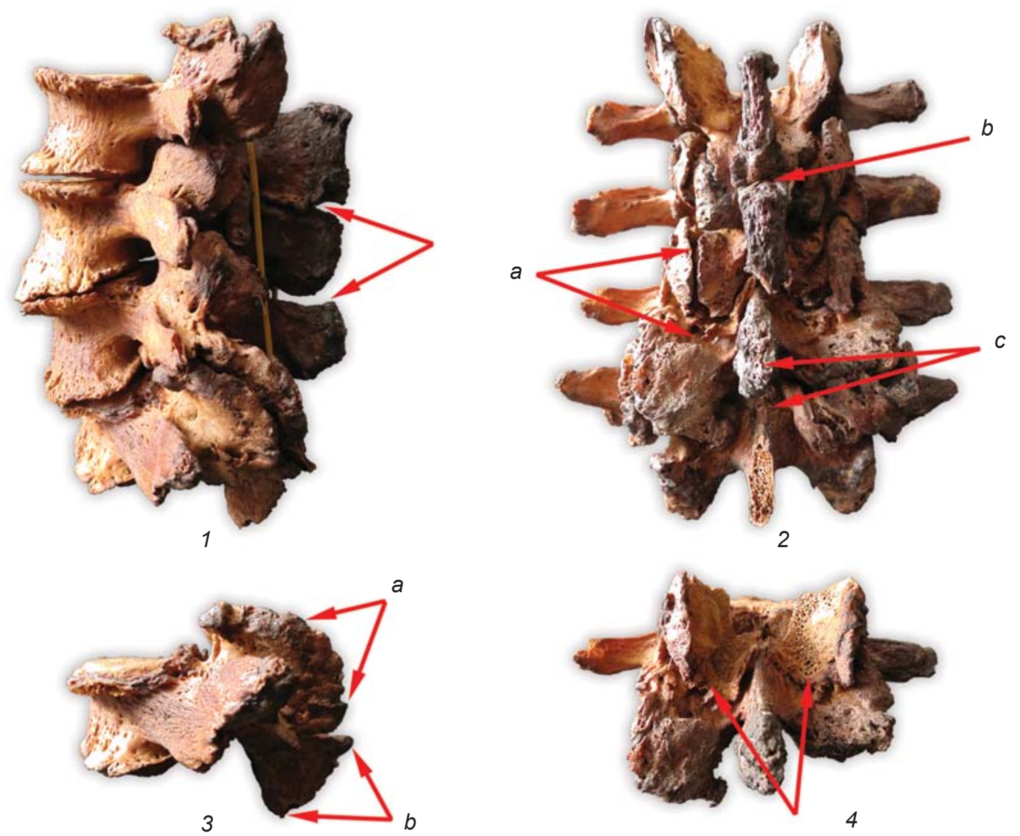


*Fig. 5.* Lumbar spine.
*1* – left view (the arrows indicate the false joints between the spinous processes); *2* – posterior view: *a* – intervertebral joints, *b* – false joints between the spinous processes, *c* – newly formed articular facets in the overgrown spinous processes; *3* – L5: *a* – large "shell-like" articular processes, *b* – overgrown spinous processes; *4* – L2 (the arrows indicate the articular processes forming a "stand" for the overlying vertebra).

which confirms the diagnosis of the Forestier's disease (Zharkov, 1994: 77). The intervertebral space between L4 and L5 is almost absent. The bodies display a "fish vertebra" shape in the sagittal plane. Marked hyperlordosis and spondylolisthesis of L4 are observed.

The vertebral arches display huge bone outgrowths located mainly in the articular, spinous and, to a lesser extent, transverse processes. The articular processes are flattened and reach 4.5 cm in diameter; their margins exhibit a wavy "shell-like" outline (Fig. 5, *3*). The compact layer of the articular surfaces is absent. The lower aspect of the upper articular processes is bent down posteriorly and reminds a "stand" for the upper vertebrae (Fig. 5, *4*). These changes might reflect the adaptation of the skeleton to extreme physical loading via enhancing the articulations of the vertebrae. The huge articular processes of the individual exhibit numerous vessel pores (even canals in some cases); thus, the observed pathological process began quite early and was developing for at least 10–15 years. From a formal point of view, such vertebral lesions—enlargement, destruction of the chondral and subchonrdal layers, extensive outgrowths of the articular margins—when not accompanied by bone fusions (Fig. 5, *2*, *a*), are typical of spondyloarthrosis. But the scale of the changes in this case is impressive. Spondyloarthrosis of any joint develops only in the cases of a substantial functional overload (Ibid.: 67–68). This, in turn, might provoke spondylolisthesis: under excessive loadings, the intervertebral discs, which are the main amortizing structures, collapse, and the upper vertebra just "slide" in the anterior direction.

The spinous processes are enlarged and display large bone outgrowths along the posterior borders, at the supraspinous ligament attachment site. Both their upper and lower margins exhibit clear signs of false joints between the processes (Fig. 5, *1*, *2*, *b*, *c*). Such a phenomenon is known in the clinical practice as the Baastrup syndrome* or the "kissing spine": the overgrown spinous processes come into contact and gradually form false joints. The pathology is fairly rare, emerges at older age, and is typically accompanied by a lasting and burning pain. Such patients receive fairly long conservative therapy, and then a surgery if the pain is still present. The factors provoking the disease are osteochondrosis, bending of the spine (in our case, hyperlordosis of the lumbar spine), and metabolic syndromes.

Cases of the Baastrup syndrome in ancient populations, according to the Russian and foreign literature on the subject, were rare. A description of spine pathologies in the Middle Paleolithic Neanderthal individual from La Chapelle-aux-Saints (male, 50–60 years old), diagnostic for the syndrome, was published by Haeusler and colleagues (Haeusler et al., 2019). False joints between the spinous processes of C6 and C7, L4, L5, and S1 (first sacral vertebra) were detected. As a probable factor, hyperlordosis of the cervical and lumbar spine was suggested. Three cases of the Baastrup syndrome were observed in the individuals from late medieval burials in France (Kacki, Villotte, Knüsel, 2011). The authors suggest that in those cases the disease was related to trauma, kyphoscoliosis, and metabolic disorders.

Our study of the CT images of the bones has shown serious defects in the internal bone structure of the lumbar vertebrae. The cortical layer is thinned, while the spongy bone displays loci of angiomatosis (i.e. excessive growth of small blood vessels). This picture is different from hemangioma, where some "swelling" of the vertebral body is typical—not present in our case. Most vertebral hemangiomas are associated to some extent to the degenerative and dystrophic processes of the spine, namely with involution of the red bone marrow and osteoporosis (Kravtsov et al., 2015: 2). In our case, many typical features of osteoporosis are present: partial lytic loci of trabecular bone are separated by vertically-oriented sclerotized trabeculae, i.e. "velvet" symptom (Kavalerovskiy et al., 2008); absence of horizontally-oriented trabeculae (Kravtsov et al., 2015: 8). Such vertebral lesions are interpreted as spondylopathies.

**Pelvic bones.** These are extremely light. The iliac crests of both bones exhibit massive bone overgrowths in the area of the broad abdominal muscles attachments (Fig. 6, 7). The lateral labrums—the enthesa of the external oblique abdominal muscle—are particularly enlarged. The sacrum and the left innominate are fused at the sacroiliac joint (Fig. 7). It is unclear if this fusion is a case of true ankylosis or a result of ossification of the chondral layer covering the auricular surfaces of the sacrum and iliac bone in the area of the synovial joint*? The cavity of the synovial part is clearly visible in the CT images (Fig. 8, *a*), as well the ossified interosseous sacroiliac ligament in the upper part of

*The disease was thoroughly studied and described by Christian Baastrup, a roentgenologist from Copenhagen.

*The sacroiliac joint has two sections: the smaller upper part (approximately a third) is a syndesmosis formed by the anterior, posterior, and interosseous sacroiliac ligaments. The lower two thirds of the surface are the synovial part of the joint (Prives, Lysenkov, Bushkovich, 2006: 159–160; Ivashkin, Sultanov, 2005: 23). A fusion of the synovial part is called an ankyloses; this is usually preceded by inflammation of the joint (sacroiliitis).

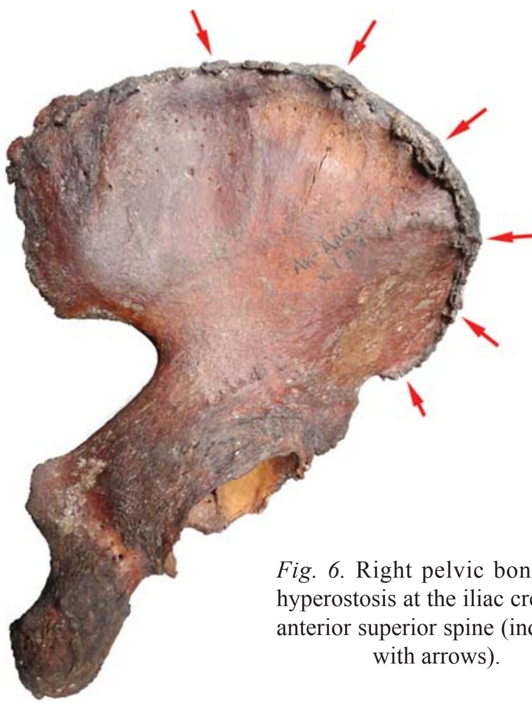

*Fig. 6.* Right pelvic bone with hyperostosis at the iliac crest and anterior superior spine (indicated with arrows).

*Fig. 7.* Ankylosis of the upper part of the left sacroiliac joint and hyperostosis of the iliac crest.

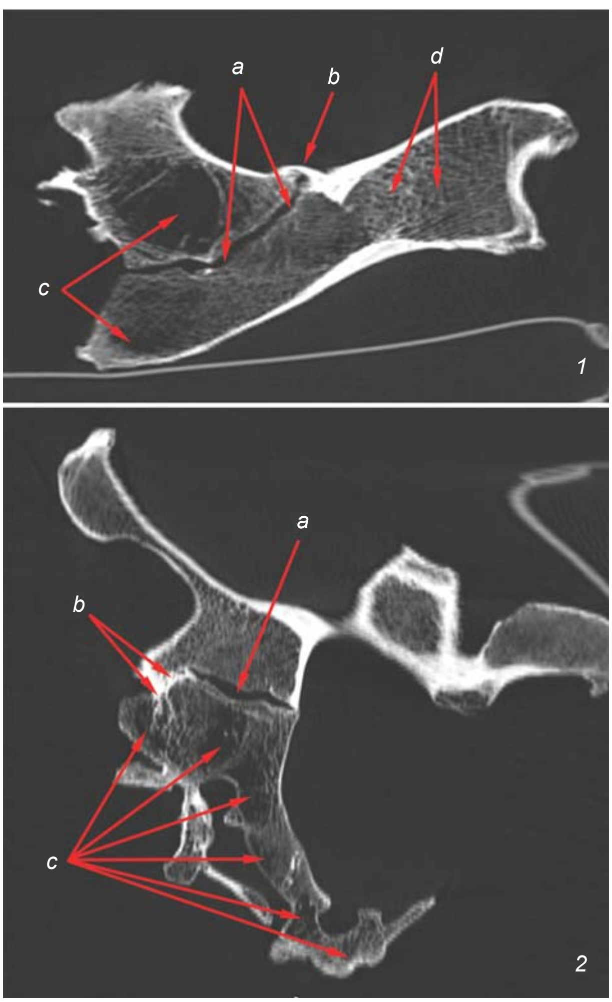


*Fig. 8.* CT images of the pelvic bones.
*1* – vertical projection; *2* – sagittal projection.
*a* – articular cavity of the synovial part of the sacroiliac joint (unaffected); *b* – ossified sacroiliac ligaments penetrating into the spongy bone; *c* – large lysed loci inside the cancellous bone of the sacrum and pelvic bones; *d* – "honeycombs".

the articular surface (Fig. 8, *b*), which forms the fusion of the bones. The pelvic auricular surfaces are clearly outlined by ossified connective tissue structures: joint capsule and ventral sacroiliac ligament. A large area of lysed trabecular bone tissue of the lateral parts of the sacrum—classic marker of osteoporosis—is also visible in the CT images (Fig. 8, *c*). The pelvic bones display some manifestations of osteoporosis as well: areas of lysed bone intervening with sclerotized trabeculae-"honeycombs" (Fig. 8, *d*) (Ibid.: 5).

### *Appendicular skeleton*

Ankylosis formed as a result of synchondrosis between the sternum and first left rib is observed; no fusion between the sternum and the rib is visible on the right side, though the costal cartilages of both first ribs are ossified. The ossification at the right

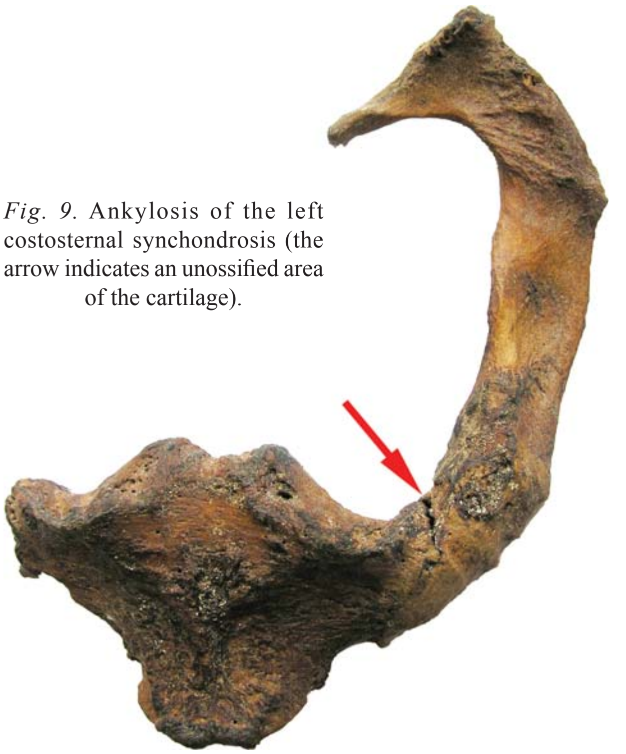

*Fig. 9*. Ankylosis of the left costosternal synchondrosis (the arrow indicates an unossified area of the cartilage).

rib was not complete, which is suggested by the presence of a prominent fissure in the internal side of the joint (Fig. 9).

Numerous loci of ossifying enthesopathy are present in the limb bones. These are most pronounced in the distal parts of the limbs, where the pathological process affected not only the structures surrounding the joints but diaphyses as well (Fig. 10). The ossifying hyperostosis and enthesopathy are in some cases accompanied by deforming arthrosis (Figs. 11, 12, 13, *1*). Hyperostosis and enthesopathies are detected in the acromial and coracoid processes of both clavicles (Fig. 13, *2*); at several attachment sites: the calcaneus to the Achilles tendon (Fig. 14, *1*), quadriceps femoris to patella (Fig. 14, *2*); triceps brachii tendon to olecranon (Fig. 14, *3*).

The complex of pathological lesions of the skeletal elements suggests that the individual from Ak-Alakha burial 1 was affected by the diffuse idiopathic skeletal hyperostosis (DISH). A wider array of manifestations in the musculoskeletal system has been described for DISH as compared to the Forestier's disease (idiopathic fixing spine hyperostosis). It has been long thought that the Forestier's disease is limited to the ossification of the spine ligaments. But since the middle 1970s, it has become gradually understood that the disease is a generalized pathological process affecting numerous ligaments and tendons of both spine and appendicular skeleton (Resnick, Niwayama, 1976; Mazières, 2013; Mader et al., 2009; Holgate, Steyn, 2016). In the skeleton from Ak-Alakha-1 kurgan 1 burial 1, the main skeletal manifestations of this process were detected. The combination of skeletal lesions typical for DISH has been detected and described in many ancient populations (Buzhilova, 2005: 190–192; Rokhlin, 1965: 191, 195–197; Klaus, Novak, Bavka, 2012; Karapetian, Mkrtchyan, Simonyan, 2019).

The etiology of DISH is not completely understood, but it is known that it is associated with elderly age, metabolic disorders, and associated diseases: hyperuricemia and gout, hyperinsulinemia and type 2 diabetes mellitus, obesity (Pillai, Littlejohn, 2014). Paleopathological studies have detected an association between DISH and social differentiation, which indirectly suggests an influence of the lifestyle on its occurrence. The prevalence of DISH in medieval Europe was analyzed based on a large corpus of sources. The markers of the disease are significantly more often detected in the samples from burials of clergy, monks, and benefactors of monasteries, churches, and chapels than from lay burials (Rogers,


1 2

*Fig. 10*. Fibulae.
*1* – enthesopathy in the area of the distal tibiofibular syndesmosis; *2* – hyperostosis of the fibular diaphyses.

*Fig. 11*. Proximal tibial epiphyses displaying marked osteoarthritic manifestations in the knee joints (note the large bone defects of the articular surfaces and the subchondral area; ossified remains of the intraarticular structures; massive coarse ostephytes of various shapes surrounding the articular surfaces).

*Fig. 12*. Ulna and radius.
*1* – ossifying enthesopathy of the capsules of the proximal radioulnar joints; *2* – deforming arthritis of the distal epiphyses; numerous eburnated areas at the distal ends of the ulnae; complete loss of the articular disc and the styloid process of the left ulna.

*Fig. 13*. Right humerus with an ossifying enthesopathy of the articular capsule, massive osteophytes near the tubercles, pronounced narrowing of the intertubercular groove, remnants of an ossified tendon of the long head of the biceps (*1*), and the scapulae displaying hyperostosis and numerous massive osteophytes of the acromial and coracoid processes (*2*).

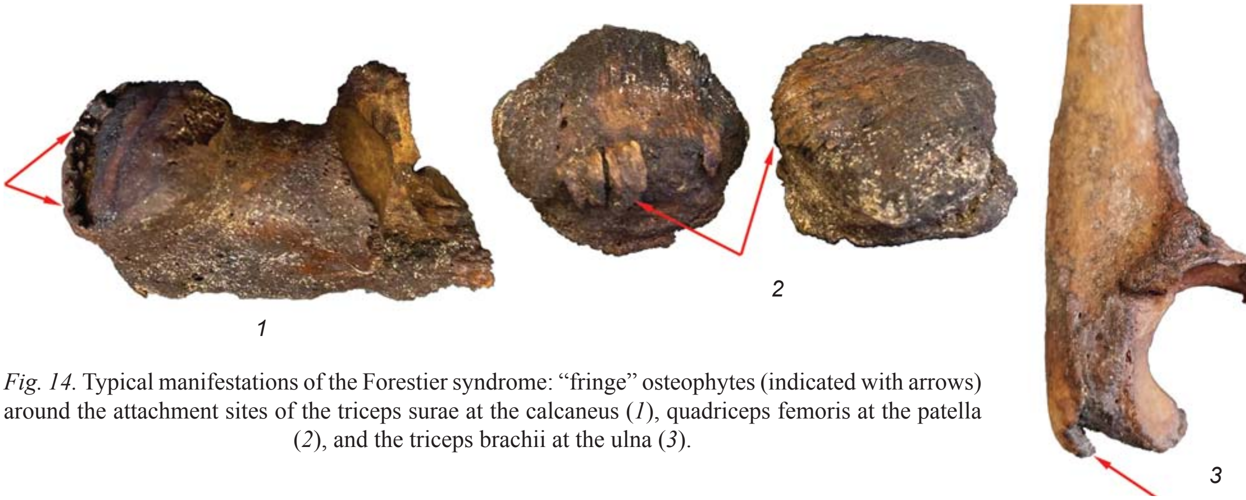


*Fig. 14.* Typical manifestations of the Forestier syndrome: "fringe" osteophytes (indicated with arrows) around the attachment sites of the triceps surae at the calcaneus (*1*), quadriceps femoris at the patella (*2*), and the triceps brachii at the ulna (*3*).


*Fig. 15.* Clavicles (bottom view). *1* – left clavicle with an improperly healed fracture of the diaphysis and an ossified area of the torn coracoclavicular ligament; *2* – right clavicle (unaffected).

Waldron, 2001; Holgate, Steyn, 2016). An analysis of written sources has shown that the monastic daily ration was richer on animal protein and fat, vegetable oil, as well as wine and ale, and more nutritional in general. This could lead to the development of the disease in the individuals predisposed to it (Rogers, Waldron, 2001).

In the studied skeleton, traumatic pre-mortem lesions were detected as well. The diaphysis of the left clavicle displays a consolidated oblique (spiral?) fracture with a substantial displacement of the bone fragments and shortening of the bone by 2 cm (Fig. 15). It was accompanied by some damage to the coracoclavicular ligament, a part of which got ossified during the process of healing. The possible cause of the fracture was a fall on the shoulder.

A rectangular opening 40 × 7 mm in size was detected in the body of the left clavicle (Fig. 16). It is located near the lateral margin of the bone along the line crossing the scapular notch and its lower angle approximately at the level of the 4th and 5th ribs. The

*Fig. 16.* Left scapula displaying a healed fracture.

margins of the lesion are straight and smooth. Possible causes of such defects in the body of the scapula can be pathological processes of an osteolytic character: skeletal metastases, myelomas (Pate et al., 1985: 275), or trauma. The lesions produced by malignant diseases have uneven edges, and other bones of the skeleton are involved in the osteolytic process: the picture we do not observed in the studied skeleton. The trauma of the man's scapula is accompanied by a fracture of the left clavicle due to a fall on his left shoulder, which resulted in hitting his back against a hard object.

A number of cases of healed fractures of the scapular body have been described in the literature (Blondiaux et al., 2012), and can be employed here as a reference. Blondiaux and colleagues have analyzed bilateral fractures and interpreted those as a result of strong repeating blows to the back given during punishments (Ibid.). An examination of the left ribs revealed the presence of consolidated fractures with a relocation of the fractures in their anterior portions (i.e. along the anterior axillary line), as well as damages to the exterior cortical layers of the 4th and 5th ribs, lateral to the tubercles. The observed combination of lesions in the scapula and ribs suggests that the trauma might have been caused by a blow with a flat-faced pick-axe. The trauma was not fatal, because it did not lead to pneumothorax due to a rupture of lung tissue; thus, the fractures have gradually healed.

Manifestations of a traumatic lesion were detected in the right half of the shoulder girdle as well. The remains of an ossified joint capsule and its outgrowths were found in the articular surface of the head of the right humerus (see Fig. 13, *1*). The area of the articular surface is substantially decreased and displays numerous Pommer's nodes along the margin. The upper posterior portion of the surface exhibit an area of eburnation, 25 × 15 mm in size. The surface of the superior part of the greater tubercle is also smooth and partially eburnated. The intertubercle groove is severely narrowed and filled with bone outgrowths and with the remains of a torn off and ossified tendon of the long head of the biceps muscle. These pathological manifestations, together with the trauma of the left bones of the shoulder girdle, were necessarily associated with significant dysfunction of both shoulder joints and severe pain syndrome.

## Conclusions

Our study of the male skeleton from the Pazyryk burial at Ak-Alakha has detected numerous pathologic manifestations that cannot be explained by the elderly age of the individual only. Bone tissue changes throughout a person's life, and loci of bone remodeling are always present in the skeleton. In an adult individual, during a year, approximately 25 % of spongy tissue and 3 % of the compact layer gets substituted by new bone (Avrunin, Tikhilov, Klimov, 2005: 23; Avrunin, Parshin, Abolin, 2006). Any change in the internal structure and shape of bones reflects the adaptation of the skeleton to a specific lifestyle and physical loadings—the main determinant of the bone mass (Riggs, Melton, 2000: 43). Our CT examination has shown a severe disturbance of the internal bone structure of the individual from Ak-Alakha: an almost complete destruction of the cancellous bone of the lumbar vertebrae and pelvic bones, and the development of osteoporosis of the 4th stage. This suggests prolonged inactivity, which might have been a result of the trauma of the shoulder girdle bones, which occurred long before death, and its consequences. Metabolic and endocrine disorders of a genetic nature provoked serious diseases and syndromes, which caused severe sufferings to this undoubtedly strong-willed, courageous, and strong man at the end of his life. These disabilities caused unbearable pain, with some relief coming only in a lying position.

The archaeological context of the burial points towards a high social status of the individual. According to his anthropological features—both craniometric and reconstructed somatological—the origin of this individual was not connected to the aboriginal local populations: a migrant status of his parents can be reasonably assumed. Thus, the individual was not genetically adapted to the conditions of the Altai Mountains. This might be the reason for the large-scale and generalized pattern of the clinic picture of the rheumatologic disease that he suffered, as well as for the extreme severity of the skeletal pathological manifestations.

## Acknowledgement

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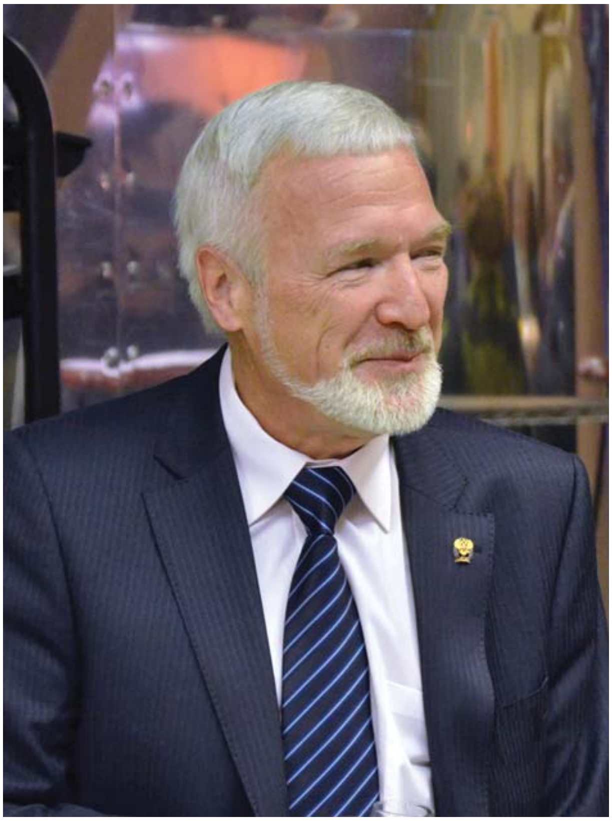
# PERSONALIA

## Academician Vyacheslav Ivanovich Molodin: 75 Years Since Birth and 50 Years in Science



On September 26, 2023, Vyacheslav Molodin—an outstanding Russian scholar, member of the Russian Academy of Sciences, awardee of the State Prize of the Russian Federation, A.P. Karpinskij Prize (Germany), and Demidov Prize—celebrates his 75th birthday. His contribution to science was embodied in 71 monographs and over 1500 articles. Molodin's scholarly interests focus on a wide range of topics: from the Paleolithic to the Modern Age, from cultural to ethnic genesis, from typologies to art-historical analysis and historical interpretation of archaeological sources. The studies of Vyacheslav Molodin on Russian history, staurography, history of Humanities, and problems of higher historical education are also well-known.

The career of Vyacheslav Molodin, who was awarded high ranks and state awards, including the Order of Friendship, Order of Honor, Order of Merit for the Fatherland of the Fourth Degree, evolved from a postgraduate student of extramural program to the Deputy Director of the Institute of Archaeology and Ethnography (IAET) of the Siberian Branch of the Russian Academy of Sciences (SB RAS) and the First Deputy Chairman of the SB RAS (2001–2008). At present, Academician Vyacheslav Molodin is an Advisor to the Director of the IAET SB RAS, Head of the Department of the Late Bronze Age Archaeology, and member of the Presidium of the SB RAS.

Vyacheslav Molodin was born in 1948 in the village of Orekhovo, in the Brest Region (Byelorussian Soviet Socialist Republic), in the family of a border guard officer. His formation was greatly influenced by his parents Vera and Ivan, as well as by the whole way of life on military bases. In 1963, the Molodins moved to Novosibirsk, where Vyacheslav received general education certificate and studied at the Department of History and Philology of Novosibirsk State Pedagogical Institute (1966–1971). As a student, every year he participated in archaeological expeditions and student conferences. Importantly, Vyacheslav Molodin received his first archaeological excavation permit, issued by the Field Research Department at the Institute of Archaeology of the Soviet Academy of Sciences, after completing his third year of university studies. After graduating from university, Molodin entered extramural doctoral program at the Institute of History, Philology, and Philosophy of the Siberian Branch of the Soviet Academy of Sciences, while working as vice-principal in a secondary school in the village of Elban in the Maslyaninsky District, Novosibirsk Region. In December 1973, on the initiative of A.P. Okladnikov, the young specialist was transferred to full-time doctoral program; and in the beginning of 1974, he was hired as junior researcher in the Institute of History, Philology, and Philosophy SB SAS. A.P. Okladnikov set V.I. Molodin a difficult task: to explore the preliterate period of the understudied forest-steppe belt of the Ob-Irtysh region. The painstaking and hard work in the field and in laboratory, as well as the search for new approaches to scholarly research, resulted in the dissertation, "The Neolithic and Bronze Age of the Forest-Steppe Zone of the Ob-Irtysh Interfluve" (1975). It introduced the analysis and periodization of the Neolithic and Early Bronze Age of Baraba and basin of the Upper Ob River—two centers of cultural genesis in the forest-steppe zone. Research work in the first half of the 1970s provided a basis for large-scale study of prehistoric sites in the forest-steppe Ob-Irtysh region.

In 1983, Vyacheslav Molodin defended his doctoral dissertation. His doctoral research was based on his own concept of historical and cultural development of the population inhabiting the Baraba forest-steppe from the Final Upper Pleistocene to the Modern Age (over 13–14 thousand years). This concept incorporated ideas about cultural, ethnic, and political genesis, many of which have not lost their scholarly relevance until now and have been confirmed by new archaeological sources and research carried out by modern methods. During the work on his dissertation, Vyacheslav Molodin participated in field research in the Gobi Desert and Transbaikalia, excavated the Shestakovo Paleolithic site, Aidashinskaya Cave, as well as Forts Ilimsk and Kazym. As a Deputy Head of the Middle Yenisei Archaeological Expedition of the Leningrad Division of the Institute of Archaeology of the Soviet Academy of Sciences, which was headed by M.P. Gryaznov, Vyacheslav Molodin excavated Tagar burial mounds in Southern Khakassia. As a member of a team of specialists, the young scholar participated in archaeological research in Cuba.

During that period, V.I. Molodin published five monographs. His successful archaeological works in the 1970s, tremendous in their scope, were fostered by his effectiveness and dedication to science, excellent organization skills and high responsibility for results and schedule of research, integrity, high intelligence, and honesty—all the qualities typical of Vyacheslav Molodin.

In 1987, V.I. Molodin was elected a corresponding member of the Soviet Academy of Sciences. Changes in his scholarly status and position (since 1983, he acted as the Head of the Bronze Age and Iron Age Archaeology Department) did not affect the pace and results of his research.

The crisis that gripped Russia in the 1990s, only affected the vector of Molodin's research. Without stopping the excavations in Baraba, he spent the major part of field seasons at the sites of the Altai Mountains, which came to his attention back in the 1980s. Vyacheslav Molodin supervized the first excavations of Holocene deposits in Denisova Cave, which resulted in establishing the cultural and chronological sequence from the Afanasyevo to the Modern Age, presented in the joint monograph with A.P. Derevianko. Simultaneously with the work at Denisova Cave, Vyacheslav Molodin excavated Pazyryk burial mounds and studied the unique Kuilyu complex on the Kucherla River.

Vyacheslav Molodin has made an invaluable contribution to the Russian-Japanese project "Pazyryk" as its co-leader. Today, scholarly community and general public in Russia and abroad know about the discovery of burials with mummies in the Altai, in particular, the "Princess of Ukok". The inaccessible Ukok plateau was fully explored in the most difficult conditions of highlands, and its archaeological map, with over four hundred designated sites, was created. Particularly noteworthy is the discovery and research of the earliest rock art of the Final Pleistocene. This find was of fundamental importance for the study of ancient art and cultural genesis of Central Asia and adjacent territories. In the early 2000s, Vyacheslav Molodin, already as the Head of the Joint Specialized Russian-French Laboratory at Novosibirsk State University, returned to the study of the earliest layers of rock art in the Altai Mountains, and later in the Mongolian Altai. The Altai cycle of research by Vyacheslav Molodin was incorporated into the monograph "The Phenomenon of the Altai Mummies". The research at Ukok is unparalleled in the history of Russian archaeology in terms of scale and volume of applying the natural scientific methods, level of technical and instrumental equipment, and variety of experts participating in the study of the evidence from the "frozen" burial mounds. In 2005, for his great contribution to scholarship, including the study of the ancient history of the Altai Mountains, Vyacheslav Molodin and Natalia Polosmak were awarded the State Prize of the Russian Federation.

Vyacheslav Molodin is a proponent of a multidisciplinary approach, and was one of the first Russian scholars who began to introduce geophysical methods into archaeological studies. Excavations at the fortified settlement of Chicha-1 in Baraba, carried out by the joint expedition of the IAET SB RAS and Eurasian Department of the German Archaeological Institute (headed by H. Parzinger), are a good example of the effectiveness of such work. The excavation findings were published in three volumes. The experience of research with participation of geophysicists, geneticists, geologists, etc. was supported by the study of Scythian burials with permafrost in northwestern Mongolia, discovered by the Russian-German-Mongolian expedition (headed by Academician V.I. Molodin, Professor H. Parzinger, and Professor D. Tseveendorj).

A source of particular pride for Vyacheslav Molodin is the Laboratory of Paleogenetics, established jointly with the Institute of Cytology and Genetics SB RAS. Its creation was due to the commitment and perseverance of Academicians V.I. Molodin and A.P. Derevianko. At present, the Laboratory of Paleogenetics has achieved great results in solving the problems related to the emergence of ancient populations and contemporary indigenous peoples of Siberia.

Today, it is difficult to imagine any archaeological works under the leadership of Vyacheslav Molodin without participation of natural scientists. This integration is inextricably linked to international nature of research. Partnership with the Eurasian Department of the German Archaeological Institute resulted in joint field research, exhibitions and international symposiums, as well as publication of monographs and articles. Vyacheslav Molodin was elected a corresponding member of the German Archaeological Institute (1996). The long-term cooperation with French specialists, thematically related to rock art studies, has made it possible to identify the "Kalgutin" style in the rock art of Central Asia. The Vyacheslav Molodin's election as a corresponding member of the Shanghai Archaeology Forum is another recognition of his contribution to international scholarly collaboration. Vyacheslav Molodin's doctoral students, who have defended their dissertations, are the representatives of the younger generation of archaeologists from Russia, Republic of Korea, China, Germany, France, and Kazakhstan.

Science, and the field stage of research in particular, is the meaning of Vyacheslav Molodin's life. His election as a full member of the Russian Academy of Sciences in 1997 did not affect the rhythm of his scholarly activities. Many years of studies have led to the discovery of unique sites in Baraba. This year marks twenty years of research into the Tartas-1 complex. This complex is in many ways superior to the nearby Sopka-2 site, which has gained worldwide fame. It is difficult to list all scholarly achievements of the hero of the day in a short congratulatory essay. In the last five years alone, the Barabinskaya culture of the Early Neolithic in the Baraba region and the Barabinskaya variant of the Pakhomovo culture of the Late Bronze Age have been identified; six monographs have been prepared and published, including two volumes on the Sopka-2 site. Vyacheslav Molodin is also the author of many sections in the first two volumes of the "History of Siberia".

The contribution of Vyacheslav Molodin to organization of science is particularly noteworthy. In 1997, he was elected Deputy and in 2001 First Deputy Chairman of the SB RAS. Since 2007, Academician V.I. Molodin has been the head of the Scientific and Publishing Council of the SB RAS. In 2015, by the decision of the Presidium of the RAS, he was included in the Scientific and Publishing Council of the RAS. Vyacheslav Molodin participated in the work of the Council on Science, Technology, and Education under the President of the Russian Federation (2008–2011), and Council on Grants of the President of the Russian Federation for state support of young Russian scientists and leading scientific schools of the Russian Federation (2014–2018). Vyacheslav Molodin is a member of the Council on the Problems of Social Sciences and Humanities under the Governor of the Novosibirsk Region.

The pedagogical activities of Vyacheslav Molodin should not be overlooked. He is a member of the Board of Trustees of Novosibirsk State University (NSU), Professor and Honorary Professor of Novosibirsk State Pedagogical University (2012). Vyacheslav Molodin headed the Department of Archaeology and Ethnography of NSU, where he is currently a professor, giving specialized courses on the archaeology of Siberia. Vyacheslav Molodin is an Honorary Doctor of Tomsk State University (2017) and a member of its Board of Trustees. Under the leadership of Vyacheslav Molodin, 41 doctoral dissertations were prepared and successfully defended, and 14 post-doctoral works were completed with his academic advisement.

In 2023, the brainchild of Vyacheslav Molodin—Western Siberian Archaeological Unit—celebrated its 50th anniversary. The backbone of the Unit consists of his students, who are proud of and committed to the achievements of the team and its leader.

Science takes the main place in the life of Vyacheslav Molodin, but there is also love, family, and friends. Many colleagues note his civility in communication, complete absence of arrogance, kindness, sincerity, openness, ability to listen to everyone and, more importantly, to hear everyone, and desire to assist in everything. These qualities of Vyacheslav Molodin endear people and attract them to him. The destinies of many people would have turned out completely differently if not for his support and his fatherly warm and at the same time rigorous attitude.

The hero of the day has new field research, scientific quests, hypotheses, discoveries, new books and articles, reports and discussions, and new students ahead. We congratulate Vyacheslav Molodin on his 75th birthday and wish him unquenchable thirst for knowledge and new scholarly achievements, inspirations, and happy moments.

*A.P. Derevianko, A.I. Krivoshapkin, N.V. Polosmak, M.V. Shunkov, V.V. Bobrov, L.N. Mylnikova, V.P. Mylnikov, A.P. Borodovsky, S.P. Nesterov, A.I. Soloviev, A.V. Tabarev, and T.A. Chikisheva*

AN SSSR – USSR Academy of Sciences

BAR – British Archaeological Reports

BION BNC SO RAN – Buryat Institute of Social Sciences of the BNC SO RAN (Ulan-Ude)

BNC SO RAN – Buryat Science Center, Siberian Branch, Russian Academy of Sciences (Ulan-Ude)

GIN AN SSSR – Geological Institute, USSR Academy of Sciences (Moscow)

IA RAN – Institute of Archaeology, Russian Academy of Sciences (Moscow)

IAET SO RAN – Institute of Archaeology and Ethnography, Siberian Branch, Russian Academy of Sciences (Novosibirsk)

IIFF SO AN SSSR – Institute of History, Philology and Philosophy, Siberian Branch, USSR Academy of Sciences (Novosibirsk)

IIMK RAN – Institute for the History of Material Culture, Russian Academy of Sciences (St. Petersburg)

KSIA – Brief Communications of the Institute of Archaeology, Russian Academy of Sciences

SVKNII DVO RAN – Shilo North-East Interdisciplinary Scientific Research Institute, Far East Branch, Russian Academy of Sciences (Magadan)

TIE – Transactions of the Institute of Ethnography

TyumNC SO RAN – Tyumen Scientific Centre, Siberian Branch, Russian Academy of Sciences (Tyumen)

VSEGEI – Karpinsky Russian Geological Research Institute (St. Petersburg)

VSORGO – East Siberian Department of the Russian Geographical Society

YuNC RAN – Southern Scientific Center, Russian Academy of Sciences (Rostov-on-Don)

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